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STATISTICS

OF

MINES AND MINING

IN THE STATES AND TERRITORIES

WEST OF THE ROCKY MOUNTAINS;

BEING THE FIFTH ANNUAL REPORT OF

ROSSITER W. RAYMOND,
UNITED STATES COMMISSIONER OF MINING STATISTICS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1873.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

A report on the Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains.

TREASURY DEPARTMENT,
Washington, February 13, 1873.

SIR: I have the honor to transmit the report of Rossiter W. Raymond, on the Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains.

Very respectfully, your obedient servant,

GEO. S. BOUTWELL,
Secretary of the Treasury.

Hon. JAMES G. BLAINE,
Speaker of the House of Representatives.

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INTRODUCTORY.

WASHINGTON, *February* 8, 1873.

SIR: I have the honor to transmit herewith my report on mines and mining in the States and Territories of California, Nevada, Idaho, Oregon, Montana, Utah, Colorado, Wyoming, New Mexico and Arizona, together with such discussions and suggestions relative to the condition of this industry as are deemed important to the Government and the mining community.

The number of professional men and citizens who have co-operated in the preparation of this report is very large—larger, probably, than in any previous year—a circumstance which constitutes in itself a cheering evidence of the esteem which the intelligent population of the country has come to entertain for the endeavors of the Government to assist at once the general welfare and the special prosperity of mining and metallurgical arts by the diffusion of correct information. Due credit is given, throughout the following pages, for the contributions of these gentlemen. In this place particular mention will be made of a few only (without disparagement of others) who have furnished material of unusual value and amount, and thus rendered the present report in many respects the most practically important of the whole series to which it belongs.

Attention is called to the paper of Mr. Dutken, of Grass Valley, California, (constituting the greater part of Chapter XI,) on the treatment of gold-bearing ores in California. The thorough and trustworthy nature of this treatise is guaranteed by the character and ability of its author, and will be self-evident to the careful student of the text itself. Representing, as it does, the best American practice, it may be accepted as a true picture of the metallurgical and economical results of the stamp-mill process, in its present stage of perfection; and it must be confessed that there is shown to be greater loss in the best mills than has heretofore been supposed by cautious and close observers. The vague assertions of great waste of gold in stamp-mills, which have proceeded from the inventors of new and rival apparatus, or from unsuccessful managers, desirous to shift upon the deficiencies of "the process" the blame of their own failures, have naturally found little credence among practical operators; and experimental tests, as they are usually conducted, involve the serious error of reasoning from reactions and measurements on a small scale to alleged results upon the large scale. But Mr. Dutken's impartial demonstration possesses the required element of method in metallurgical discussions—it is based on working operations extending over large quantities and long periods. In every respect this chapter is recommended to the earnest attention of American mill-men.

The contribution of Mr. Ellsworth Daggett, of Bingham Cañon, Utah (Chapter XIII,) is characterized by the same peculiarity. It is a record of actual practice in smelting the lead and silver ores of Utah; and it is upon such records only that the comparisons may be based, out of which a complete art of American metallurgy can be built up. An example of the immediate practical use to which material of this kind may be put is found in the summary of Mr. Eilers, contained in Chapter XII, which, although based upon data in many respects incomplete, is nevertheless calculated to be fruitful in suggestions of value to metallurgists.

In Part III will be found a full discussion of the dynamics of water in geology and in mining. The natural processes by which gold has been accumulated in our placer and gravel deposits, and the imitation of natural processes by which, in hydraulic mining and in ore-dressing, the valuable material is separated by man from its earthy matrix or its worthless associated minerals, are set forth plainly and comprehensively. The essay (Chapter XVI,) by Mr. Bowman, on the Pliocene ruins of California, conveys the latest knowledge of the origin of the ancient auriferous gravels of the western flank of the Sierra, as obtained by the assiduous and acute investigations of the California geological survey, under Professor Whitney—labors in which Mr. Bowman bore no inconsiderable part, particularly as regards the subject here referred to.

Mr. Waldeyer's account of hydraulic mining (Chapter XVII,) will be universally recognized as the most complete description of this characteristic American industry that has ever been published. As a manual of practice it leaves little to be desired. The wide experience and the sagacity of the author entitle his views and recommendations on various points to the highest respect.

The brief but perspicuous explanation of the principles of ore-dressing (Chapter XVIII,) from the pen of Mr. Ward, is a timely contribution to the very incomplete knowledge of this subject now current in the United States. In view of the growing importance of separation and concentration, as a necessary element in the economy of mining operations, I can only regret that this chapter is so brief. A volume might well be filled with the details of an art so interesting at the present time to the mine-owners and smelters of America.

The subject of the mechanical appliances of mining was ably treated by Professor Blake, in my report rendered March, 1870. In the present volume (Chapter XIX,) I present, with necessarily brief explanations, and without any attempt at critical discussion, a series of engravings, courteously furnished me by H. J. Booth & Co., of San Francisco, which represent the leading patterns, in several important departments, as now in use on the Pacific slope.

Thanks are especially due to several gentlemen who have taken much pains to collect and arrange the statistics of large districts, or whole Territories or States. It is believed that, in all these cases, complete acknowledgment has been made at the appropriate places in the report. If any omission has occurred, it has been unintentional, and will be sincerely regretted.

The intelligent and uninterrupted activity of my deputy, Mr. A. Eilers, has borne visible fruit in the portions of this volume specially credited to him; but its yet greater results, in the form of steady and trustworthy assistance, in all the departments of the work, I can only gratefully acknowledge, without attempting to define.

It is proper to mention also in this place the courtesy of the Union Pacific, the Central Pacific, and the Denver and Rio Grande Railway Companies, and of the stage-proprietors of Colorado, Utah, Nevada, and Idaho, who placed at my disposal the facilities of extensive travel. Wells, Fargo & Co., as in all former years, have shown, through their officers and all their agents, a ready and most sympathetic interest in my work, and have never failed to render efficient help. It will be seen, in several of the chapters of this report, that I have not been able to agree in all cases with the estimates of bullion-product, prepared in January by Mr. Valentine, the accomplished superintendent of the vast express-business of this company on the Pacific slope. But the difference is one of opinion merely, relating to those matters only which do not come within the precise accounts of the express-agencies. So far as the latter are concerned, I believe it is generally admitted that they have never been more accurately systematized than under Mr. Valentine's management.

According to the most careful determinations I have been able to make, the bullion-product of 1872, compared with that of previous years, was as follows:

	1869.	1870.	1871.	1872.
Arizona	$1,000,000	$800,000	$800,000	$625,000
California	22,500,000	25,000,000	20,000,000	19,049,098
Colorado	*4,000,000	3,675,000	4,663,000	4,661,465
Idaho	7,000,000	6,000,000	5,000,000	2,695,870
Montana	9,000,000	9,100,000	8,050,000	6,068,339
Nevada	14,000,000	16,000,000	22,500,000	25,548,801
New Mexico	500,000	500,000	500,000	500,000
Oregon and Washington	3,000,000	3,000,000	2,500,000	2,000,000
Wyoming	......	100,000	100,000	100,000
Utah	......	1,300,000	2,300,000	2,445,284
Other sources	†500,000	525,000	250,000	250,000
Total	61,500,000	66,000,000	66,663,000	63,943,857

* Including Wyoming. † Including Utah.

The items in this estimate for 1872 are discussed in the different chapters of the following report. The decline of more than $2,000,000 in production will not surprise those who are aware how disastrous has been the indirect effect of the prosperity of the more accessible districts upon the mining industry of Idaho, Montana, and Oregon. The placer-miners of these regions have emigrated in large numbers, attracted by the prospect of steady work in the quartz-mines of Nevada and Utah, or have turned their attention to stock-raising, a business which the completion of the Pacific railroads, and the rapid increase of the settlements along the railroad-belt, have rendered exceptionally profitable. The desultory industry which, during a few months of each year, produced from thousands of gulches and bars a large aggregate of gold, has been suspended partly by the causes just named, and partly, no doubt, on account of the exhaustion of much of the ground formerly profitably worked without capital or machinery. But the treasures of these Territories are not exhausted. On the contrary, they have hardly been discovered. When the completion of the Northern Pacific and of various projected branches shall have made Eastern Oregon, Idaho, and Montana as accessible to trade and travel as are Colorado, Utah, and Nevada, it will be quickly made to appear that the mineral resources of our northern belt are as vast and as varied as those of any other part of the country.

The product of 1872 was about equally divided between gold and silver mines, if the bullion of the Comstock is reckoned in the latter class. The amount derived from systematic and permanent operations (quartz and hydraulic mines) is larger than ever; and this circumstance, so encouraging in itself, explains the impression entertained by many who ignore the former extent and present decay of small placer-mining operations, that the total yield of the country was greater. The transition from precarious surface-mining to organized, permanent, and extensive work is going steadily forward. Every year witnesses a substantial gain; and, though the aggregate production may fluctuate, there is no real retrogression, but a constant advance, in this most important industry.

I have the honor to be, yours respectfully,

ROSSITER W. RAYMOND,
United States Commissioner of Mining Statistics.

HON. GEORGE S. BOUTWELL,
Secretary of the Treasury.

PART I.

CONDITION OF THE MINING INDUSTRY.

CHAPTER I.

CALIFORNIA.

Mining for the precious metals has prospered in California during the year 1872. In both vein and placer mines the general record has been a good one. Mr. Valentine, superintendent of Wells Fargo's Express, estimates the yield of the State, for 1872, as follows:

Gold by express	$16,493,922
By other conveyance	1,649,392
Silver by express	232,668
Ores and base bullion	673,116
Total	19,049,098

Other authorities put the figure several millions higher, but I follow Mr. Valentine in his estimates for California and Nevada, though I have not hesitated to dissent from his figures for other regions. Mr. Valentine allows only 10 per cent., this year, for undervaluation of gold and shipments through private hands. The year before he allowed 20 per cent. for this item, but nothing for base bullion (from Cerro Gordo.) I therefore put the total for 1871 some $320,000 higher than his estimate, while for 1872 I accept his figures, not finding any omission in them, and presuming that for the reduction of the percentage of allowance he has had good reason. For the State of California his authority is conclusive. I need hardly say that it is impracticable, with the means at the disposal of the commissioner, to obtain in that State complete detailed returns from individual mines. In consequence of the abundant rainfall of the preceding winter the ditches and reservoirs were not only replenished but the melting of the heavy body of snow on the mountains kept up the supply, prolonging the water-season beyond the usual period. With so much water for hydraulic operations the gold-product has been extremely large from this source.

In the drift-diggings, prosecuted mostly in the beds of the Pliocene rivers, the general results have been equally satisfactory, the miners here, after many years of disastrous experiment, having at last been enabled to determine with more precision the proper levels on which to run their exploratory tunnels. The quantity of gold-dust taken from some of these drift-claims in the past season has been enormous.

In vein-mining, while there are no signal events to be noted, there has been a steady and healthful progress, with fewer examples of failure than were common some years ago, when mills were built and started, only to run for a short time and then shut down, perhaps permanently. Almost every quartz-mill erected in the State during the past year has since been kept steadily running; and several mills previously built, which have been standing idle for years, have again been brought into service. The number of really good establishments of this kind now unemployed in the State is comparatively small.

While the annual product of gold in California has fallen off nearly

60 per cent. from the highest point at any time reached, the population engaged in mining has been diminished in a still greater ratio. In addition to manual labor, capital and skill are at present required, and share the profits that formerly accrued to labor alone. The net gains of the miner are much less now than when he was able to carry on the business without these auxiliaries.

In considering the probable future of gold-mining in this State another element, giving assurance of increased and permanent production is presented in the great extent of the metalliferous territory, the discovery of additional and sometimes novel forms of deposit, and the manner in which certain of our placers may be said in some sense to renew themselves.

The California gold-field, which extends almost continuously over seven degrees of latitude, covering with its longer axis a distance of five hundred miles, includes an area larger than the State of New York. In no portion of this territory have the mines, other than the shallow placers, been exhausted or worked to any great extent. Even in the older and more populous districts few of them can be said to have been much more than thoroughly prospected, the majority not having been opened at all; while in the more remote sections of this gold-field still less work has been done, large districts remaining but partially explored.

Not only are the known mineral resources of the State multiplied by the finding of new localities and peculiar classes of deposits, but many former discoveries of this kind which, having failed to meet the high hopes excited at the outset, had been set down as worthless, are beginning to show themselves possessed of more merit than was at first conceded to them.

As already remarked, the year 1872 has been one of much activity and more than average success in all the more central and populous mining-districts of California. This is especially true of the placer-mines, from many of which the returns have been extremely large.

Quartz-mining.—The business of quartz-mining has been prosecuted with great energy and vigor in all portions of the State. Several new districts have been opened, and will, next year, add their quota to the gold-product. One of the most promising of these districts is in the northern portion of the State, near the Oregon line, in the counties of Klamath and Siskiyou. The development of the Black Bear, Klamath, and other mines elsewhere described, has attracted much attention to this section. The quartz-mines of Brown's Valley, Yuba County, abandoned for several years, have been re-opened with improved machinery. In Grass Valley and Nevada unusual activity prevails, consequent upon the revival of operations in several mines which have heretofore been closed or worked at a general loss. In this class we note the famous Eureka, which is again paying monthly dividends. On the mother-lode mining has also been prosecuted with success. Many of the leading mines of Amador County have been sold at large figures to English companies. At Quartz Mountain, Tuolumne County, the App and Heslep mines have been consolidated, and will be opened to great depth with new and powerful hoisting-machinery. In El Dorado County, the remarkable developments of the Saint Lawrence, Sliger, and Cedarberg mines have given a fresh impetus to mining in this, of late, neglected region. Two of the most noted of the California mines have, during the past year been worked by English companies, having offices in London—the Sierra Buttes, and Plumas Eureka. It has been impossible to obtain any data from these mines, all information being refused;

but it is believed that the product of each has exceeded $250,000 for the year.

Situated in the extreme southwesterly portion of the State is the more recently discovered, but much less extensive, San Diego gold-bearing-quartz district. Brought into notice about two years and a half ago, this section has since made very fair progress, and, with some half dozen quartz-mills in successful operation, gives promise of continued productiveness. Details of the quartz-mining operations of the State are given under the heads of respective counties.

Gold on the northern coast.—The sands of the sea-beach, for some distance along the upper part of this coast and the coast of Oregon, contain a small proportion of gold, and have been worked with some profit for a number of years. This coast, from Coos Bay south for two hundred miles or more, may be termed the gold-coast of the United States. It has been laid off in districts, and claims located and worked under local mining-regulations. The flood-tides bring up the auriferous black sand, which, when sufficiently rich, is gathered and removed when the tide is out, and washed at leisure.

Gold has also recently been found back from the coast, at various distances, and at several localities. From two to twelve miles north of the Coquille, and from one to two miles from the present beach, and 180 feet by measurement above tide-water, is an auriferous deposit of black sand extending for several miles in length, which carries from $2.50 to $40 per ton, the latter figure said to have been attained by experimental working.

This deposit is said to be from 300 to 500 feet broad and 10 to 12 feet thick on its western or sea margin. It gathers to an edge on its upper or northern side, contains logs of lignite and often tasteless gum-resin. It is covered with from 40 to 60 feet of drift-sand, much of which is like soft rock, and this, again, is covered with a heavy forest, many trees being from 4 to 6 feet in diameter, and 50 to 200 feet high. This timber is heavier further back and lighter toward the sea. Further particulars of these deposits will be found in the chapter on Oregon.

Quicksilver in California.—During the past year great attention has been paid to the prospecting and development of quicksilver-mines, resulting in the discovery of many promising lodes, and warranting the belief that the future production of this valuable mineral will be greatly increased. In no other part of the world has cinnabar, the common ore of quicksilver, been found so widely disseminated as in California. Outside of California, and until the California discoveries, the world had depended almost wholly upon the old Almaden, of Spain, and the Idria, of Austria, for this important requisite in the collection of its metallic wealth. The old Almaden quicksilver-mine of Spain, it is well established, was worked seven hundred years before the Christian era, and is still producing more than any other.

The Mining and Scientific Press, of San Francisco, thus speaks of the present condition of quicksilver-mining in the State:

> California, among its numerous mineral advantages, possesses the broadest fields of this necessary article in the world; and by far the most prolific of its mines is the well-known New Almaden, in Santa Clara County. As it may be interesting to know the amount produced from this mine yearly, as the representative one of California, the following figures will show it, in flasks, premising that the flasks contain 76½ pounds of quicksilver.
>
> In 1851, the number of flasks produced was 23,875; in 1852, 19,921; in 1853, 18,035; in 1854, 26,325; in 1855, 31,860; in 1856, 28,183; in 1857, 26,002; from July, 1857, to October, 1858, 39,935. From that time to February, 1861, the mine was closed by injunction. From February, 1861, to January, 1862, it produced 34,765 flasks; in 1862, 40,391; in 1863, 19,564; in 1864, 46,216; in 1865, 47,194; in 1866, 35,150; in 1867,

24,461 flasks; in 1868, 25,628; in 1869, 16,898; in 1870, 14,000; and in 1871, 18,763 flasks. Total up to January, 1872, 537,176 flasks, each containing 76½ pounds of quicksilver.

The New Idria mine in Fresno County produced, in 1866, 6,045 flasks; in 1867, 11,500; in 1868, 12,300; in 1869, 10,450; in 1870, 10,000; and in 1871, 9,227 flasks. The Redington mine, near Knoxville, Lake County, produced, in 1866, 2,980 flasks; in 1867, 7,145; in 1868, 8,700; in 1869, 5,000; in 1870, 4,546; and in 1871, 2,128 flasks.

Among the other mines whose product goes to swell the gross amount are the Guadalupe, in Santa Clara County, owned in Baltimore, Maryland; the Josephine, in San Luis Obispo County, owned by Barren & Co.; the Enriquita, owned by the Almaden, and the Bautista, owned by the Almaden, and now idle, both in Santa Clara County. The Pioneer is in Napa County; the Whitton is in Napa County, and there is one at Oakville; the Vallejo mine is in Solano County; the Manhattan, or Knox & Osborne mine, is three miles from Knoxville, in Lake County; the California is in Yolo, and there are several in Pope Valley near Napa; the Abbot mine is in Lake County; Excelsior in same county. There are several in Monterey, one of which is called the Pennsylvania, which produced a small quantity, and one owned by McGarrahan, not now being worked. There is one at Mount Diablo, Contra Costa County, which produced a small quantity, but is now in litigation. An occasional flask comes from the San Luis Obispo mines. The Riotte and Luckhardt mine is at Saint Helena, Napa County. The Phœnix, in Pope Valley, Napa County, produced, in 1870, from a partial working, only 7 flasks. There is also a mine in San Bernardino County, and several recent discoveries in Napa and Lake Counties, and a number are spoken of, from which we hear little, in the Coast Range, from up north down to San Bernardino County. The total product from all the California mines mentioned, for the last three years, has been estimated as follows: in 1869, 36,600 flasks; in 1870, 29,546 flasks; and in 1871, 31,881 flasks.

The total monthly product at present is said to be not over 3,100 flasks, of which the New Almaden furnishes 1,600, the Redington 600, and the New Idria 600, and all others 300.

The mines and works of the New Almaden, in Santa Clara County—the leading quicksilver-mine of California—have been repeatedly described by travelers, as well as in former reports of the Mining-Commissioners. The New Idria, in Fresno County, though but slightly inferior in production at the present time, is not so well known. The following description of this valuable property is from a recent number of the Fresno Expositor:

In 1856 a party prospecting for silver in the southwestern part of Fresno County—the present location of the New Idria works—discovered a deposit of chromate of iron, which they supposed to be a silver-deposit, and for some time worked it as such before finding out their mistake. Here the party separated, some going one way and some another. Some of the party shortly after discovered cinnabar at the San Carlos mine, and at about the same time ore was found at the Idria mine, proper, in the company's grounds. Among the company's mines are the Idria, San Carlos, Aurora, Molino, Washington, Benada, and Victorener. The largest amount of work has been done in the Idria mine, proper. San Carlos has produced well and been quite extensively worked. The San Carlos mine is several hundred feet higher than Mount Diablo, and is the highest point in the range except San Benito, (misnamed on the maps of California, being named Panoche Peak,) which is quite near. San Carlos is 4,977 feet high, and Mount Diablo 3,876, and San Benito Peak still higher than San Carlos. The workings consist of tunnels, with communications by shafts from level to level, to a depth of 600 feet. The company are now engaged in erecting machinery, probably the heaviest of its character in the State, for the purpose of sinking 500 or 600 feet lower. The new machinery is being put up at a point 1,000 feet under ground. In the Idria (proper) the under-ground work will probably measure four miles. The mine has been producing constantly since 1857. The process for reducing the ore consists of thoroughly roasting the ore in furnaces holding from 50 to 60 tons, and the vapors (quicksilver at a temperature above 80° of heat passing off in vapor) condensed in large brick condensers, where it comes in contact with cold air. These condensers consist of a series of twelve to sixteen large brick compartments, having a single opening in each wall through which the smoke of the fuel and the vapors of the ore pass, finding their way to the chimney, before reaching which the quicksilver is supposed to be precipitated, and the wood-smoke finds its way out. The chimney alone is an institution worthy of note. It is built on the slope of the hill on which it rests, and is large enough to admit the passage of a man comfortably from top to bottom. The quicksilver rarely if ever reaches the top of the chimney.

Cases of salivation are frequent among the men engaged about the furnaces, caused by inhaling the mercurial vapors. These men handle the ore in a heated state, and tie heavy bandages over their mouths and noses to prevent the inhalation of mercurial fumes, and even with this precaution they are frequently salivated.

The numerous mines of cinnabar in Napa County are reported to be in a promising condition. Valley mine has yielded 13 flasks within a month, and the Washington, with a force of five men, has yielded 28 flasks, and a net profit of $1,000 within the same period. The Phœnix has 4,000 tons of ore on hand, and has just resumed the work of reduction after a stoppage of four weeks for the modification and repair of its works. It is now prepared to furnish a large and continuous supply of quicksilver. The Oakville is also successful in operation. The Whitton mine, lately sold for $45,000, is awaiting the erection of the reduction-works. The Valley Mining Company have completed their reduction-works, which promise to be very effective in the reduction of quicksilver-ores. The tests recently made of low-grade ores in their new and superior furnace are most satisfactory. Ores which have hitherto been considered as worthless have by the effectual process here introduced been made to yield satisfactory results. The new furnace has a capacity of 80 tons, and when thoroughly seasoned will be capable of reducing at the least computation 20 tons per day. The condensing-apparatus, which form so important a feature in the reduction of quicksilver-ores, are of the most improved and satisfactory kind, are kept cool by copious streams of cool water, and the mercurial vapors effectually condensed. The whole of these works bear the impress of careful and economical management. The company have about a thousand tons of ore on hand, and with the application of new machinery on their mine, they expect to have a continuous supply of ore for the furnace.

The Silver Bow mine is yielding a good supply of metal, and when consolidated with the Valley mine enterprise will be a very valuable property.

ALPINE COUNTY.

On the eastern slope of the Sierra Nevada, within California geographically, but geologically allied with Nevada, there are several mining-districts of importance, concerning which, by reason of their remoteness, less is said in the public press or heard from travelers than they deserve. They are comprised in the counties of Alpine, Mono, and Inyo. I am indebted for valuable notes on Alpine County to Mr. Lewis Chalmers, the able and courteous manager of the Exchequer Company in that county.

Since the spring of 1871, when the same gentleman wrote for my report of that year a brief notice of the mining-industries of Alpine County, considerable progress has been made in their development.

Silver Mountain district contains the county-seat and is topographically the highest of the mining-camps, the town of Silver Mountain being 7,000 feet above sea-level.

In this district the Exchequer Gold and Silver Mining Company, of London, limited, is one of the leading enterprises. At the head of Scandinavian Cañon, about two miles north of the town, 1,380 feet above the level of Main street, this company has been at work since February, 1870, when it bought the then undeveloped Buckeye No. 2, and Acacia mines. It has driven a main tunnel 900 feet, sunk on the ledge 140 feet from the tunnel, raised 128 feet of air-shaft, and run 912 feet of drifts in various directions, chiefly on the ledge. From several stopes some very rich ore has been taken out and milled at Reno and at the company's mill. The Reno ore gave $140 per ton, in bullion 0.901 fine. For 60½ feet the ledge, which runs N. 17° W., dipped E. 76°. At that point the dip changed to 53° 30′, which it maintained for 75 feet, when it flattened to 64° 45′, and continued so to the 140 level.

The country is an eruptive porphyry, changing in places to clinkstone or phonolite, bars of which are very hard and make slow sinking. The works above enumerated have developed a strong lode, beautifully cased with clay selvages between highly polished walls.

The ore is an antimonial sulphide, (ruby-silver, both light and dark,) mixed occasionally with silver-glance and the black sulphuret; matrix, quartz. About 200 feet from the mouth of the main tunnel, in a cross-cut to the hanging-wall, and 25 feet from the foot-wall, a vein was struck, of pure white gold-bearing quartz interlaid with veins of sulphurets, a piece of which yielded, gold, $2,542.41; silver, $5.16; total, $2,547.57 per ton.

Having thus thoroughly opened the ground to a depth of 240 feet, the manager felt justified in recommending hoisting-works and a main shaft, for proper working. Since his return from London last June, machinery has been put up, capable of sinking 600 feet, and buildings to accommodate any extension which deeper working may in time demand. The main building measures 30 by 50, and 20 feet from floor to roof-plates, the roof being on a steep pitch; the carpenter's shop 20 by 22, with blacksmith's shop adjoining. The hoisting-frame is 24 feet high, with double sheaves. The engine is one of Bacon's double-cylinder hoisters, built by the Speedwell Iron-Works, of Morristown, New Jersey. The hoisting is done smoothly, at the rate of 100 feet in 34 seconds. Having no dead-center, the load can be started, stopped, or reversed at any desired point by simply turning a short lever. Pumping is done by one of Blake's steam-pumps, capacity 1,780 gallons per hour, which gives great satisfaction, and has the recommendation of occupying little room in the shaft. The engine-shaft measures 10 by 5 feet in two compartments. Water at present, 8,760 gallons in twenty-four hours, chiefly from thawing snows on the surface. The new shaft is 350 feet farther down the cañon than the main tunnel, and so placed that the floor of the hoisting-works is almost on a level with the bottom of the old incline, thus saving 140 feet of sinking and hoisting.

A strong tram-way and chute convey the ore from the upper works to the ore-dump on the road, 240 feet below the tram-way, whence it is hauled by teams to the mill on Silver Creek, about four miles distant.

This is the old Davidson mill, which was purchased by the company chiefly on account of its admirable situation, timber, and water-power. Built on the Freiberg barrel-amalgamation system, crushing dry, and roasting in the old reverberatories, it proved so expensive (though the process was efficient and the bullion 0.976 fine) that nothing but the highest grade of ore would pay to work, with labor at $4 per day and skilled labor $6 to $8. The ore appeared so free from base metal that it occurred to the manager to experiment with wet-crushing and pan-amalgamation without roasting. Accordingly several tons were worked at the Tarshish mill, Monitor, which returned 68 per cent. of the assay; and the company's mill is now being converted into a wet-crusher. The barrels have been taken out and replaced by four Hepburn pans, with steam bottoms, the wooden settler by two 8-foot iron settlers, and a "clean-up" Knox pan on the same floor; the old frame, which was good, has been provided with new mortars, new mortar-blocks, new foundations, new cam-shafts, cams, stems, and tappets. Large additions were made to the mill to give room for sand-tanks and ore floors. The excellent 40-horse engine of the old works remains. It is believed that the cost of milling, including loss of quicksilver, will not exceed $5.64 per ton; extraction will cost $2, and hauling $2; in all $9.64, say $10 per ton. Concentration will be effected by one of Rickard's patent amalgamating concentrators, the inventor of which claims that it will enrich $12-tailings to $60. A retort-house, and an excellent assay-office, with melting-furnaces, are provided. The capacity of the mill is 16 tons in twenty-four hours.

Close by the mill is a circular-saw mill, with two saws, driven by a 60-horse turbine. Last fall, 370,000 feet of lumber were sawed for mine-timber and buildings. The company owns its own teams, which leave the mill with lumber for the mines, and return from the mines with ore for the mill. The ore assays all the way from $15 to $200. Specimens give $2,000 to $3,000. So soon as the engine-shaft is down to the 140 level, the manager expects to be able to furnish the mill with 16 tons a day.

Another English company, the I X L Gold and Silver Mining Company, limited, having purchased the I X L mine, 1,700 feet lower down the cañon, (which in 1862-'63 created no small excitement in mining-circles and gave birth to the town of Silver Mountain,) is busily at work also sinking an engine-shaft, now 110 feet deep. Hoisting-works have been erected, duplicates of those at the Exchequer. At the 200 level, stoping will commence, and appearances in the old workings warrant the expectation of 20 tons a day. Some of the ore is of very high grade; $50,000 was extracted from a very limited stope in the old works by former owners. A fine specimen of native silver from the lower tunnel, and a piece of pure ruby-silver, as large as a pigeon's egg, were exhibited from this mine in London. An expert cannot distinguish some of this ore from Yellow Jacket ore on the Comstock lode.

An analysis of I X L ore, (mostly native silver,) gave:

Gold	0.004	Alumina	2.700
Silver	0.551	Lime	0.700
Copper	0.080	Water	0.720
Lead	0.060	Silica	91.762
Antimony	0.010	Loss	0.013
Zinc	0.050		
Oxide of iron	2.600		100.000
Sulphur	0.750		

Twenty-four pounds of I X L ore gave—

Pure gold	6.720 grains.
Silver	925.650 grains.

Equal to £51, or $250 per ton of 20 cwt.

Nine pounds of Buckeye ore gave—

Gold	1.575 grains.
Silver	233.887 grains.

Or about £34 = $170 per ton of 20 cwt.

The company has purchased a convenient site on Silver Creek, with ample water-power, and will erect a mill this fall, should the shaft developments justify it. Unlike many American mines placed on the London market, the two above described have not been burdened with excessive nominal capital; and it may reasonably be expected that another year will find both of them on the dividend-paying list.

The only other mine now worked in this district is the George Washington, lately re-organized in Chicago. Two men only are at work at present, but it is said that a full force will soon be put on.

Monitor and Alpine districts.—Six miles north of Silver Mountain, on the toll-road to Carson, is a small mining-town called Mount Bullion, through which runs the East Fork of the Carson River, separating the Monitor and Alpine districts.

On the Monitor side, the Imperial Company, of London, has driven a large double-track tunnel 1,406 feet through hard porphyry, to cut at right angles a series of parallel lodes. The work is now within 300 feet of the second ledge. Indications are reported promising, but the company has suspended work until the success of those mentioned above shall give fresh encouragement. The facilities for cheap mining and milling are at this point very good. The ledges are ten in number; the tunnel's location extends from the river to the center of the town of Monitor, 6,207 feet.

On the Alpine side of the river, the Mount Bullion Company, of London, has run more than 2,000 feet of tunnel, under the superintendence of Mr. Coulter, and expects to cut its first ledge in from 200 to 300 feet.

Half a mile down the river, the Monitor and Northwestern Company is running a tunnel from the Carson almost parallel to the Imperial tunnel, with the view of intersecting the same series of ledges, which appear very distinctly on the northwest side of Monitor Creek, the boundary between the two companies. This company has built a 10-stamp mill close to the tunnel-mouth, but has not yet cut its first ledge.

Returning to Bullion, leaving the main road on the right, and proceeding up Monitor Creek toward the town of Monitor, (a mining-camp with a present population of about 200,) we reach the Globe Gold and Silver Mining Company's mine and mill, on the right or eastern side of the creek. This company, under the superintendence of General Winchester, has done a considerable amount of work. About 300 feet from the mouth of its tunnel was struck a bunch or *Stockwerk* of gray sulphide of copper, some of which assayed as high as 37 per cent. copper, and $20 in silver, with a trace of gold. On this the company commenced sinking, but had got down only 30 or 40 feet when the water proved too much for the machinery. The company is driving the main tunnel to the ledge, which is on the same belt as the Imperial, and which is expected to be struck in 60 or 70 feet. The mill has been run only experimentally.

On the western side of the creek, and within a few hundred yards of Monitor, is the Monitor and Northwestern Company's silver-glance claim. On this the company has run 300 feet of tunnel, drifted west, and found small pockets of rich ore, chiefly silver-glance and black sulphuret, but not, it appears, in quantity sufficient to run their mill at Bullion steadily. They are now sinking from this west drift, and find, occasionally, bunches of high-grade ore. A tram-way from the mine leads to an excellent ore-house.

We now come to the Tarshish, the representative mine of Monitor, situated on the outskirts of the town, and belonging to the Schenectady Silver Mining Company. Considerable work has been done on this mine since the year 1863. The vein-matter, consisting of a highly metamorphosed laminated sandstone, lying at an angle of about 80°, has been cut by both upper and lower tunnels, at about 450 feet in the former and 900 in the latter. An incline has been sunk 225 feet, connecting the upper with the lower works. From this incline drifts have been run north and south, on the course of the ore-deposit, which can be traced on the surface for a mile, all of which have yielded more or less ore, generally in clayey pockets. From one of these pockets $10,000 was taken in rich black sulphide, which was washed by hand-jiggers, and sold in San Francisco for $2,000 per ton. From the upper tunnel about

1,500 tons of ore have been extracted, the greater part of which still remains on the dumps. It assays about $30, and came principally from an excavation raised from this tunnel some 80 or 90 feet. The ore is an argentiferous zincblende, averaging about 7 per cent. of zinc, and carrying about one-third of its value in gold. It also contains a quantity of iron-pyrites with traces of copper-pyrites. The pink carbonate of manganese is met with in the hard rock in the vicinity of the rich clay pockets. The country-rock is a soft, greenish-blue porphyry.

A 20-stamp mill was erected in 1872, with a White's revolving roasting-furnace. Three hundred tons were worked, when operations were suspended in consequence of the furnace failing to do its work, the chlorination not exceeding 47 per cent. of the assay value. Wet crushing was then tried, but abandoned, the clayey nature of the ore preventing its settling in the tanks. The funds of the company being exhausted, the mine and mill are at present idle, with the exception of two miners engaged in explorations from the lower tunnel. The work of these two men has shown that the ore is increasing in quantity below the level of the tunnel; and it is the intention of the company to erect hoisting-works this spring, it being the general opinion that this mine will prove a good investment if properly worked in depth.

Mogul district.—Of this district, lying north of the Monitor, the Morning Star used to be the representative mine. It has not been worked for three or four years. Good cupriferous silver-ore, associated with a very large amount of iron-pyrites, has been from time to time taken out and sold in San Francisco at from $100 to $150 per ton. A parcel sent to Swansea sold as high as $300 per ton. There is a very complete set of steam hoisting-works and pumps, and it is said work will soon be resumed.

The leading mine of this district at present is the Leviathan copper-mine, for a full description of which I am indebted to Mr. W. T. Rickard, F. C. S., of London. I give his account in full:

The Leviathan mine is situated five miles north of the town of Monitor, in the Great Mogul mining-district. The property is covered by fine timber, and the Leviathan Creek running through the claim, and communicating with the Carson River, furnishes an abundant supply of pure water all the year round. Following the course of this creek, a toll-road has been surveyed, which, when completed, will enable the mine to ship ore at all seasons of the year, at very moderate rates, to the San Francisco market, via the Central Pacific Railroad branch through Carson, an extension of which is expected to be made shortly to the Aurora and Cerro Gordo districts, which will then place the Leviathan within twelve miles of railway communication—a most important feature in copper-mining operations.

The claim consists of 3,800 feet, running north and south, having an average surface-width of 1,000 feet; the geological formation being metamorphic sandstone, which can be traced over two miles in a north and south direction, beside other outbursts in different parts of the locality, all of which are more or less metalliferous. This sandstone reposes on a formation of blue clay, with water-worn bowlders of trachyte, varying in size from a pebble to masses of several tons' weight. The formation dips 30° E. The west country-rock is trachyte, that on the east gray porphyry.

This mine was opened in 1863 by some poor working miners, who drove in a tunnel about 400 feet, with an air-shaft some 150 feet beneath the croppings. Finding neither gold nor silver, and not considering the copper which had been struck worthy of attention, they abandoned the undertaking, and it remained in abeyance till 1869, when operations were resumed by the late Edward Dorsett, of London, under my superintendence, with a view of developing the very promising indications for copper. This work has opened out an immense deposit of unusually rich ore, two-thirds of which have proved, from sales of some 500 tons taken out during the exploratory operations, to carry over 30 per cent. copper. The quantity now in sight has been variously estimated, by some of the best judges in California and Nevada, at from 1,500 to 2,000 tons.

With a view of draining the upper works, and taking out ore to better advantage, a second tunnel has been run, 176 feet below the upper one. This is now in 928 feet, An incline also has been started to connect the two tunnels, and is now completed within 30 feet. When the connection has been effected, perfect drainage and ventilation will be secured; and it is estimated that a minimum of 10 tons per day can be taken out for $2 per ton.

Up to the present time the explorations in the upper tunnel have not reached the boundaries of the first deposit struck in 1863, though it has been opened out to a circumference of 300 feet horizontally on the floor; and for 60 feet down the incline, ore of 55 per cent. copper, connecting with the same deposit, (bunch or *Stockwerk*,) has been gone through, from 3 to 5 feet in thickness. Twenty-five feet below this is a stratum of sandstone, 20 feet thick, impregnated to the extent of 26 per cent. with pure sulphur.

The copper is mineralized in the form of silicate, black and red oxides, and gray sulphide, with metallic copper in a finely-divided condition. The sulphide predominates in depth, and the oxidized ores near the surface, while over all is found the customary deposit of red oxide of iron, (the "iron hat" of the Germans.)

In addition to the large deposit discovered in the upper works various other deposits or bunches have been found in other portions of the sandstone, which appears mineral-bearing from the croppings to its lowest part, resting on the clay and bowlder formation, a thickness of more than 300 feet, evincing thus its identity with those practically inexhaustible deposits of copper found in the celebrated sandstone formations of Bolivia and the Isle of Anglesea.

In consequence of the death of the late enterprising proprietor, operations are at present suspended; but it is expected they will soon be resumed by an English company, with sufficient capital to complete the opening out of the mine, and erect bluestone works for the purpose of utilizing the low-grade ores, which cannot at present be shipped to advantage.

The existence of an apparently unlimited supply of sulphur for the purpose of manufacturing the sulphuric acid required for producing the bluestone, and the absence of lime in the matrix, together with the unusually small proportion of iron found in the ore, offer peculiar advantages for the manufacture of sulphate of copper on the spot, whence it can be delivered to the Washoe market at a cost not exceeding one cent per pound, and find a ready sale to the extent of from 5 to 7 tons per day.

The Leviathan mine has been nearly self-sustaining for the last two years; the ore taken out in merely exploratory operations having realized over $30,000 by sales to the bluestone manufacturers of Nevada and California. The production of bluestone at a cheap rate, within fifty miles of Virginia City, will doubtless prove a great boon to the Comstock mines, the economical reduction of these ores being greatly dependent on the liberal use of this indispensable article, particularly in reworking tailings.

It may be mentioned in conclusion that copper has been found in a north and south direction in the Pine Nut range of mountains and its spurs, forming the eastern boundary of Carson Valley, all the way from near the town of Dayton to the Leviathan mine.

Up to a recent period the mines of Alpine County have been mostly owned by poor miners and others, who, unable or unwilling to work themselves, have steadily refused to sell unless at highly exaggerated, in fact ridiculous prices. Tired of playing this part they at last offered inducements to Eastern and English capitalists, who found the mines totally undeveloped. This will account for the time which has elapsed since the discovery of the mines without the achievement of satisfactory results.

MONO COUNTY.

This county contains the following mills: The Pioneer, at Montgomery; an arrastra, barrel, and lavadero roasting-furnace now being added; run by water-power; worked last summer 125 tons of ore, assaying from $100 to $700 per ton; average $247 per ton. Extracted about 85 per cent. of assay, and paid well. Also worked over about 100 tons of tailings. Riley's mill, also in Montgomery; small stamps and pans; run by water-power; formerly profitable, idle and dilapidated now. A small mill at Hot Springs, owned by J. Partz; four small stamps; barrel and separators; water-power; process same as Pioneer mill, working about a ton a day, and fairly profitable. W. J. Williams & Co.'s mill was built in 1871; steam-power, ten stamps, two pans, two separators, and a White's furnace.

One of the most important mining enterprises of Mono County is that of the Dunderberg Mining Company, of San Francisco. The Dunderberg mine is situated at Castle Peak, on the head-waters of East Walker River, formerly a placer-region of some note. It was discovered and located by Charles Snyder & Co. several years ago, and was afterward purchased by Dr. George Munckton and others, of Carson, Nevada. When they made the purchase a shaft had been sunk on the ledge to the depth of about 40 feet, from which were taken about 100 tons of ore. Three tons, of an average grade, were hauled to Aurora, about thirty miles, which paid by mill-process over $50 to the ton, being about three-quarters gold and one-quarter silver—the bullion being worth $4 per ounce. Munckton & Co. then started a tunnel, which has been run a little over 600 feet in length, which taps the ledge about 250 feet from the surface. They then cut across the ledge 34 feet, but failed to find the hanging or west wall, (the ledge running north and south,) but being in vein-matter the whole distance. On the foot or east wall there were about 5 feet of solid quartz, the bottom being more or less mixed with porphyry and slate formation. The company then ran drifts both north and south along the foot-wall for about 300 feet, which does not vary a foot from a straight line the whole length. They found continuous quartz the whole distance, varying in richness. A stope, started up over a portion of the richest ore, did not hold out as good as it was below, showing that to get out the richest ore in large quantities it requires greater depth. Several hundred assays made by the company for their own private use, to see what to select and what to reject in running other drifts, averaged nearly $100 to the ton. Reduction-works were erected some time ago, when it was found that to work that rich ore closely the amalgamating part of the works required a change. It is the intention of the company to make several cross-cuts across the ledge to the west or hanging wall, and to sink deeper on the ledge, where they are confident of taking out rich ore. It is estimated that the ore can be mined and milled for less than $10 per ton.

INYO COUNTY.

The gold-mining industry in this county has always been greatly inferior to that which has, within the last few years, sprung up in connection with the silver-mines of Cerro Gordo mining-district. Still, the usual limited activity has been displayed by a few Mexicans, who work, in a dilatory way, gold-mines situated some fifteen or twenty miles southeast of the southern end of Owen's Lake. They work altogether with arrastras, and sell their product, amounting to a few thousand dollars a year, from time to time at Lone Pine. The mills erected several years ago at the base of the Sierra Nevada, southwest of Lone Pine, one of them a large establishment, are idle.

The lead and silver mines have done better than ever before, as will be seen from the production during the year given below. Although one of the works, that of the Owen's Lake Silver-Mining Company, was compelled to stop smelting during a great portion of the year, its furnaces having been shaken down by the severe earthquake of March 26, 1872. The shipments of bullion from Cerro Gordo district exceed those of the previous year by over 1,000 tons. These works are located on the east shore of Owen's Lake, in the valley, and stand on ground which subsided from two to five feet during the disturbance. The works are by this time rebuilt and enlarged, there being now three shaft-furnaces instead of the two formerly in existence. But the shaking down of the furnaces, which were in blast at the time, and therefore came very near burning the buildings, was not the only damage done here by the earthquake. A permanent inconvenience is the fact that since the occurrence of the phenomenon, water is encountered in the floor of the building upon even digging to the slight depth required for lead and slag basins outside of the furnaces. The difficulty was overcome by inserting iron kettles into the excavation necessary for the metal-basin, and by using iron pots to remove the slag.

The mines which have furnished almost exclusively the ore for the three smelting-works in the district are the Union, Santa Maria, and Belmont. The two former have furnished the lead-ores, while the latter, together with half a dozen smaller mines, yielding irregularly a few tons, has produced the cupriferous silver-ores, added to a greater or less extent to the charge in all the works. The San Ignacio and San Lucas, both favorably regarded in previous years on account of rich and large ore-bodies near the surface, are now idle, the known bodies being worked out and new ones not having been discovered. It should, however, be said, in justice to these mines, that the work of exploration has not been extensive nor carried out with much ability.

The Santa Maria and Union are situated on the western slope of Buena Vista Mountain, directly above the mining-town of Cerro Gordo, from the streets of which some of the tunnels, driven into these two deposits, have been started. Both deposits run on top with the strata of the country-rock, crystalline limestone, and clay-slate, and approximately with the axis of the mountain. They were formerly known also as Freiberg Nos. 1 and 3, but lately all interests in the two deposits have been consolidated, so that at present the Union is owned by Messrs. Belshaw, Judson, Beaudoy, and others, while the different interests centering around the Santa Maria have all been gathered in the hands of the Owen's Lake Silver Mining and Smelting Company of New York.

The Union, the highest on the mountain-side, has undergone considerable development during the past year. On the surface the ore-body strikes about S. 30° E., and dips steeply to the southwest. But at the level of the main working-tunnel, which strikes the Union at a depth of about 175 feet from the surface, the ore-body begins to stand nearly perpendicularly, and continues so for a depth, below this level, of 165 feet, the lowest point reached in September, 1872. At a depth of 200 feet below the tunnel a branch leaves the main ore-body toward the west. Its dip is very flat, and it has been followed over 100 feet, always in very excellent ore, the greater part of which is galena. This branch is about 3 feet thick. It is thought and hoped by the owners of the Union that it will eventually run into the Santa Maria; and as the Union has the older title, the independent existence of the Santa Maria would in that case be endangered. The longest level on the vein in the whole mine is the one driven at a depth of 200 feet below the tunnel, and even this one is little over 100 feet long. But the ore-deposit, as developed by this level, and the work done in the 65 feet below, is of extraordinary extent, being in many places 40 feet wide and nowhere less than 15. At the same time the ore is very solid, being either reddish-yellow carbonate, or pure gray carbonate, lying in great blodges in the former. The masses of the latter kind have frequently a diameter of from 3 to 6 feet, and always show a concentric arrangement; *i. e.*, every mass of this kind, which has been cut through by the excavations, shows concentric rings around an interior nucleus, (generally a small lump of unaltered galena,) the rings being somewhat darker than the main mass. This arrangement presents a beautiful aspect, and though common with gray carbonate of lead, when lying in a ferruginous gangue, it is not often seen on as large a scale as exposed in the Union. The carbonate-ores of the Union, on account of their friability termed "fuse-ores" by the miners, average, as delivered to the furnace, about 25 ounces of silver per ton, and the galena from 50 to 80 ounces.

The Union is sufficiently opened to show a really very large amount of ore ready for stoping and raising, but the facilities for bringing it to the ground were, up to the fall of 1872, very limited and entirely inadequate to the resources of the mine. The main shaft starts, as mentioned before, from the level of the tunnel, which strikes the ore-body 175 feet below the surface. To this point the ore is raised in buckets by horse-power; here it is dumped into cars, and taken through the tunnel to the surface, where the fine ore is separated from the galena before transportation to the furnaces. During the latter part of the year, I am informed, the owners erected steam hoisting-works, which were in successful operation at the end of the year. The furnace belonging to Belshaw and Judson is not more than 150 yards distant from the mouth of the main tunnel. It is built on a slightly higher level than that of the tunnel-mouth, and in a saddle of the main ridge of Buena Vista Mountain, so that it actually stands on the very water-shed. The back of the ridge here is not over 150 feet broad, and from the furnace-door one can look into the valleys on both sides of the ridge. If it was one of the objects of the owners, in locating the furnace here, to secure sufficient dumping-ground for the slags, they have assuredly most amply succeeded, for there is probably no smelting-works in the world which stand so well provided for in this respect, with a slag-dump over 2,000 feet high on two sides. But the main reason for locating the furnace where it now is was probably the convenient and central location in regard to the mines of the district, the lead-mines being located on the western slope of Buena Vista Mountain, while many mines carrying cupriferous copper-ores are on the eastern declivity, both classes lying high up on the mountain, and the outcrops of most of them being above the level of the smelting-works.

Beaudoy's Smelting-Works, lying in a ravine on the western slope of Buena Vista Mountain, in the town of Cerro Gordo, and a couple of hundred feet below the level of the working-tunnel of the Union, smelt also mainly ores from this mine. There is only one shaft-furnace of the same size as Belshaw's. Both of these works, and their method of working, are described in another part of this report.—(See Metallurgy.)

The Santa Maria is located lower down Buena Vista Mountain, and nearer to the town of Cerro Gordo than the Union. It runs generally parallel to the latter, and is separated from it by a stratum of clay-slate, which varies in thickness from 30 to 120 feet, and a varying stratum of limestone. The Santa Maria lies closely to the slate, which dips on the surface 64° west. The upper works in the deposit show that it is completely broken down near the surface, so that it is here much wider than lower down, and apparently tipped over, *i. e.*, it dips to the east; but at a depth of about 60 feet the dip changes to the west, becoming conformable with that of the slate. Much work of an irregular character, evidently wanting in a uniform plan, has been done on this deposit. Several tunnels and shafts have developed the following so-called chambers, some of which are now worked out. In going along the vein from north to south they are:

1. The Santa Maria chamber, 25 feet wide and 50 feet long.
2. The front chamber, 15 feet wide and 40 feet long. This ore-mass

lies, not on the strike of the vein, but west of it, and lower down the hill. It is in soft, gravelly ground and broken rock, evidently a part of the former outcrop, which is tipped over and has been partly covered up by other detritus.

3. The Schneider pocket, on the course of the vein.

4. The Buena Vista pockets, 180 feet long and from 5 to 30 feet wide.

The Omega Tunnel, driven from below Belshaw's Smelting-Works obliquely toward the Santa Maria, (it has, however, several branches and windings in all directions,) strikes the Santa Maria deposit at a depth of over 200 feet from the surface. This tunnel has lately also been acquired by the Owen's Lake Silver Mining and Smelting Company, of New York.

The latest accounts I have from this district are dated December 18, 1872. They were furnished by Mr. William H. Van Arsdale, E. M., the superintendent of the last-named company, whose valuable assistance to Mr. Eilers, when visiting Cerro Gordo district in the fall, I take here occasion to acknowledge. In his late letter he says in regard to the Santa Maria mine:

I have been engaged in removing ore from the upper part of the Santa Maria mine, and in exploring the same at and below the level of the Omega Tunnel.

About 100 feet south of the original Santa Maria workings I have found a body of ore 50 or 60 feet from the surfaee, which I have uncovered for a considerable extent on top. It is from 10 to over 20 feet wide, 50 or 60 feet long, and, so far as I know, 50 feet deep, a mass of galena and oxidized ores. More or less ore is also found in the vicinity of this solid mass on either side. I have removed about 600 tons from it, a small part of the whole.

The vein seems to have changed its direction somewhat at the level of the Omega Tunnel, (over 200 feet from the surface,) and seems to run in more of a northerly and southerly direction than on the surface, where the general course of the deposits is about S. 30° E. The character of the lode is also different on that level, where, at the northern end of the works, galena and soft ores predominate, with some quartz, while at the southern end there is but a vein of quartz tolerably uniform in size, and, at the back, where it is being worked, carrying galena and copper ores, much mixed with quartz, from 3 to 8 feet of the width of the vein. The rock, as taken out without careful sorting, averages from 60 to 90 ounces per ton in silver.

In the northern workings we have gone down 160 feet below the tunnel in galena and carbonate of lead, apparently increasing in width toward the bottom. We have also drifted 180 feet on the level of the tunnel, and 100 feet at 110 feet below the tunnel, on more or less ore all the way. This ore is much richer than that near the surface. I have taken possession of the Omega Tunnel, and stopped all work outside of our own vein. I understand that the Union mine is doing as well as ever.

The smelting-works of the Owen's Lake Silver Mining and Smelting Company are situated at Swansea, on the eastern shore of Owen's Lake, ten miles from Cerro Gordo. The difference in the level between the two places is over 2,000. The working of these furnaces, before their destruction by the earthquake and their subsequent rebuilding, is described under "Metallurgy" in another part of this report. An account of the operations of these works since Mr. Eiler's visit in that region is contained in Mr. Van Arsdale's letter above referred to. He says:

After you left this place I completed my flues and chimneys, and erected another furnace. I blew in one of the furnaces on October 20, and ran thirty-six days, producing 142 tons of lead. Then I stopped that furnace and started the other, and have continued to produce bullion at about the same rate. I used on an average 3¾ tons of lead-ore per ton of lead made. I employed very little of the argentiferous copper-ore. The matte I re-treated in the same furnace. The dust-deposit from the flues I mixed with the fine oxidized ores in a sluice-box, thus washing out the carbon and clay. The resulting fine-ore I dried partially and charged it in the furnace-damp. The result was very satisfactory. I saved nearly all of it. I used about 1 ton of galena and 2¾ tons of the oxidized ores per ton of lead produced, and about 30 bushels of charcoal per ton of ore.

When formerly the ores were roasted and slagged in the "galenador" there was much less coal employed in the subsequent fusion. The slags produced in this last run contained 2 to 5 per cent. of lead, and never over $1 in silver per ton; generally very much less.* I have not treated nor found lately any ores with an appreciable quantity of gold.

From December 1, 1871, to December 1, 1872, the freight-contractors for the bullion removed from the Cerro Gordo furnaces (Belshaw's and Beaudoy's) 2,600 tons of lead, the richness of which is not stated. From the works at Swansea there were removed 620 tons of lead, carrying from $120 to $340 of silver per ton. A small part of the latter was even much richer. To judge from former shipments, the bullion from Belshaw's and Beaudoy's furnaces has probably averaged about 140 ounces of silver per ton, and that from the Swansea works 150 ounces.

The total shipment of base bullion from Cerro Gordo district during the year from December 1, 1871, to December 1, 1872, and its approximate value, was therefore:

From the works of—	Number of tons.	Number of ounces silver per ton.	Total value of silver at $1.2929 per ounce.	Total value of lead at 6c. gold per pound.	Aggregate value.
Belshaw & Beaudoy	2,600	140	$470,615 60	$312,000	$782,615 60
Owen's Lake Silver Mining and Smelting Company	620	150	120,239 70	74,400	194,639 70
Total	3,220	....	590,855 30	386,400	977,255 30

The question of procuring cheap fuel is, in Cerro Gordo, the same as in nearly all smelting-districts of the West, one of great importance and not easily solved. The price paid for charcoal at the furnaces in the town of Cerro Gordo (Belshaw's and Beaudoy's) was 32½ cents per bushel in the latter part of 1872, and the smelting-works at Swansea, even, were obliged to pay 30 cents, though the latter are favorably located for procuring fuel across the lake from the Sierra Nevada. The supply of wood on the Inyo Mountain, though of the best quality for charring purposes, (piñon,) has lately become so precarious and expensive that various schemes have been talked of for securing cheap transportation of the abundant stores of wood and timber in the Sierra Nevada. A small steamer was built last year, which commenced running in the early fall, and has since then transported base bullion from Swansea to the southeast end of the lake. On the back trips it is loaded with merchandise and other necessary supplies for the mining and smelting establishments. Some forty or fifty miles of an exceedingly bad road around the upper end of the lake are thus avoided, and the distance to Los Angeles is materially shortened. To that point, distant not less than two hundred and seventy-five miles, all the bullion has so far been shipped, the road leading over sandy deserts most of the way.

It is now proposed by Mr. S. Stevens to build in Cottonwood Cañon, which opens upon the lake about midway of its western shore, a large flume, with branches in the side cañons. At the upper end of this cañon, and at an elevation of about 5,000 feet above the lake, is a series of val-

*This great improvement in the production of poor slags is undoubtedly due to the omission from the charge of the quartzose copper-silver ores, which were formerly much used, occasioning the formation of silicate of lead, to decompose which there was not sufficient iron-oxide present.

leys containing many square miles of forest, which will be rendered available for fuel by means of the flume. The latter is intended to be from six to twelve miles long, and there is an abundance of water for it. The timber growing along its course will be serviceable for lumber and mining-timbers as well as for charcoal. It is thought that the flume can be finished and ready for use by the end of the summer of 1873, and that then charcoal can be laid down at Swansea for less than 20 cents per bushel.

THE SOUTHERN COUNTIES.

The mineral-field of Southern California is scattered over a very extensive area comprising the counties of San Bernardino, Fresno, San Luis Obispo, Kern, Tulare, Los Angeles, and San Diego. Within the limits of these counties are found gold, in placer and quartz, copper, silver, cinnabar, and tin, though, with the exception of one or two districts in San Diego and Kern Counties, there are no communities in which mining is the predominating interest. In fact, so far as all this part of the State is concerned, the mineral-resources may be looked upon as undeveloped, if not undiscovered. Tin in considerable quantities has been discovered in San Bernardino County, but being within the limits of private land-grants, the development of the mines has not been as energetically prosecuted as it would have been on the public domain.

The San Jacinto tin-estate is in San Bernardino County, about fifty miles east of Los Angeles, where, it is said, the company have fifty tin-bearing ledges, some of them with the unusual breadth of ore of 13 feet. Kern County, an early placer and a later quartz-mining locality, and one having experienced good and evil fortune, is now recovering from a long season of depression, with a most encouraging prospect of becoming a flourishing and progressive mining-county. Old mines, that have been lying idle for the past six years for the want of proper knowledge of the manner in which they could be worked profitably, and which were formerly under the control of superindendents who never saw a mine before they came here, have been relocated and worked to advantage. We can refer to many instances involving great losses; and again, to the very same places which, on being worked by competent hands, have paid handsomely, much to the wonder of their former workers. This only illustrates the vicissitudes and trials that have marked the general history of quartz-mining on the Pacific coast. Beginning at a time when labor and material were enormously high, ignorant of the requirements of the business, and overlooking many treacherous elements of defeat, the miner and mill-man were baffled alike, and subject to disappointment and loss in consequence of a lack of knowledge concerning mining. Seven years of constant working and experiment have overcome all former impediments, and mining in this county is no longer an experiment. Not only are the mine and management now here perfect, but the mill and plant are first-class, all the late labor-saving appliances and other advanced improvements having been added, greatly increasing the efficiency of profitable mining.

The Havilah Courier says of the mining-region of which Havilah is the center:

The mineral-belt carrying the system of veins here, pursues a northwest and southeast direction. It is about forty miles wide and seventy miles long, the town of Havilah being located near its center. There are many other mines in the county situated in smaller belts which bound it on the east near Sageland, and on the west at White River. Within our area the bulk of the more extensively developed mines are located. The entire belt is cut and ribbed with gold-bearing veins which cut its course diagonally, running generally in an easterly direction. The vein-matter is principally quartz, very little foreign rock being discovered in it. Its walls are always granite or slate. The ledges, though almost invariably well walled, are not massive, but in keeping with the general average width of all gold-bearing ledges on the coast, varying from 2½ to 6 and 10 feet. The Big Blue lode at Kernville is between 60 and 70 feet thick. They pitch at angles of 35 to 85 degrees.

The mineral-belt to the west of Havilah commences at White River, running from Tulare into Kern County, ranging from there to Long Tom mining-district, thence east to Delonega mining-district. Skipping a few miles over an unprospected country brings us to the once famous Keyseville mining-district, which was abandoned some years ago in consequence of the old cause—bad management and inexperience. A few miles to the right of Keyseville is Kernville, which has now all of its stamps in operation on rock of a very rich grade. Crossing Kern River to the Havilah side, the mines in this large belt continue, the first mining-district being the Washington, which includes Havilah, with its numerous mines, and extends south to Caliente mining-district, a distance of thirty miles. The leads mostly run east and west in this portion of the belt. Next to this comes Erskine Creek, where the lodes do not seem to obey any rule, but run at random in net-work style. The lodes of the newly-discovered mines, Grizzly Mountain district, run almost directly north and south. In Pi Ute, Sageland, and Claraville districts the ledges run nearly east and west, varying slightly toward the north and south occasionally. The most of the rock in this district is of the best high-grade ore, and turns out under the stamps $20 to $38 per ton. The deep mines of the county which have been fairly tested, develop an increase in the width of the ledges. By way of illustration, we cite the Saint John and Bright Star mines, which were only 3 feet in width when first struck. They both held this uniform width until down 260 feet, when the ledges commenced to widen without any decrease in the richness of the quartz, which pays from wall to wall the same as before the extension in width. The ledges are now almost 8 feet in width, with a tendency to still increase.

SAN DIEGO COUNTY.

The mines of this county* are mainly situated in Julian and Banner districts, in the Santa Isabella Mountain, about sixty miles by stage-road northeast of San Diego. Attention was first called to them early in 1870, and a temporary excitement was caused by the reported richness of the ore. As usual in such cases, the value of the quartz was somewhat exaggerated; and the recognition of this fact occasioned a reaction. Julian district fell into bad repute. Moreover, a prejudice exists, or did exist, among the people of San Francisco and Northern and Middle California, against San Diego County. For this reason it was difficult to procure capital to develop the claims. However, as a few claims showed evidence of being worth working, a small population remained after the first rush was over; and to them the camp owes its present prosperity.

Little seems to be known of these mines, even in California, outside of those interested in the advancement of the county; and it has been difficult to obtain any details of the working of particular mines. The geological features of the district in which they are situated have been given at length in a former report of the Mining Commissioner. The formation is slate, sparsely interspersed with granite, in which the veins run northeast and southwest. One of the most prominent mines, however, the Golden Chariot, is located at the junction of granite and slate. The auriferous belt is, as nearly as can be ascertained, about four miles in width by ten in length. The veins are unusually numerous, but small; few, if any, blind lodes have been discovered; the majority crop out at intervals for considerable distances.

* The following matter relative to the rich and comparatively unknown quartz-districts of San Diego County was prepared by Mr. Charles G. Yale, of San Francisco. Mr. Yale is a former resident of the county, familiar with its quartz-interests from the period of their discovery, and has a personal knowledge of the principal mines referred to.—R. W. R.

Since the discovery of the Washington mine, February 22, 1870, a large number of veins have been discovered and prospected. Many of them have been abandoned, although a sufficient number are now worked to make the camp a comparatively lively one.

Banner district.—At first only one district was laid out—Julian—and the principal part of the population resides there yet, at Julian City. About seven months after the first discoveries on the mountains around Julian City, a rich ledge was struck in San Felipe cañon by parties hunting for wild grapes. The ledge was found on the edge of a creek, and both the sands in the creek and the ore from the ledge were found to be rich in gold. This ledge was called the Redman, and was, where found, about 3 feet wide. In a few days after this discovery was made known, the precipitous and chaparral-covered south side of San Felipe cañon was alive with prospectors, and a number of ledges, extending for a distance of three miles, were located; although many were barren, a majority were exceedingly rich in gold, and all the ore was "specimen-rock," showing free gold in abundance.

A new mining-district was immediately formed and called Banner. It adjoins Julian on the east, and the mountains through which the mineral-belt passes are drained by the south and west tributaries of San Felipe Creek, which flows, through the cañon of the same name, to the desert. The creek lies about 1,400 feet below Julian City, although only about two miles distant. The majority of the mines in this district are situated on the south side of the cañon, about half way up, and the ore is packed on mules down the side of the mountain. The cañon runs out to the Colorado desert, about ten or twelve miles from the mines.

The principal mines now worked in Banner district are the Golden Chariot, Madden, Antelope, Kentuck, Ready Relief, Pacific, Mabel, and Aguardiente. Locations made on ledges which have not been worked to any extent, or which are now temporarily idle, are numerous. Among this class are the Mogul, Don't Bodder Me, Montezuma, Chapparal, Ophir, Hidden Treasure, Romeo, Atlantic Cable, Redman, Hubbard, Poor Man, City of Richmond, Last Chance, Buena Vista, Blue Lead, Trail, and several extensions of the Golden Chariot. On a few of these mines considerable work has been done; and from some, considerable amounts of gold have been taken. Among the latter may be mentioned the Chapparal, Redman, and Blue Lead.

The Madden mine was discovered September 10, 1870. The ledge, at the depth of 80 feet, is 14 inches thick. The rock has been very hard, requiring continuous blasting. The ore worked has averaged $75 per ton.

The Redman mine was found in August, 1870, being the first discovery in the district. It was thought for some time to be the main ledge of the camp, and was at one time extensively worked. A large amount of bullion has been taken from the mine; but inexperience and financial difficulties have caused operations to be temporarily suspended. A Wilson steam stamp-mill, formerly at Julian, was brought down to the creek near by and the ore worked there. The present owners intend running shortly. The vein-matter has run from 6 to 10 feet in width. The mine was for awhile worked by a tunnel on the ledge in the face of the mountain. A shaft 80 feet deep was also sunk, but the water was so abundant as to require pumping-apparatus, which, with the necessary hoisting-apparatus, the proprietors were unable to purchase. The Ready Relief and Hubbard are southerly extensions of this vein; and the ore of the Kentuck and Madden, on the west, much resembles that of the Redman.

The Ready Relief, which crops boldly on the face of the mountain, was discovered immediately after the Redman, on the south fork of the San Felipe Creek, which divides the two mines. This is better known as the Bailey Brothers' mine. It is in a peculiarly favorable situation for working. A fine stream of water flows by it, which the owners have tapped at some distance above, and, by means of a ditch and small flume, have brought the water to run their 3-stamp mill with an overshot-wheel. The ledge averages from 2 to 8 feet in thickness where it crops out, and shows free gold in nearly all the croppings, from the point of commencement on the level of the creek, to the top of the hill, which rises, at an angle of 40° to it, to the height of about 600 feet. The company has run a tunnel on the lower level, 130 feet, and two other tunnels 40 or 50 feet. These tunnels are run wholly in the vein, and rich ore has been taken from all of them. Ten tons of ore, crushed at the mill, yielded $980. The claim comprises 1,000 feet.

The Hubbard ledge lies south of the Ready Relief; the croppings are very rich. A tunnel has been run into the hill to within about 40 feet, it is supposed, of the ledge. Want of means has suspended operations for the present.

The Kentuck was found in October, 1870. It is one mile northwest of the Redman. The lode is about 16 inches wide, and the ore has averaged about $40 per ton. A large amount of dead work has been done on this claim. A shaft has been sunk 80 feet, at which depth the mine looks better than ever.

The Antelope lies northwest of the Kentuck, and contains some fine ore. Some selected rock has been pounded out in a mortar, which has yielded $4 per pound. Some notion of the richness of this rock may be formed from the fact that the owners pounded out by hand enough to erect an arrastra, and with that (and hand-mortars) got enough gold to buy a fine 5-stamp quartz-mill, engine and all, complete. They began without a dollar and with no knowledge of mining. Ninety feet is the extreme depth to which their shaft has been sunk. This claim comprises 1,200 feet.

The Golden Chariot, discovered in February, 1871, has proved the most productive mine in the district. At 50 feet in depth water was encountered on the 2-foot main ledge, and no drifting has been done below the 50-foot level, although the shaft has been sunk 125 feet, showing ore as rich, if not richer than above. The drift on the 50-foot level has been run 125 feet, out of which most of the ore milled has been taken. A recent crushing of 100 tons of ore from this mine yielded $23,000, or $230 per ton. Unlike the other mines in this district, this one is located between the slate and granite. Most of the ore averages about $200 per ton at the mill. The ore has to be packed in "burros" to Whitney's mill in the cañon, as the wagon-road is not yet completed. The Golden Chariot is a mine of great promise. The ore taken from the lower levels averaged $230 per ton, while that from above paid about $190. There are three shafts on this vein, one of which is down 125 feet, and is now going 75 feet deeper. In one drift the breast shows 14 feet of pay-ore. About twenty-five men are regularly worked. One run, of 50 tons, crushed at the mill in October last, yielded $8,100, or $162 per ton; 52 tons crushed last August from this mine yielded the sum of $13,621, or $257 per ton. The ledge averages about 2 feet in thickness, but varies considerably, as do all in the district. The last ore of which any account has been given, it was estimated would yield $300 per ton, as it was richer than any previously struck. This mine has paid its own expenses for development, and a very handsome profit besides, ever since it was opened.

The Atlantic Cable lies several hundred feet northwest of the Redman; the ore contains more sulphurets than any of the lodes in the mineral belt, with the exception, perhaps, of the Sullivan, several miles from Julian. A small amount of sulphurets is found in nearly all the ore in the two districts. There has been but little work done to develop this mine: thirty tons of ore worked yielded $40 per ton; the vein was 15 inches wide at the surface.

The Chapparal has yielded some very rich ore, and at one time was thought to be extremely valuable; but the rich ore did not hold out with depth. No work is now doing.

The Mabel is a good-paying mine, situated about a quarter of a mile from Julian district. There are many other locations in the camp which show fine ledges at the surface with free-gold ore, but nothing is worked which will not pay a profit from the top down.

There are three quartz-mills in the district, two steam and one water-power, all wet-crushers with copper plates, and working no pans, settlers, concentrators, or arrastras. One of the mills is a 2-stamp Wilson battery, which is run by a direct application of the steam to the stamp. The charges for milling are from $7 to $8 per ton, but money could be made by the mill-men at $5, in consideration of the abundance of water and the cheapness of fuel and labor.

Julian district.—It was here that the first mines of any account in San Diego County were struck. The first was discovered on February 22, 1870, and called, in honor of the day, the Washington. The prominent mines in the district are the Owens, Helvetia, Good Hope, Van Wert, Hayden, Big Blue, Great Eastern, and others.

The Owens has recently been incorporated, with a capital stock of $500,000. It is systematically worked, and has paid large dividends for the past eight months. The shaft is down 275 feet, and the first level, 100 feet from the surface, extends east 200 feet, and west 100 feet from the shaft, all in ore that averages at the mill $20 per ton. The second level leaves the shaft at a depth of 200 feet, and runs east 140 feet, and west 180 feet. The ledge in this level averages 3 feet in width, and has paid at the mill about $35 per ton. The third level, at a depth of 275 feet, runs east 260 feet, and west 200 feet, and in this the ore has yielded from $50 to $75 per ton; a considerable quantity has been milled which yielded $75 per ton. In the eight months ending January 1, 1873, the sum of $42,319.50 was taken from 920 tons of ore, with an average of twelve men at work. During this time a good deal of dead work was done in sinking the shaft and running levels. The cost averaged $26.55 per ton. One run of 109 tons turned out $8,878.28, and 48 tons were worked that yielded $3,987.44. The ledge, as now exposed, ranges from 2 to 4 feet in width, averaging 3 feet, and others 2. The mine is owned by six men, and some idea of the value of the lode may be had from the following summary of operations for the past eight months:

920 tons of ore yielded	$42,319 50
Expenses of extraction, milling, &c	24,210 25
Net proceeds in eight months	18,109 25

A fine set of hoisting-works is now erecting at the mine, with a 25-horse engine. This is the first complete set ever erected in the county. The mine has paid its own expenses from the start, and the prospects for increased richness of ore in the lower level are exceedingly good.

The Helvetia mine has also paid expenses since its accidental discovery by a drunken miner, who lay down with his head upon a bowlder, to sleep off his debauch, and found on waking that the bowlder was float-quartz, and sprinkled with gold. The mine has yielded some very rich ore. The shaft is down 160 feet, and levels have been run on a vein averaging about 2½ feet, and paying about $28 per ton. Work is now prosecuted with vigor.

The San Diego is one of the old locations, and, after having lain idle for some time, is again worked with good prospects. Very rich ore came from this ledge at the surface.

Among other mines being worked to some extent at present are the Hayden, Great Eastern, Van Wert, Good Hope, Mammoth, &c.

A large number of locations, half prospected, are lying idle for want of capital, the owners holding on to them in hopes that the success of more fortunate mines may inspire confidence in the country. Among them are the Washington, California, Eagle, Rough and Ready, Sullivan, and many others.

Cuyamaca Mountains.—The Stonewall Jackson mine, belonging to Frary & Farley, lies about eight miles southeast from Julian City, in the Cuyamaca Mountains, and cannot, therefore, properly be noticed as belonging to Julian district. A fine 10-stamp mill is in operation at the mouth of the mine, and arrangements have been made to bring, in pipes, from a lagune a few hundred yards distant, the supply of water necessary to run it. The mine is worked systematically, and has been very well developed. It is situated in the rolling hills at the base of the mountains, and near the Cuyamaca Valley. At first the ore was hauled to mill in Julian, but the proprietors soon purchased a 5-stamp battery, which they have since increased to 10 stamps. The vein-matter ranges from 10 to 16 feet in width—the latter at the lowest depth. The mill is now run by a 40-horse engine, to which is also attached a small set of hoisting-works. The vein has been in some places 20 feet in width, and yields on an average from $12 to $20 per ton throughout. The main shaft is now 150 feet deep, and a level has been run at 130 feet. This ledge has paid from the start, the croppings being rich and the ore increasing in value with depth. The mine appears to be isolated, since no others of value have been found within several miles. Work is now prosecuted with energy, and the mill is kept running to its full capacity. The bullion is the finest in the camp.

Stamp-mills.—The stamp-mills of the county may be recapitulated as follows: Stonewall Jackson, 10 stamps; Defrees & Co., in Julian, 10 stamps; Reynolds & Co., at Julian, 5 stamps; Whitney's Wilson steam stamp-battery in Banner, 2 stamps; the Antelope, in Banner, 5 stamps; and Bailey Brothers, at the Ready Relief mine, (water-power,) 3 stamps.

All the gulches in this belt prospect a little in gold. No placer-mining operations on any large scale have ever been prosecuted, although some work was done with rockers, &c., in the vicinity of the Stonewall Jackson mine and elsewhere. Scarcity of water, and the scarcity and fineness of the gold, defeated profitable work.

Coal.—Coal, reported to be of excellent quality, has recently been found in the vicinity of Temecula, in this county. The seam is said to be about 4 feet wide. The land on which it is located is Government property, and no doubt the neighborhood will be thoroughly prospected. It is about sixty-five miles from the city of San Diego.

There is an abundance of wood and water for quartz-mining in the districts described, although the general impression is that such is not the case. The timber is principally pine and oak, and the highest price paid at the mills for wood is $5 per cord. Timbers for shafts, tunnels, &c., are worth 16 cents a foot. At Julian City water is not so plenty as in the cañon, but it has been demonstrated that a sufficient supply can be procured with little trouble. At Defrees's mill pipes have been laid from a number of springs, and water is found on the upper edges of the flat at small depth. The mill is able to run day and night. At Reynolds's mill the water is used over again from the tanks. In the cañon the creek supplies an abundance of water the year round. A saw-mill in the vicinity supplies all the lumber required. The population of Julian City has increased materially of late, and the amount of business done there is considerable. It is next in importance, in the county, to San Diego, and, in fact, before the late railroad excitement in the latter place, was a much more lively town than its rival. The scenery in the mountains around the mines is magnificent. From the top of the Volcan or Big Cuyamaca Mountains, the observer may look out upon the Colorado desert on one side, and the Pacific Ocean on the other. The agricultural lands in the mountains and valleys around the mines are without doubt the finest in the country, as the climate is not so dry as on the coast. Thunder-showers occur occasionally in the summer, and the snows and rains are plentiful in winter, though not so plentiful as to prevent the mines from being worked. It sometimes happens that it is stormy or foggy and disagreeable in Julian City, while in the cañon the sun is shining brightly. Large bands of sheep and cattle are fed in these mountains, so that meat is plentiful and cheap. Many ranches are now cultivated in the vicinity, and the camp is well supplied with vegetables, &c. Wild game is abundant, particularly deer.

The town of Julian City contains two good hotels, a restaurant, a post-office, Wells, Fargo & Co.'s express-office, and a number of stores. The houses are substantially built of frame, and the population is a permanent one.

The bullion-product of these mines is rapidly increasing, though it is difficult to arrive at correct figures. The San Diego Union, in an article on the reports of the county, says the most important item is the bullion from the mines, and gives the product for 1872 at $488,670; for 1871, at $175,919; increase, $312,751.

This increase exceeds all expectation, even of those interested in the mines. Moreover, it is the opinion of Mr. Yale that the figures given are low, since a very great proportion of the bullion is not sent through Wells, Fargo & Co.'s express, from which these returns are probably made, but is carried out of the county by other means.

From the foregoing it will be seen that the mines of San Diego County are more important than many suppose, and that, with more improved milling-appliances and the aid of a little capital, these districts will, in the future, add materially to the bullion-product of the State. No refractory ores have yet been met with; the gold in the quartz is, as a general thing, evenly distributed throughout; no sulphurets appear in the lowest levels of the prominent mines; those mines that were rich at the surface have, whenever developed to any considerable extent, paid regularly in depth. Ledges that pay from $12 to $20 per ton, and are 20 feet wide, like the Stonewall Jackson, would be called unusually good anywhere. The Golden Chariot, with its fine 2-foot ledge, and rock that mills from $190 to $257 per ton, is still more remarkable. The Owens, which has paid its six owners the sum of $18,109, over and above expenses, in eight months, is another example full of promise. These three mines are the leading ones at present of San

Diego County, and, as they are more fully developed than any others, and are some distance apart, (the Stonewall Jacksen being at the foot of the Cuyamaca Mountains, eight miles from the Owens, and about four from the Golden Chariot,) they give reasonable ground for the expectation that others, equally good, may be hereafter opened. The bullion from all the mines varies considerably. The Banner-district mines, which are low down in the cañon, contain a large proportion of silver. The bullion has sold at the stores from some mines at from $12 to $14 per ounce; that from the Julian mines, high up on the mountain, has sold for $16 per ounce, and Mr. Frary, of the Stonewall Jackson, reports that he sold his bullion at the mint for $18 an ounce. The miners in the section get $3 per day, and board themselves.

It is noteworthy that these mining-districts have paid their own way from the commencement—a circumstance not very common in quartz-mining, and one which explains the alternations of enforced idleness, of discouragement, with active and hopeful work, through which they have passed. It is probable that at one time Julian would have been deserted, but for the fortunate discovery of the Cañon mines, as they are called, in Banner district. There is no fear of another relapse, but every prospect of increasing and permanently prosperous industry.

MARIPOSA COUNTY.

I have received no returns of a trustworthy character from this county, my letters addressed to mine-owners having remained unanswered, and a personal visitation by myself or Mr. Skidmore having been impracticable.

The Mariposa Land and Mining Company—a corporation which has succeeded to the old Mariposa Company in the ownership of the well-known estate of that name—is reported to have consolidated after much trouble all the interests involved, and to be ready for active operations in the mines and mills. Mr. Easton, the new engineer, asserts the discovery of large amounts of good ore standing in the Josephine and Pine Tree mines, and propounds in his report of December 3, 1872, to the company, some theories as to the structure and relations of the veins, which it is unnecessary to criticise here, since the developments of this year will doubtless settle many of the points involved, and illustrate what is of more importance, the merits of the practical arrangements proposed for working. Among the new measures announced is an adit from the Ophir mills on the Merced, such as was long ago recommended by the late Dr. Adelberg.

TUOLUMNE COUNTY.

Sonora,* the county-seat, is a thriving town, containing about 1,300 souls.

By a convention of miners held at Sonora, in 1872, all previous rules and regulations concerning quartz-mining were repealed, and all the smaller districts formerly existing in the county discontinued. The county now comprises but one district with the county-clerk as recorder.

The county has 32 quartz-mills, having in all 360 stamps. Of these, 12 mills, with 158 stamps, were in operation during the whole or part of 1872.

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* The summary of the condition of the mining-interest of Tuolumne County is based on the notes of Mr. D. T. Hughes, of Jamestown.—R. W. R.

The Confidence mine, about fourteen miles nearly due east from Sonora, has been one of the most productive in the county. It started with 20 stamps several years ago, and has since increased the number to 40, all of which have been running pretty steadily, with the exception of about two or three months this year, when the mill was idle for the want of ore. Attached to the mill are a Blake's crusher and three arrastras, the whole driven by steam-power, crushing, on an average, about 1,200 tons per month. Weight of stamps, 550 pounds; 6-inch drop, 70 times per minute; discharges through a No. 7 slot-punched screen; amalgamation on copper plates. The sulphurets are concentrated on carpet and blankets, then mixed with salt for the purpose of hastening the oxidation, and afterward amalgamated in the arrastras. The ore is hoisted out of the mine by steam, through an incline 650 feet deep on an angle of 35°, (at and near the bottom only 17°.) The vein varies in thickness from 2 to 16 feet, and carries quartz mostly well filled with seams, rather easily broken, and inclosed in granite. The cost of mining and milling this ore is said to be about $6.50 per ton. Yield unknown.

The App mine, situated at Quartz Mountain, now owned by Messrs. Griffin & Tolten, is on the mother-vein.* Course nearly north and south; dip of 63° E. The present owners have worked diligently for several years in the development of the mine. The main shaft has now reached the depth of 775 feet. At the depth of 650 feet they struck a chimney of ore from 2½ to 8 feet in thickness, which it is said will yield from $12 to $30 per ton in the mill. The quartz carries a small percentage of sulphurets, and is inclosed in hard greenstone on the hanging-wall and talcose slate on the foot-wall. The mill consists of 25 stamps, (self-feeding,) one Blake crusher, and three pans. Weight of stamps, 700 pounds; 9-inch drop, 65 times per minute; discharge through wire-cloth, 40 holes per linear inch; amalgamation done on copper plates. This mill is run by water-power and has been in operation less than one-half the time during this year.

The Heslep mine, also owned by Messrs. Griffin & Tolten, runs nearly parallel with the App, and has nearly the same dip. The two are about 200 feet apart. This mine was formerly worked by a tunnel, but the ore is now brought to the surface by steam-power and let down to the mill by an inclined plane. The shaft is about 250 feet deep, 150 feet below the tunnel. The vein averages from 2 to 8 feet in thickness, having a gouge on the hanging-wall. The ore is quartz and slate, highly charged with auriferous pyrites, with some antimonial sulphides. This vein has a hard greenstone on the foot-wall and slate on the hanging-wall, exactly contrary to the App. This, with other indications, shows very conclusively the country-rock between these two veins to be this hard greenstone, or, perhaps, that the greenstone occupies the central zone of a channel in the slate-formation, the two marginal zones of which are these two veins. This does not specially encourage the belief that they will come together in depth. The Heslep mill has water-power and 15 stamps, (self-feeding,) and amalgamating with copper plates only. Weight of stamps, 700 pounds; 9-inch drop; discharge through a wire-cloth No. 40. The ore is said to yield from $12 to $15 per ton. Sulphurets are partly concentrated and saved near the mill.

The Orcutt mine, situated near Jacksonville, is owned by Mr. Orcutt. The ore from this mine is crushed in the App and Wright mills. The vein is small, but has paid well thus far.

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*This mine has been described in my report of 1869, and in that of Mr. J. Ross Browne, preceding mine.—R. W. R.

The Spring Gulch mine, situated between the North and Middle Forks of the Tuolumne River, owned by Sherwood & Co., is a new mine and promises to be a productive one. The last run of ore is reported to have yielded over $40 per ton.

The Excelsior mine, situated at Sugar Pine Creek, is owned by Wright & Co. This is quite an old mine, once very productive, but abandoned for several years, under the impression that the pay-ore was exhausted. But one of the former owners returned and prospected again with very favorable results, on the strength of which a 10-stamp mill was erected last summer. The vein is small.

The Mount Jefferson mine, near Garrote, has a 10-stamp mill, run by steam; worked only part of the time.

The Chandler and Beal mine, situated on the main fork of Tuolumne River, is owned by the parties whose names it bears. There is a rather small vein of hard, bluish quartz, and a 4-stamp mill. The enterprise is worked economically and reported very profitable to the owners.

The Tullock mine, owned by Tullock & Gashweiler, situated on Bear Creek, about eight miles, nearly west of Sonora, is a new mine, and little developed except by the sinking of a shaft now over 200 feet deep on a vein from 3 to 4 feet thick, and reported to carry gold in paying quantities throughout nearly the whole depth. The company has a 5-stamp mill on the claim, used only for crushing samples as the shaft proceeds.

The Knox and Boyle mine, owned by Judge Preston & Co., situated on the slope of Quartz Mountain, is rather a small vein from 12 to 30 inches in width, running nearly north and south, with a dip of 63° E., inclosed in greenstone and slate. Although this vein is a considerable distance east of the mother-vein, the quartz strongly resembles much of the mother-vein. It is hard, with bluish stains, carrying a small percentage of sulphides of antimony and copper, with a little silver. The mill has 10 stamps and two arrastras; amalgamates with copper plates. Some of the tailings are saved and worked in the arrastras. The ore crushed from this vein is said to have yielded nearly $30 per ton, but for some reason the mill was not much in operation during 1872.

The Santa Maria mine, situated about twenty-five miles from Big Oak Flat, and near the main road leading to Yosemite, has a rather small vein, rich in gold. The mine has been lately sold. A 10-stamp mill is nearly finished.

The Von Tromp mine is situated two and a half miles northeast of Columbia. This vein was discovered several years ago in a hard limestone formation, and a shaft was sunk to the depth of 30 feet, showing the vein from 18 to 20 inches wide, of hard, bluish quartz, intercalated and impregnated in the limestone, without a gouge or even a seam to separate the two. In 1872, a new company bought the claim and continued the shaft to the depth of 70 feet, when they struck through the limestone, penetrating a slate-ledge. At this point the vein increased to more than double its previous width, and acquired well-defined walls. A small 5-stamp mill has just been completed near this shaft. Most of the quartz veins in this section carry more or less galena through the ore; but the Von Tromp vein is remarkably free from all sulphides whatever.

The Patterson mine, owned by William Patterson, is situated near Tuttletown, on one of the main turnpike roads from Sonora to Stockton. This mine, though quite extensive, has escaped the notice of most of the mining experts. It has been worked for nearly fifteen years, but on rather a small scale compared with its real magnitude. The vein is prominent on the ridges, where the most labor has been performed, and can easily be traced over a large portion of the claim. These ridges rise on a gradual slope to the height of nearly 200 feet above Mormon Gulch, once famous for its very rich placers. Dividing the two ridges is a gulch by means of which the vein is easily opened by short tunnels to the depth of 120 feet. The location has cheap water-power and is accessible from all points. The vein is large, varying in thickness from 4 to over 50 feet, and well defined, with gouges or selvages on both foot and hanging wall. The country-rock is hard slate. The ore is very peculiar, composed of quartz, slate, and solomite or magnesite, blending together all through the vein, and the whole highly charged with auriferous pyrites. The cubes of pyrites are unusually large, and not seldom the gold may be seen inclosedin them; but more frequently a thin coating of gold appears adhering to the surface. A 5 stamp mill of a very old pattern, and unsuitable for work, belongs to the mill. All the amalgamation has been done in this mill by copper plates only. No attempt has ever been made to work the sulphurets which have escaped down the gulches and have been lost, with fully 50 per cent., it is safe to say, of the gold contained in the ore.

The Shawmut mine has been re-opened by a company, which has re-timbered and cleaned up the old shaft, and is reported to have struck good ore.

Among other discoveries made in this county during 1872, may be mentioned a silver-mine, discovered within seven or eight miles of the summit of the Sierra, and near the toll-road leading from Sonora to Mono and Inyo Counties. The vein is 6 feet wide, in granite, and the ore is rather refractory, carrying, besides gold and silver, the sulphides of iron and lead, with a small quantity of zinc-blende. Samples of this ore assay from $60 to $140 per ton in gold and silver. This discovery, made in December, 1872, I believe, will probably lead to much prospecting in the spring of 1873.

Gravel-mining.—This industry has not been very thriving in the county the past year, except in two or three claims. At the Rough and Ready claim, owned by McLain & Co., hydraulic mining has been prosecuted, with results reported good.

The Table Mountain Blue Gravel Mining Company (formerly known as the Humbug and New York Companies) has employed a large number of hands, made considerable improvements, and moved a good deal of gravel during the year. Some of the gravel is reported to be rich in gold. This is a drifting claim, and the gravel is crushed in one of Cox's cement-mills.

The Alpha claim adjoins the Humbug claim. This company has recently sunk a slope, struck pay-gravel, and made one washing, which is said to have given a satisfactory yield.

The Omega claim is located below the Alpha. This company has spent considerable money in prospecting Table Mountain, and is now driving a tunnel to strike the channel of the Alpha Company.

Miners' wages in this county range from $2.50 to $3 per day; price of water, about 6 cents per inch, miners' measure, and sometimes more; but much of the water is sold at 6 cents and less.

List of quartz-mills in Tuolumne district, Tuolumne County, California. Reported by D. T. Hughes.

Name of mill.	Location.	Owners.	Stamps.	Arrastras.	Power.	Remarks.
Confidence	Confidence		40	3	Steam	Quartz.
Excelsior	Sugar Pine	Wright & Co	10		do	Quartz.
Orcutt	Near Jacksonville	App & Wright	4		Water	Slate and quartz.
Griffin & Tolten	Quartz Mountain	Griffin & Tolten	25		do	Quartz, mother lode
Heslep	Quartz Mountain	Griffin & Tolten	15		do	Quartz and slate, mother-lode.
Spring Gulch	Spring Gulch	Sherwood & Co	10		do	Quartz
Chandler & Beal	South Tuolumne River.	Chandler & Beal	4		do	Quartz.
Grizzly	North Fork Tuolumne River.		20		Water & steam.	Running on quartz from Lady Washington mine.
Tullock	Bear Creek	Gashweiler & Tullock.	5		Water	Quartz.
Knox & Boyle	Quartz Mountain	Preston & Co	10		do	Quartz.
Mount Jefferson	Garrote		10		Steam	

CALAVERAS COUNTY.

Calaveras County belongs to the group of counties described under the general head of "The Southern Mines" in the report for 1872. The mother-lode, running through the county from northwest to southeast, has been extensively worked, with varying results, for many years. Besides this lode, which will always form a basis for extensive mining, there are many outlying districts containing numerous quartz-veins, such as Railroad Flat, West Point, Washington, and Sheep Ranch. A local paper says:

The quartz-mining interest of Calaveras has advanced the past year more than during the whole period previous, since work upon the ledges was commenced. Gravel-mining is also being more extensively and vigorously prosecuted than it had been for two or three years past. It has been found that, with the reduced rates for water now prevalent, a larger percentage of the ground, abandoned years ago, will pay for washing. At several points in the county extensive hydraulics—similar to those in the northern counties—are being opened, and, as the rains set in, operations will be commenced on a large scale. There is a considerable area of mining-ground in this county, yet untouched, that will pay for working, while many claims abandoned in earlier days are being mined with profit to their owners. While it cannot be disputed that the surface-deposits—those that are readily reached without difficulty or expense—are in a great degree exhausted, the permanency of the mines now being developed will more than balance the ephemeral richness of the placers.

Mokelumne Hill.—The Paloma, or Gwin mine, six miles from Mokelumne Hill, is a consolidation of the Paloma and Alexander mines, and is the most thoroughly prospected mine in Calaveras County. The characteristics of the ore are those of the prominent mines on the mother-lode—sulphureted rock and occasionally free gold. The lode is nearly vertical, runs nearly north and south, and is traceable throughout its entire length by prominent croppings.

The south shaft is sunk to a depth of 600 feet, with levels opened both north and south, as follows: At 200 feet a level is run 240 feet north and 150 feet south, and considerable "stoping" done. At 300 feet the north level extends 240 feet, and the south level 150 feet. At 400 feet, levels are run north and south to same extent as on 300-foot level. At 430 feet, levels are run 100 feet north and 200 feet south, the ground between this and the 400-level being stoped out as fast as the drifts are run. This shaft receives the drainage of a great extent of ground, and powerful pumping-machinery has been provided with a view of future development. The middle shaft has attained a depth of 200 feet, with levels opened 100 feet north and 40 feet south. This shaft has powerful steam hoisting-works, and will be continued in depth. The north shaft is 350 feet in depth. Two levels have been run, the first at a depth of 200 feet, the second at 300 feet. The first level has been extended 200 feet north and 400 feet south of shaft; the second level (at 300 feet) 100 feet north and 250 feet south. All these shafts are timbered, and are provided with suitable hoisting and pumping machinery, run by steam-power.

The company owns two mills—one of 40 stamps, the other of 24 stamps. The process is amalgamation in battery, blanket-concentration, and chlorination. The mine has so far yielded 50,000 tons of rock, which has averaged about $8 per ton. The product and average yield have been estimated, as there are no reliable data of the operations of the predecessors of the present owners. The improvements on the property at the present time, including shafts, drifts, hoisting and pumping works, two mills, and buildings, &c., represent an expenditure of about $250,000.

Between the 500 and 600 foot levels there is an immense body of ore. The 500-foot level has been driven south 290 feet, in first-class ore the entire distance, and the end of the chimney is not yet reached. The shaft between the two levels was sunk through rock that paid $50 per ton, and the quartz in the bottom of the "sump" is richer than at any other point. The extension of the 500-foot level and the sinking of the shaft have uncovered a mass of rock 900 feet in length by 100 feet in depth—known to be of extraordinary richness—enough to keep the batteries occupied for an unlimited time.

West Point.—This is a quartz-mining town, between the Middle and North Forks of the Mokelumne River, eastward from Mokelumne Hill, sixteen miles by stage-road; its elevation is about 2,800 feet above the sea. The climate is mild; but little snow falls during the winter season. The formation is granite; the lodes are narrow and in most cases rich in gold and sulphurets, and are found to increase in width as they go down to the depth of 100 to 300 feet. Mining and milling at one time seemed to be separate occupations, but of late they work to much better advantage conjointly. This section of country has been worked by Mexicans, who, as a general thing, hunt for rich pockets and those near the surface. They seldom go deeper than 50 feet, and when they find water or blasting-ground they give up the claim and go after new deposits. The developments on the Zacatera mine have established the permanency of the leads in that district. At Mosquito Gulch the San Bruno, Good Hope, and Grasshopper leads, though not large ledges, pay well. At San Andreas the Thorn and Sciſford mines are in operation, the former having been bonded for $80,000. At Angels the "Big mine" and Stickle claims are paying handsomely.

Railroad Flat.—The prospects of the mines in and near Railroad Flat have rapidly improved during the year. The Petticoat has struck the pay-chimney by continued drifting to the north, but the disadvantageous position of the main shaft in relation to this ore-body has much retarded the prosperity of the enterprise.

Meanwhile several mines, but little known a year ago, have developed into first-class properties. Among these are the Wolverine, Sanderson, and Prussian Hill. The Wolverine has a 4-foot ledge at a depth of 250 feet, with rock of exceeding richness.

Washington district.—In this district there are three mills, aggregating 33 stamps. The principal mine is the Calaveras, the property of a San Francisco company.

The average yield of the Calaveras Company's ore the past year has been $19.60 per ton; cost of working in mill, $2 per ton.

The average yield of the Ferguson & Wallace mine has been $40 per ton; cost of hauling and milling, $4 per ton; cost of mining, about $5 per ton.

The yield of rock from the Woods mine, near Indian Creek, has been from $25 to $80 per ton; averaging at least $50. Cost of hauling to mill, $2.75; of working, $1.25; total, $4 per ton.

All the above-mentioned mines are now vigorously worked, with very flattering prospects.

List of quartz-mills in Washington district, Calaveras County, California. Reported by W. M. Donnell.

Calaveras Gold Mining Company's mill, located at Indian Creek; 20 stamps; steam-power; mill run four months. Idle for want of development in mine.

Ferguson & Wallace mill, located at Sheep Ranch; 5 stamps; water-power; nearly all the time at work.

Samuel Wood's mill, located at San Antone Creek; 8 stamps; water-power; 4 stamps idle for want of water.

The above mills were all built in 1871.

Mr. Henry F. Terry, of Mokelumne Hill, one of the United States mineral-surveyors of the county, has kindly furnished the following, in reply to a letter of inquiry:

It is almost impossible to notice other than the most noted improvements in this industry. Almost every claim is improving more or less.

The Heckendorn mine, on Blue Mountain, is re-opened, and a 5-stamp mill erected.

A very lively interest is manifested in the mines near Railroad Flat and West Point. Several old claims have been opened during the year with good results, giving fresh impetus to prospectors.

Among the many paying mines at or near West Point, I may mention the Zacatera and Bartola.

The Woodhouse, in Sandy Gulch, is lying idle, but considered valuable; and a United States patent has been applied for.

The Petticoat, near Railroad Flat, is re-opened with a full complement of men.

The Sanderson mine, a new discovery, also near Railroad Flat, has paid exceedingly well from the commencement.

The Wolverine is showing good results, and the proprietors are erecting a mill, capable of enlargement to 20 stamps.

Operations on the Poor Man are suspended, for reasons known only to its owners. United States patents have been applied for on the Wolverine and the Poor Man.

The San Bruno, near Mosquito Gulch, is considered among the permanent mines of the county.

The Quartz Glen, near Upper Rich Gulch, has been re-opened and put in readiness for working.

The Hudson, lately sold to an English company, located four miles west of San Andreas, is in a flourishing condition; extensive improvements are making, and application for United States patent pending. A mill is erecting.

Work on the Empire Chief, near San Andreas, has been pushed considerably this year.

The Union Gold-Mining claim, three miles south of San Andreas, is considered a good mine, and constantly worked on a small scale.

Scrifard's claim, near San Andreas, has been re-opened with good prospects.

The Madeira, near El Dorado, is considered a permanent mine, and is constantly worked. A new mill has been erected on the premises.

There are several mines at the Sheep Ranch, a few miles southeast of El Dorado, and a small quartz-mill.

A San Francisco company has purchased the Oramento, Enchantress, and Southbank, situated about two miles northeast of Murphy's, and is working them to good advantage. A 20-stamp mill has been built within the last eighteen months.

The Right Bower and Washington, near the last-mentioned mines, are also considered permanent.

The Stickles mine, in Angels Camp, is a well-prospected mine, and is considered among the permanent and paying mines of the county. A new mill is in course of construction.

The Big mine, also in Angels, is considered a permanent institution.

List of quartz-mills in Calaveras County, running in 1872. Reported by Henry F. Terry.

Name of mill.	Location.	Owner.	Stamps.	Power.	Remarks.
Heckendorn	Blue Mountain	Heckendorn Mining Co.	5	Water	Run three months.
Harris	Sandy Gulch	A. M. Harris	8	...do	Constantly.
Woodhouse	......do	......do	5	...do	Idle during the whole year.
Hope	......do	Hope	15	...do	Nine months.
Lacy	......do	A. Lacy	5	...do	Eight months.
Vance	Mosquito		8	Steam	Idle; undergoing repairs.
Thoss	West Point	W. H. Thoss	5	Water	
Hepburn	Railroad Flat	Hepburn & Co	10	Steam	Ten months.
Petticoat	......do		15	...do	Five months; pay recently struck in this mine.
Clark's	......do	W. V. Clark	5	...do	Seven months.
Lewis Bros. & Co.	Near Railroad Flat	Lewis Bros. & Co.	5	...do	Idle during the whole year.
Wolverine	......do	S. O. Putnam	10	...do	Erecting; a promising enterprise.
Whisky Slide	Whisky Slide	Whisky Slide Mining Co.	10	...do	Three months.
Smith's	Near Mokelumne Hill.	Smith	5	Water	Two months.
Gwin's	Lower Rich Gulch	Gwin Mining Co	40	Steam	Eight months.
Alexander	......do	......do	24	.. do	Idle the whole year.
Lloyd	San Andreas	Lloyd Bros	5	Water	Three months crushing gravel.
Hudson	Near San Andreas	S. O. Brown	20	...do	Erecting.
Madeira	Near El Dorado	G. Roderiein	10	...do	Erecting.
El Dorado	......do	William Irvin	5	Steam	Idle the whole year.
Oramento	Oramento mine	G. H. Congdon & Co.	20	. do	Ten months.
Stickles	Angels	Stickles & Co	10	Water	On mother-lode.
Big Mill	......do	Big Mining Co	30	...do	On mother lode.

AMADOR COUNTY.

This county justly ranks as one of the leading quartz-mining counties of the State. There are within its limits thirty-five quartz-mills, with an aggregate of nearly 600 stamps. The most extensive mining enterprises are on the mother-lode, in the vicinity of Jackson, Sutter Creek, and Amador City, but the county contains, aside from these, numerous valuable ledges, to which attention has been attracted during the past year. At no period in the history of mining in this county has the prospect been more cheerful than at present, and it is expected the gold-yield for the coming year will greatly exceed that of the last.

The Pennsylvania, Erie, and Original Amador mines, near Amador City, have been purchased by English capital. From the admirably thorough reports upon these mines, made in September and October, 1872, by J. D. Hague, M. E., of San Francisco, I extract and condense the following descriptions:

The Pennsylvania is an old mine, having been worked during a number of years by various parties. There are now no available records of their operations, and no very definite information can now be obtained concerning the upper portion of the mine. The mine is opened by a single shaft which is said to be located about 300 feet from the south boundary of the property. The length of the claim is stated at 3,900 feet, the greater portion, therefore, lying north of the present works. The shaft is 620 feet deep, and is sunk on the dip of the veins, at an angle of about 45°.

Above the 320-foot level the work is all old, and is now inaccessible. The vein, as developed in the lower works, presents the following features: It is inclosed in granite. Its course is about N. 55° W., magnetic, or nearly northwest and southeast, true. It dips to the northeast at an angle of about 45°. Its walls are very well defined and regular, showing good indications of permanence. The width of the vein varies from 2 or 3 inches to about 2 feet. It is said to have been about 3 feet wide in some of the stopes recently worked out, but the widest place just now visible is about 18 inches. The seam is filled with quartz, usually highly charged with sulphurets, generally presenting the appearance of high-grade ore. Free gold in coarse grains is frequently visible. The proportion of sulphurets appears from the milling-operations of the last eight months to be between 5 and 6 per cent.

At the date of purchase by the present owners the mine had been opened to the depth of 250 feet; the 520-foot level has since been driven south 297 feet, and north 150 feet. The 420-foot level is 240 feet long north of the shaft, and 251 feet long south of the shaft. The 320-foot level is 272 feet long north, and 125 feet long south of the shaft. These levels, with the stopes between them, are hardly sufficient yet to afford a definite idea of the extent and mode of distribution of the pay-chutes, but there appear to be courses of good and barren ground, which, so far as yet indicated, dip from north to south.

Most of the ground now opened above the 520-foot level has been stoped out, excepting certain portions which are either known or supposed to be too poor to pay. North of the shaft above the 520-foot level there is a block of ground of considerable extent still standing. Some trial-stopes in this ground have been made without very satisfactory results; but it has not yet been thoroughly tested, and it remains to be seen whether or not it may be mined with profit. Some portions of the vein, as shown in the drift, are good-looking but small. At the present moment this block of ground is believed to be the only reserve above the 520-foot level which may supply ore to the mill before new ground is opened, either in depth or length. It appears that during the first half of the present year, while the stopes above the 520-south were furnishing good ore, too little work was done in opening new ground for the future. The result is that it is now impossible to keep the mill fully supplied; and should the ground above the 520-north prove to be too poor to pay, this condition of affairs is likely to last until new resources are developed.

The vein in the shaft below the 520-foot level is looking well, though small; its width varies from about 2½ inches to 15 inches. The new level going south from the bottom of the shaft shows a very small vein. The winze 75 feet south of this shaft was, at date of visit, about 75 feet deep. The average width of the quartz was about 18 inches, and much of it appears to be of very good quality. The hope and reasonable expectations are that when the drift from the shaft is connected with this winze and extended farther to the south, a vein of paying width will be found, and thus a block of good ground be made available for milling. The prospects for the future, therefore, both in the bottom and in the north end of the levels above, are encouraging. The late experience of the mine shows that the vein, though small, carries rich ore which may be mined at a cost affording a handsome margin of profit. From the commencement of operations by the present owners to the 31st of August, there were, according to the records in the office of the company, 2,047 tons of ore mined, and 2,076½ tons of ore milled. During this period the expenses have been as follows:

For mining	$18,168 53
For milling	4,316 47
For bullion-expenses, several expenses, and expenses on gravel-claim	3,216 27
Making a total of	25,701 27

Dividing the total mining and milling items during this period by the number of tons mined and milled, the cost of mining is shown to be $8.88, and the cost of milling $2.08 per ton; while including the incidental cost, the sum-total of expense, (diminished by $1,300 expended on the gravel-claim and not chargeable to the mine,) divided by the number of tons treated, shows a whole cost per ton of $11.92.* During the period referred to the total bullion-product is shown to be $56,955.26. Of this sum $989.94 was derived from the gravel-claim, and is not to be credited to the quartz-mine; this deduction being made, the bullion-product to August 31 is $55,965.32, equal to a product per ton, including the yield of free gold in the mill and the sulphurets subsequently obtained, of $26.95, or a profit of about $15 per ton of ore.

* It is to be noted that this sum does not include the expenses of the San Francisco and London agencies. This sum is also something less than it would have been if a due proportion of prospecting work had been performed during the prosperous months; the result being now that the costs, per ton, must apparently increase.

The mine is well furnished with the necessary appliances for working. The shaft is about 9 feet long by 4½ feet wide in the clear. It is well timbered and provided with hoisting and ladder ways. The rock is hoisted in cars. The shaft is provided with two 6-inch lifting-pumps, one at the 420-foot level and the other at the 520-foot level. Below that point the pump is 4 inches in diameter. The rod, bob, and other working-appliances of the pump are apparently in good condition, and will probably answer the purpose for continued sinking. The water is not very abundant. The pump runs on a 4-foot stroke, making six strokes per minute. The hoisting and pumping machinery at surface comprises two engines, each 10 inches diameter by 20 inches stroke; one for hoisting and the other for pumping. They are so arranged that they can be coupled together, and each one aid or serve as substitute for the other.

The mill is situated near the shaft-house, connected with it by a short tram-road. There is ample room behind the batteries for an ore-dump. The mill has 8 stamps, weighing about 750 pounds each. They are run at a speed of about 60 blows per minute, and drop 9 inches. The mill is old, but is still in fair working order. It is furnished with the usual contrivances for saving the gold. Amalgamation is effected in the battery and on plates outside. The ore, after leaving the plates, is concentrated in ties, washed upon a rocker for the separation of the sulphurets, which are sent to the chlorination-works for treatment, while the mass of tailings are further concentrated on a large buddle. The sulphurets have an average value of about $110 per ton, and their treatment costs $22.50 per ton. This gives between $85 and $90 per ton net; and as the average proportion of sulphurets per ton of ore has been nearly 5½ per cent., the yield of gold obtained from the sulphurets amounts to about $4.50, or $5 per ton of ore. The buddle is worked on shares by tributors, and its product adds somewhat to the yield obtained in the mill. The mill is driven by steam, being furnished with an engine of 8 inches diameter of cylinder by 14 inches stroke.

The Erie mine is near the summit-ridge of a mountain-spur between the north fork and the south fork of Poorman Creek, a tributary of the South Yuba. These streams flow in a general direction from northeast to southwest. The mine is situated on the brow of the hill overlooking their confluence, and the form of the surface is such that, the course of the lode being nearly north and south, the ground falls off steeply in three directions, north, south, and west; while to the northeast it rises gradually toward the more elevated mountain-range. The streams flow in deep cañons, probably over 1,000, perhaps 1,500 feet below the present mine. These conditions afford good opportunities for working the ground by means of adits or tunnels driven in from below, should future developments sufficiently assure the permanent value of the property. Just to the eastward of the present works the ground is nearly level for a considerable distance, giving a favorable site for the requisite buildings, hoisting-works, mill, wood-yards, and other appurtenances.

The mine is at present worked through a single shaft upon the inclination of the vein, or about 67° from the horizon. The shaft is said to be near the center of the property, but is near the south end of its developed portion. It was 250 feet deep in September, on the dip of the vein. At 80 feet and 160 feet, levels have been driven between 200 and 300 feet in length north, and over 100 feet south. Below the second, or 160-foot level, the shaft has been sunk already 90 feet, and further sinking is in progress to open a new level 100 feet below the last.

The mine has been worked during a number of years, and by several different parties, operating generally on a small scale. The greater portion of the ground above the first and second levels north of the shaft, and some of the ground south of the shaft, have been already stoped out. The older stopes are for the most part filled up, and now inaccessible, while the newer stopes, still open, show the vein to possess the following characteristics: a general course of N. 20° W. magnetic, or within a few degrees of due N. and S., and a dip 67° E., both conformable with the general strike and inclination of the inclosing slates. The slates are not very hard, irregularly laminated, and carry many veins and intercalations of quartz. The width of the vein is variable; walls not very well defined. The average width of the stopes is probably about 15 feet. A recent stope above the first level, south of the shaft, is 30 feet wide in places. This lies entirely west of the shaft, while east of the shaft, 20 feet below the first level, a cross-cut has been made 50 feet to the eastward, entirely in quartz. The mass of the vein is a mixture of quartz and slate. In the ground now standing above the second level, which is generally poor, the quantity of slate seems to exceed that of the quartz. Its value in gold cannot be very closely estimated by the eye, but it is generally of a low grade, according to results recently obtained in the mill. The proportion of sulphurets in the quartz is exceedingly small. Below the second level, both in the shaft and in a winze which is now being sunk about 100 feet north, the quartz is better-looking, frequently showing free gold.

The length of vein proved in the present works of the mine is about 290 feet on the first level, and about 220 feet on the second level. When the property came into the hands of its present owners all the work lay north of the shaft. The first level had been driven, it is said, 240 feet north, at which point the vein becomes pinched.

This level is now impassable, and the ground cannot readily be examined. The second level, at the date referred to, had also been driven 140 feet north in the vein, and at that distance the quartz is pinched to a small seam. The level has since been carried on in the eastern country-rock, and, at a point about 90 feet beyond a cross-cut, has been driven westward, cutting what appears to be the wall of the vein, but developing thus far only a narrow seam. This is therefore practically the north end of the present pay-chute, though the vein continues, and should be opened out by drifting either on a second or a lower level, in the expectation of finding a widening out of the ledge, and thus developing a greater length of productive ground.

Under the new management both levels, the 80-foot and the 160-foot, have been driven southward from the shaft. Both passed through a mass of mixed quartz and slate, which afforded a low yield of gold by milling. At about 45 feet from the shaft, on the first level, the quartz abruptly terminated, having been apparently cut off by a dike; and on the second level the same dike was encountered at a distance of 75 feet from the shaft. This dike of eruptive rock has a course about N. 70° W. magnetic, making an angle of about 50° with the course of the vein. Its dip is south at a pretty high angle. Its width, judging from developments under ground, and from appearances on the surface, is only a few feet. Search for the continuation of the vein beyond the dike has not yet been thoroughly made. On both levels a drift has been run on the course of the dike, but not in the regular country-rock of the vein. I am unable to say with certainty whether the dike has occasioned any extensive faulting or displacement of the vein, but such does not appear to be the case at present; and, if the vein is continuous beyond the dike, it will probably be found without much trouble. Whether or not it is continuous remains to be proved. The dike is therefore the present southern limit of the proved quartz-vein, and the pinch on the north, already described, is the present limit in that direction.

Between these limits the developed ground of known value has been, as already stated, chiefly stoped out. North of the shaft, above and along the entire length of the first level, the earlier operators of the mine had stoped away a considerable portion, leaving, however, a large reserve between these stopes and the surface. The present manager has raised stopes along the entire line of this reserve for perhaps 10 or 20 feet, but, unfortunately, the rock yielded so poorly in the mill that the ground was subsequently abandoned. Between the first and second levels north of the shaft were the stopes of the late owners, and from this region came the ore which made an excellent yield during the six months previous to the purchase by the present owners. Some ground in this block, remaining at date of purchase, has since been stoped, affording good returns, but all of known worth in this portion of the mine has now been removed. South of shaft in first level a large stope has been made by the present management. It extends from near the shaft to the southern limits of the quartz, and rises as high toward the surface as it is prudent to go. From this chamber, which has a width of 20 or 30 feet, probably over 2,000, perhaps 2,500, tons of ore have been taken and milled, hardly, if quite, paying the costs of mining and milling.

Below this stope, between the first and second levels, the ground is all standing. This block is practically the only known reserve of unprospected or unimproved value above the second level. Should it be no richer than the stope just above it there would hardly be profit in working it, but, as the vein here is very wide, there may possibly be found a better seam somewhere between the walls of the vein, and in this hope it should be prospected.

The present condition of the mine may be briefly summed up as follows: The length of known vein, limited on the south by a dike and on the north by a pinch, is 290 feet on the first level, and 220 feet on the second, diminishing therefore in depth. Above the second level, between these limits, all the quartz that is now believed to be profitable for working has been stoped out, though large reserves of low-grade quartz remain, and further prospecting may show some portions to be valuable. The hope for the future, therefore, lies in opening new ground below the second level, and in extending the work longitudinally with the purpose of opening up a greater length of ore-ground. The sinking now in progress gives most satisfactory indications of a good vein and profitable quartz. The probabilities are that the shaft and winze will open a block of very good milling-ore.

The hoisting and pumping works are established at the mouth of the shaft, which has a nearly uniform pitch of 67° from the horizon. When complete its dimensions will be 7 feet by 14 feet over all, timbered up with square timbers in three compartments, each about 5 feet by 4 feet. Two of these are designed for hoisting and one for pumping. The rock is hoisted in iron buckets, sliding upon guides. The shaft is provided with an 8-inch lift-pump, which extends to the 160-foot level; and there is already a supply of pipe to reach to the level below. The mine at times is very wet, and of late the water has proved a cause of serious delay in sinking, as the means provided for its removal were insufficient.

The hoisting and pumping machinery is driven by a steam-engine, 14 inches diameter of cylinder, which also drives the stamps; the mill and hoisting-works being under one roof. This arrangement, though well adapted in some respects to a small scale of operations, possesses the disadvantage of making the several departments of the work too closely dependent upon each other. If the pump is driven at the most advantageous speed the stamps run too slowly; and, if an accident causes a stoppage in one department, it is very likely to delay all the rest of the work. The mill has 10 stamps of about 800 pounds each. Their average speed is from 64 to 70 9-inch drops per minute, though they might be run to 80 if disconnected from the other machinery. Their duty in crushing rock varies, but may average 2½ tons per day per head. Amalgamation is effected in the battery and on plates, as usual. The tailings run over blankets for the accumulation of the sulphurets, but these form an inconsiderable proportion of the ore. The costs of mining and milling are comparatively low under the advantages derived from working a large vein of rather soft rock, and from the cheapness of fuel, timber, and other essential materials. Cord-wood costs from $2.25 to $2.50 per cord. Labor varies from $3 to $3.50 per day. According to the data obtained from the record of operations, the total amount of ore mined by the present company up to August 1 was 3,842 tons, and the whole mining and milling cost of this, including all prospecting and dead work, was $5.88 per ton. This includes also bullion and general expenses. The average cost of milling alone, during this period, has been about $1.50 per ton, leaving $4.38 per ton for all other current costs. As the prospecting and dead work have probably been somewhat in excess of their due proportion under ordinary conditions, this cost may be regarded as a safe indication for the future, if the width, hardness, and ore-producing capacity of the vein remain about as they have been in the past.

As nearly as I could ascertain, the average yield of the rock worked by the late owners, during the five or six months prior to the purchase by the present company, was about $10 per ton. All or nearly all this rock came from between the first and second levels; and, at the time of the transfer of the property there was a small pillar remaining of similar quality. This was mixed, by the present superintendent, with other rock in the mill while it lasted; and, during the six or seven months of the present year, July inclusive, the highest month's average yield has been $8.14 per ton, and the lowest $4.12. The total receipts for this period, divided by the number of tons milled, shows an average yield of $5.84 per ton of ore.

There would be but small hope for profitable business in the future if there were no prospect of increasing the yield thus far obtained by the present owners. There is, however, much encouragement in the appearance of the ground now being opened below the second level. Should the present indications be found to fairly represent the character of the quartz, the yield should be brought up to the original estimates, say of nine or ten dollars per ton.

This, with an expense of, say, $6 per ton, (or, when working on a large scale and with increased facilities, a still lower cost than this,) would leave a marginal profit of, say, $3 per ton or more.

The so-called East Vein has lately been receiving some attention in the way of exploration.

It crops out boldly about 300 feet east of the Erie hoisting-shaft. Its croppings can be traced for a long distance; and they might readily be assumed to belong to the Erie if not carefully observed. They appear, however, to indicate a parallel vein, which, so far as surface-croppings show its character, is large and permanent. Little or nothing is yet known of its value. Some prospects have been obtained from panning the rock from the croppings. At present a pit has been sunk upon it from the surface, and on the second level of the mine, north end, a cross-cut is being run through the country-rock to strike it.

The Original Amador claim covers 1,450 linear feet, while the underground workings extend about 650 feet in a northwesterly direction from the south boundary. The mine is opened by three shafts, which follow nearly the dip of the vein, inclined, say, at from 40° to 70°.

The southernmost of these shafts, 68 feet from the south boundary, 175 feet deep, of small dimensions, was used by the oldest workers of the mine. Of late it has been employed as a pump-shaft, a steam-pump being established at the bottom of it. The middle shaft is 196 feet northwest from the last mentioned, and 48 feet vertically above it on the hill, 356 feet deep on the vein, and is the main working-shaft, though in poor condition for extended operations. The upper shaft is about 133 feet farther north. Its mouth is, say, 17 feet above the mouth of the present working-shaft. It was designed and partly sunk by the recent owners as a new working-shaft, but it is not yet completed. The ground has been excavated from the surface to bottom level of the mine. The ground passed through by these shafts has been opened horizontally by drifts at various levels.

The vein courses northwest and southeast, dips from 40° to 70°, averaging, perhaps, about 55° E. It has a hard, slaty greenstone as a hanging-wall; while the foot-wall is a some-what soft, coal-black, thinly and irregularly laminated slate or shale. The vein has many features in common with those of the celebrated Hayward, Amador, and Keystone mines. The last-named mine is a near neighbor on the south of the Original Amador. The vein varies in width from 1 or 2 feet to 20, and perhaps more. It presents two characteristic seams, commonly distinguished as the hanging-wall vein and the foot-wall vein. These may be present together or single.

The hanging-wall vein appears to be usually much the larger of the two. It generally consists of hard, white quartz, frequently mixed with much greenstone, and sometimes joined to the greenstone of the hanging-wall rock, without any gouge or well-defined limit between them. This quartz carries some iron pyrites or sulphurets, usually sparsely distributed in spots and bunches, not often in seams. The general appearance of the hanging-wall quartz now visible is of that low-grade rock.

The foot-wall quartz is usually a narrower vein, inclosed in or associated with the soft black slate. It shows an abundance of clefts and crevices, in which are seams of sulphurets, and sometimes visible free gold. So far as known it has always been much richer than the hanging-wall quartz, and in the old works was stoped out, while the hanging-wall quartz was left, the latter being at that time too poor to pay. As already described, this foot-wall quartz may be associated with the hanging-wall quartz, or it may form isolated bunches, or chutes, or chimneys in the foot-wall slate.

The condition of the mine may be summed up as follows:

1. In the portion of the mine south of the middle shaft, and above the third level, there remains a large quantity of hanging-wall quartz, but with a small exception all the known foot-wall quartz has been removed.

2. North of the same shaft, and above the same level, there may remain good ground, but it is not yet proved.

3. Below the third level, and south of the middle shaft, the vein takes an easterly pitch into the greenstone, so that at the fourth and fifth levels, where it has been reached by cross-cuts, there is a mass of greenstone 50 feet thick intervening between the quartz and the regular foot-wall slate. This greenstone may be regarded as a "horse;" and the probability is that in greater depth it may disappear, and the quartz return again to its true place at the junction of the greenstone and foot-wall slate. The so-called foot-wall vein is almost entirely lacking in this portion of the mine so far as present developments show; and the hope for the future is, that when the bottom of the greenstone-horse is reached the coming in of the quartz in its true place will afford a good foot-wall vein of pay-rock.

4. Below the third level, on the north side of the shaft, there are large bodies of quartz opened, of which the greater portion stands now in reserve. The exact relation of this quartz to the hanging-wall vein found east of the greenstone-horse, further south, is not yet quite clear. It remains to be seen whether the greenstone pinches out, and the two veins come together going north. The indications are that this will take place in depth, since the foot-wall slate in the fifth level is taking a flatter pitch than it has had above. Of the quartz removed from this ground some portions have been excellent in quality, but the mass of it, as indicated by our present data, is of low value.

5. I have made no careful estimate of reserves now standing in the mine, since the present indications are that only a small portion of it, if any, will prove to be worth stoping; and such portion or portions have yet to be determined by special tests. The quantity of quartz is, however, not in question. I think there would be no difficulty in supplying the mill for a long time to come with the quartz now available; but the quality indicated by the crushings, so far, is such as to make an exact estimate of reserves of but little moment.

The yield of the quartz had not been exactly determined by mill-results at the date of my visit, as no complete clean-up had been made. The mill had made a continuous run from about the middle of July until the last of August, crushing, according to the records at the mine, 2,347 tons of quartz. The yield of this rock, obtained from partial clean-ups, is estimated to have been about $4 per ton.

Since the date of my visit the clean-up for September has been made. The value of the gold is not exactly determined at date of writing, but will exceed $8,400. The amount of ore crushed was about 1,300 tons, equal to about $6.50 per ton. The average product thus far obtained would not be far from $5 per ton.

With regard to this yield it is to be observed, first, that the difficulties of starting a new mill and of obtaining immediately a fair percentage of the value of the ore, are sometimes so great that it would be unwise to base any conclusions on the first results until they are confirmed by longer operation. A variable and sometimes large amount of gold must be absorbed by and remain upon the amalgamating-plates of a new mill, and this item alone may considerably diminish the amount of gold obtained from the first run. Thus Mr. Oliver tells me that in the case of the new Coulter mill at the Sierra Buttes mine, it was only after three months' running that the yield of the rock was equal to that crushed in the other two mills of the company, at work on similar ore. During the first month the difference was $4 per ton; and subsequently the improvement was gradual, until the yield in the new mill was finally brought up to the average yield in the others.

In the present case the operations of the mill show a gradual improvement. That the yield of the rock, however, will fall far below the estimated value, and probably below the working-costs, is too clearly indicated.

Further, the rock thus far crushed in the new mill has come chiefly from the stopes opened above the fifth level. Only small quantities have come from other points in the mine. None had yet been taken, at the date of my visit, from the immediate vicinity of the larger of the two stopes that furnished the rock for the working-tests made by the recent owners, although some have been crushed from a stope not far below it. I think it quite improbable that this circumstance will furnish the reason for a lower yield than was expected, for, judging of the rock by its appearance, that which has recently been crushed is quite as good as that which remains in the stope referred to; but it still remains to be determined by special tests whether the rock so far crushed fairly represents the average value of the quartz now available in the mine, or whether there are any portions of the mine that may yield a higher grade of ore.

With regard to the wide difference between this yield obtained and that estimated, I have but a simple suggestion to offer, in effect, that, accepting as true the reported milling results on which the estimates were based, it is probable, in the light of our present knowledge, that the yield of the higher-grade rock obtained from the foot-wall chimney, before described, unduly raised the average value of the rock obtained from the larger stope in the hanging-wall quartz, which is of much lower grade.

The working-expenses of the mine during July and August are set forth by detailed statements furnished from the office. The mining-costs are as follows:

	July.	August.
Officials	$500 00	$500 00
Extracting ore, (labor and materials)	3,780 52	1,991 04
Prospecting and dead work	2,037 31	2,452 39
General work	415 28	11 50
Hoisting-works	519 00	431 85
	7,252 11	5,386 78

The amount of ore extracted from the mine in July was 802 tons, and in August, 1,178 tons. Taking the figures given above, the total mining-cost (not including milling) was, in July, $6.71 per ton, and in August, $6.13 per ton. The amount of prospecting-work applied to the amount of ore extracted, was, in July, $2.48, and in August, $1.73 per ton; these sums, subtracted from the foregoing, leave the mining-costs, prospecting deducted, for July, $4.23, and for August, $4.40 per ton. It is to be observed that the present unexpected condition of affairs has induced a considerable outlay for prospecting; and this, when applied to the amount of ore extracted, considerably increases the mining-costs per ton. The cost for extraction, moreover, while applied only to the amount of ore hoisted, really covers the cost of breaking a large amount of rock remaining in the mine, and yet to be raised. The superintendent estimates 1,500 tons as broken in the mine and ready for hoisting. This, of course, unduly raises the mining-cost for the period of time in question.

The current costs of working will depend largely upon the relation which the outlay of prospecting and dead work will bear to the cost of actual extraction. If the quartz now open and available in the mine were to be stoped out, or if the ground to be opened in future should present as favorable conditions for working as that now opened, the expenses ought not to exceed much, if at all, the estimates made at the time of the purchase of the property, say $6 per ton for mining and milling. If, however, the hanging-wall quartz in deeper workings should remain too poor to pay, and the work in the mine should thus be restricted to what might be found of the narrower seams or smaller chutes of foot-wall quartz, the cost of working must necessarily be increased.

The mine is at present furnished with hoisting-works located at the mouth of the middle shaft. These comprise an engine, 12 inches diameter of cylinder, with one steam-boiler and two winding-reels. The shaft is fitted for hoisting with two iron buckets of 1,000 pounds capacity each. The shaft is in rather poor condition, having been sunk at various angles, which make it inconvenient for hoisting. The water is removed from the south shaft by means of a steam-pump; from the bottom of the middle shaft it is taken out by a bucket. The hoisting-works at the middle shaft are inclosed by a suitable shaft-house built of wood, connected with which is a smith's shop. The mill is located between the middle and the north shafts. It is connected with the former by a short trestle-work, so that the cars having received their load of rock from the bucket are moved into the mill and deliver their charge at the rock-breaker. The mill is furnished with one rock-breaker, which prepares the rock for the stamps. There are 40 stamps, each said to weigh 750 pounds, making 78 blows per minute, dropping about 8 inches. Judging from their work thus far their capacity will be about a ton and a half per head per day. Amalgamation is effected in the battery, and each battery is provided with an apron or table covered with an amalgamated-copper plate, over which the crushed material passes, and thence on to blanket-tables about 20 feet in length. The blankets are washed every half hour and the accumulated sulphurets and concentrated ore are ground in a pan for six hours. That which passes away from the blankets escapes from the mill, and is subject to no further treatment. The sulphurets having been ground in a pan are reserved for further concentration. Percussion-tables are now being constructed in the mills for their treatment. The operation of the mill appears to be generally satisfactory. I caused a series of assays to be made of the tailings escaping from the mill. The results varied from $2.50 to $3.26 per ton. This value might perhaps be diminished somewhat, though not much, by additional appliances for saving the gold, but it clearly indicates that the difference between the yield expected and that obtained is not to be accounted for by imperfect milling.

The power for driving the mill consists of a steam-engine, 18 inches diameter of cylinder, by 42 inches stroke. Steam is furnished by two boilers set separately in brick-work. This machinery appears to be well established and adapted to its purpose. It has been provided under the new management, as the turbine originally placed in the mill proved to be inefficient. Since the mill started in the middle of July the steam-power has been working satisfactorily.

The costs for milling in July were	$1,594 78
And in August	3,601 69
Making a total of	5,196 47

	Tons.
The amount of ore crushed in July was	847
And in August	1,500
Or in all	2,347

The cost per ton in July, therefore, was	$1 88
And in August	2 40
Or an average of	2 21

This cost may be decreased if, under more favorable conditions or with softer rock, the monthly duty of the mill should be increased, as may be the case.

On a foregoing page the total costs for mining in August, per ton of rock extracted, were shown to be	$6 13
Deducting the cost of prospecting per ton	1 73
We have as ordinary mining cost	4 40

As this is said to have included some other extraordinary expenses this sum might be still further diminished, and we may probably take as a minimum cost per ton	$3 75
And allowing a milling-cost of	2 25
We have as a minimum of working-expense under any probable conditions	6 00
The yield per ton according to present data is	5 00
And this leaves a net loss per ton of	1 00

In the same vicinity the Keystone has yielded from $35,000 to $40,000 per month during the greater part of the year.

At Plymouth, the Phœnix mine is being developed into one of the most valuable mines in the county. At the present depth of the main shaft, 500 feet, the ledge has attained the width of 20 feet without defining its full extent, and the whole of the ledge ranging from $10 to $100 per ton. A 40-stamp mill in connection with the mine is now being erected with the most approved appliances for saving gold and sulphurets.

The Alpine, a continuation of the Phœnix on the north, at a depth of 300 feet is turning out excellent rock, and gives every assurance that it is a valuable mine.

Near Jackson, the Kennedy is fast assuming its position among the most valuable mines in the county; the average yield of the last crushing reached $24 per ton, and the rock increases in value and quantity as greater depths are gained. A fine shaft, with powerful hoisting-works, is sinking southwest of the old shaft, to strike the ledge at a depth of 400 feet. The mill is running constantly from rock supplied through the old shaft, from the first and second levels, yielding from $15,000 to $20,000 per month. A new 40-stamp mill will be erected early in 1873.

The Amador, Oneida, and other mines near Sutter Creek, are yielding large returns. The former, better known as the "Hayward" mine, has been disincorporated preparatory to its transfer to English purchasers. With the completion of the Sutter Canal, of which but a few miles are now unfinished, the expenses of milling will be materially reduced, as it will yield an abundant and unfailing water-supply for power throughout the year, even in the dryest seasons.

A rich discovery was made recently on the 270-foot level of the Bunker Hill mine, extending up to the 170-foot level. The rock is well charged with free gold, and very rich in sulphurets, paying from $50 to $75 per ton.

Work on the Summit mine is progressing, and the main shaft has been put down 360 feet. From present indications the lead will be reached soon. The hoisting-works, machinery, and in fact everything about the mine is new and first quality.

East of Jackson is the State of Maine mine, which as far as the ledge has been sunk upon gives evidence of permanent value. A fine water-power mill connected with the mine has recently been completed.

The Marklee mine, situated north of Volcano, is doing better from the number of stamps employed than, perhaps, any mine in the county. The Marklee, and other mines in this vicinity, establish the fact that rich gold-bearing ledges exist in the county outside of the Amador belt.

In addition to the quartz-resources of Amador County, it contains a large area of unworked placer-ground, which will afford profitable employment to hundreds of men as soon as water can be had. The great want of the county is water; but this will, ere long, be supplied by the completion of the Sutter Canal. When that event shall take place, a new impetus will be given to every industrial pursuit in the county, besides opening up new branches of labor and business, adding largely to its population and wealth.

Mr. Skidmore informs me that, out of thirty-two circulars and mill-blanks sent to Amador County, addressed to the various mine owners and superintendents, not one reply was received, and no blanks were returned.

EL DORADO COUNTY.

This county, noted as the locality of the discovery of gold in California, is situated between the Cosumnes River and the Middle Fork of the American. For a number of years after the exhaustion of the surface-placers, the decline in population and wealth here was more marked than in any other portion of the gold-region. In 1861–'62, during the wild quartz-excitement prevailing in the State, the numerous veins exposed on the surface attracted the attention of speculators, who formed incorporations for the purpose of selling the stock rather than for the development of the mines. With the collapse of this excitement, El Dorado acquired an unenviable reputation as a mining-field, which it has taken years to outlive. Within the past two years, however, attention has been drawn to her extensive fields of auriferous dirt, her peculiar "seam-diggings," and her rich ledges of gold-bearing quartz. The result has been that her old-time prosperity is returning, quartz-mines have been opened, and vast enterprises are in progress for the purpose of bringing water in abundance on the deposits of auriferous ground which extend from the lava-capping of the high Sierras to the vine-clad foot-hills on the border of the Sacramento Valley. Two of these, of more than ordinary magnitude, will be briefly noticed.

The California Water Company, of San Francisco, has undertaken a system of works for the supply of the country between the Middle and South Forks of the American River, at a cost which it is estimated will not be less than $250,000. From a system of lakes and of natural streams rising on the western slopes of the Sierras, at an elevation of 6,000 feet above sea-level, a series of ditches, flumes, tunnels, and iron pipes will convey 4,000 to 5,000 inches of water down the various ridges through the auriferous region to the foot-hills of the Sacramento Valley, thus supplying an area of about two hundred and forty square miles, the greater portion of which contains gravel and auriferous dirt in paying quantities. The entire length of the ditches, flumes, &c., will not be less than two hundred miles. Where practicable, iron pipe, 22 inches in diameter, made from No. 12 and No. 16 iron, will be used. The iron is cut in 2-feet plates, bent by machinery and strongly riveted. When thus prepared in 18-feet sections, it is ready for use, and is buried 2 feet deep in trenches cut for the purpose along the line of the ridges selected, after careful surveys, as the most practicable routes. At one point, crossing the head of Greenwood Valley, one continuous mile of this main pipe will be laid, overcoming a mean depression of 330 feet in crossing the valley. By the use of extensive reservoirs and high dams near the supply-head, the water will be rendered available throughout the entire year, even in the driest seasons. This company owns large and valuable mining-interests also.

The Mount Gregory Water Company is engaged in a like undertaking, but of less magnitude. Its operations are fully described in Mr. Fairchild's paper, given below. It is believed that all the water furnished by both companies will be in demand within a few years. The contemplated water-rates will be 10 cents for ten hours, per miners' inch.

The lower portion of the county (from the valley to an elevation of 3,000 feet) is traversed from north to south by several distinct belts of auriferous ground, generally running in ridges between the Middle Fork and the South Fork of the American. These belts are respectively ten or twelve miles in length, and from one to two miles in width, with strips of non-auriferous ground lying between them. The general appearance of the gold-bearing portions of the country differs from that of the country (in Placer County) north of the Middle Fork; here there exist little or no cemented gravel and no indications of channels or "dead rivers." The "channels" of Placer County probably entered the county higher up, in the region described by Mr. Fairchild, and the distribution of gold in the lower portion is probably owing to the distribution of the contents of these higher channels. These belts or ridges are underlaid by vertically-tilted slates, sometimes highly metamorphosed, permeated in all directions by seams and small intercalated veins of quartz, and heavy "reefs" of siliceous sands. This strange formation constitutes the "seam-diggings," the most interesting features of which are exposed at Georgia Slide and Spanish Dry Diggings. The seams run in all directions, sometimes uniting and again scattering, but not giving promise of uniting in compact ledges, though such is the popular theory of the miner. They probably continue in this form as far down as the fractures in the slate have permitted the process of infiltration. This formation is worked most advantageously by the hydraulic process, assisted by blasting and picking. The gold does not seem to have been precipitated in the seams in the same way, as in quartz-ledges, but rather to have been brought in by the water when the seams were filled by infiltration. It is therefore generally found in the interstices between the quartz and slate, and is readily released by water, though in some instances small mills have been advantageously employed in crushing the quartz.

The strong ledges of this part of the county are on the borders of a belt of greenstone, and present all the characteristics of regular lodes. Of this class there are many promising mines, but their development is so limited as not to require special mention. Only a few, in an advanced stage of working, will be noticed.

The Saint Lawrence mine, justly considered one of the most valuable quartz-mines in California, is situated in Kelsey district, seven miles south of Georgetown, and is the property of H. P. McNevin, J. C. Bateman, and David Buell, by whom it was purchased, in a partially developed condition, a few years since, for $15,000. At that time but one level had been started, and the rock yielded from $10 to $12 per ton. At the time of the purchase much "dead work" had been done on a tunnel, which the owners, who were poor men, were unable to complete. Under the present proprietors this tunnel was carried on a total length of 400 feet, and the ledge struck at a depth of 115 feet. The tunnel is now used for purposes of drainage, and forms a valuable adjunct to the working of the mine. McNevin & Co., on their acquisition of the property, proceeded vigorously with its development, by sinking the shaft, with such encouraging results that they felt warranted in purchasing the adjacent ground, and acquired further, by location, a total length of 8,600 feet of ground. Within these limits it is reasonable to suppose, from surface-development at various points, that other chimneys or pay-zones exist besides the one now being worked. The sinking of the shaft was attended with the most marked success—the ledge widening from 2 feet, at a depth of 68 feet, to 8 feet 6 inches, at present lowest level found, 400 feet in depth, and the length of the paying-zone steadily increasing as each successive level was opened. At first level, 115 feet from surface, the pay-rock extended 105 feet; 200-foot level, 143 feet; 300-foot level, 210 feet had been opened in October, 1872, without limits of pay-rock being reached—the ledge widening toward the south, carrying at face of drift 8 feet of "pay." Since then the 400-level has been started, and main shaft carried down to a depth of 500 feet. A remarkable feature has been the steady increase of yield of the quartz, from $10 to $12 per ton for first 100 feet to $30 to $35 per ton between the third level and bottom of shaft. The course of the ledge is nearly north and south, and its dip 45° to the east. The foot-wall preserves the smoothness and polish of all large veins in this formation, while the hanging-wall is not so regular. A strong "gouge" of black talcose slate, often 6 or 8 inches in thickness, accompanies the hanging-wall, greatly facilitating the extraction of quartz. The country-rock is slate and greenstone; the quartz, of the blue, laminated description, rarely shows free gold, carries about 1 per cent. of sulphurets, the latter yielding from $300 to $500 per ton at the Nevada City Chlorination-Works, where they are sent for treatment pending the erection of suitable works at the mine. The mine has powerful steam hoisting-works, with sufficient power to open the ground to a depth of 1,000 feet. The incline, 12½ feet in width by 4½ feet in height, is provided with double track and improved cars, and substantially timbered throughout. The mill has four batteries of 5 stamps each; weight of stamps, 700 pounds; drop, 8 inches; power, steam; system of reduction, amalgamation in battery, copper plates, blanket-washing, and four Handy concentrators; capacity, 30 tons per twenty-four hours. It has been run constantly since its erection. The mine is nearly free from water, and is worked with great economy, not more than thirty miners being employed in the extraction of ore and the sinking of shaft.

The Cedarberg mine is situated about ten miles north of the Saint Lawrence, and is supposed by some to be on the same ledge, though this will remain a subject of doubt until demonstrated by further development in the country between the two mines. This mine, situated on the north slope of a range overlooking the Middle Fork of the American River, about 1,000 feet above the river, was discovered and located, in 1868, by John A. Cedarberg, an indefatigable prospector, who, finding rich float-rock in a ravine, near the river's banks, followed it up the mountain-side until he discovered the croppings of the ledge. The most remarkable feature of the mine has been its enormous product of singularly rich specimens of foliated gold.* This character of rock is found on the hanging-wall in a seam varying in thickness from 2 to 4 inches, and has so far continued in depth to lowest workings, and in length as far as the levels are opened. The mine was purchased and incorporated in 1872, the purchase-price being $12,000, a sum evidently far below its value. During the last quarter of 1872 it has paid the present owners $36,000 in dividends, with every prospect of a large and continuous yield for 1873. The gold-bearing quartz, from which these large dividends have been mainly paid, is crushed in a hand-mortar, or is sold intact as specimens; but the company, on running a tunnel to strike the ledge below the croppings, cut five separate, well-defined veins of low-grade quartz, separated by sulphureted slates, which induced them to put up a 10-stamp mill. The hanging-wall is defined but irregular, dipping about 70° E. The course, as of all veins in the county, is nearly north and south, and the formations greenstone and slate. At the close of 1872 no levels had been run below 100 feet from surface, but a permanent shaft with hoisting-works was sinking for deep work. It is expected that the veins cut in the tunnel will unite on the hanging-wall to a strong ledge, though perhaps the peculiar rich seam which gave the mine its notoriety may be shut off.

The Sliger mine, also noted for the richness and amount of its "specimen" rock, is about one mile north of the Cedarberg, on the same course, though lower down and nearer the river. This ledge was discovered in 1864, and is the property of practical men, who, profiting by the experience of the former owners of the Saint Lawrence and Cedarberg, do not intend that it shall pass from their hands for a mere pittance. They are said to have refused $100,000 for it. A tunnel has been started which, at 400 feet, will strike the ledge 200 feet below the croppings. The gold here is of a different character from that of the Cedarberg, and may be characterized as "grain" gold to distinguish it from the "leaf"-like production of the latter. It is also more generally diffused throughout the rock, and occurs in wider streaks. The ledge has an average width of 5 feet, though occasionally "pinching," when

* A collection of these was exhibited last winter in the Capitol at Washington.—R. W. R.

the rock becomes richer. The quartz has a more bluish color, and is laminated in ribbon-like bands. The average quartz, not of the "specimen" character, is also of better appearance, and will probably pay a large profit for reduction. The company owns a 5-stamp mill, but which is entirely inadequate for their purposes, and will be replaced by new and improved machinery on the completion of the tunnel. Meanwhile, as in the case of the Cedarberg, the specimen rock is reduced by hand, sold to jewelers as ornaments, or sent to the refining-works at San Francisco, where its value is determined by specific gravity. A shaft is sinking to connect with the tunnel and with a prospecting tunnel run nearer the surface, on the ledge.

Between the two last-named mines are several others of less note, but of great promise, and apparently on the same ledge. Among these the Atlantic and Pacific has made the greatest development, having attained a depth of 130 feet.

I am indebted to Mr. M. D. Fairchild, of Georgetown, for the material of the following interesting description of the northern and eastern portions of this county, and for some remarks on the southeastern part of Placer County.

The portions of El Dorado County spoken of lie between the Middle and South Forks of the American River, and include the townships of Greenwood, Kelsey, and Georgetown, and the villages of Georgetown, (the largest,) Greenwood, Centerville, Saint Lawrenceburgh, Spanish Dry Diggings, Johntown, Volcanoville, Kelsey, and others of lesser note, comprising an area of not less than one hundred square miles. This territory is in close proximity to Coloma, the site of the old Sutter mill, where Marshall made his celebrated discovery of gold, and, in consequence, it was early populated, and made, for a time, so productive a mining-field as to gain for El Dorado the distinction of being the second county of the State. About 1855–'56, two small ditches were constructed, the capacity of one being, perhaps, 300 inches, and of the other 500, by which the mines were supplied with water. Of course this amount was only sufficient to conduct mining operations upon a primitive basis, and as a consequence the population has dwindled in proportion as the shallow placers have become exhausted. As the people left this region, stockholder after stockholder in the ditches above mentioned disposed of his interest therein, until the principal ownership was vested in a single individual. Much complaint has been made of the policy pursued by him, into which it is not necessary to enter here. It is enough to say that the gold-product dwindled to a nominal sum, and that, in the very center of an extensive and promising mining-region, the ditches were allowed to get out of repair, and the water so much needed, abundant at the source of supply, was allowed to flow past the placers, undirected and unused. Other water-projects were discouraged by fears of litigation; and the franchise thus held, instead of being a public benefit, as all canal systems really should be, degenerated into a public nuisance. But within the past year this has been changed. The old ditch property has passed into other hands; a new and capacious canal has been completed by a new company, monopoly no longer holds sway, and a prosperous era is dawning. The principal owner of the old canals disposed of his right for $185,000 to the Pilot Creek Water Company, of San Francisco, which has, during the past year, been energetically reconstructing the property purchased, enlarging the capacity of the main canal, building reservoirs, &c.

The new (Mount Gregory) company, mentioned in a preceding page, has a ditch below that of the Pilot Creek Water Company, and reaching, at present, only from Pilot Creek to Mount Gregory Ridge, a distance of thirteen miles, with a fall of about 11 feet per mile. It is 6 feet wide at the top, 4 at the bottom, and 3 feet deep. The company, however, is engaged now, in accordance with its original plan, in extending the canal from Pilot Creek to the South Fork of the Middle Fork of the American River, a distance of thirty miles, it being found that Pilot Creek would not afford a full head for a ditch of that capacity for more than six months a year. Where the canal taps the South Fork there is an abundance of water the year round, and it is not unlikely that the Mount Gregory Company will hereafter increase the size of its ditch. At the head of this ditch the river is so nearly level that a dam 60 feet high will create in the bed of the stream a lake fully one mile long by a fourth to three-fourths of a mile wide, thus furnishing a capacious reservoir (should one be needed) lying in the natural outlet to an immense water-shed twenty miles in length, and thus, practically, inexhaustible. It is thus shown that the dividing ridge between the Middle and South Forks of the American River can and will be abundantly supplied with water for mining.

The largest continuous body of auriferous drift in the section referred to is upon Mount Gregory Ridge, bordering the southern bank of the Middle Fork of the American. At its eastern extremity is a ridge known as Tunnel Hill, much higher than the surrounding mountains, running north and south, and cutting in twain the lateral "divides" running west from the main Sierra. Immediately at the base of this hill the gravel-deposits begin; lateral east and west ridges again shoot out, and the head branches of many streams, as Missouri Cañon, Otter Creek, Cañon Creek, and others, are formed from springs issuing from its side.

The depth of the drift varies from a few feet to about 300, and, except where it is quite shallow upon the exposed points, jutting toward the river and the cañons, the auriferous strata are covered with a heavy body of volcanic mud, the "gray cement" of the miners. The width of the gravel-deposit upon Mount Gregory Ridge is about three-fourths of a mile, and its length fully six miles. This vast body of auriferous *débris* is comparatively untouched. At intervals it has been prospected by shafts and tunnels, and in a few places the edges have been tested by the primitive hydraulic operator, with scanty water-supply. These exploitations, as a general thing made years ago, when the price of both labor and water was high, if they did not then induce extended workings, have so exposed the strata as to render prospecting quite easy; and tests have determined that they may become remunerative under the modern hydraulic treatment, with improved appliances and adequate head of water. Near the central part of the deposit the bank has been exposed upon both sides of the ridge. Upon the southern side, where Missouri Cañon affords a fine depository for tailings, the claim of Messrs Bowman & Worthingham, and upon the northern side the claims of Bitters & Co., and the Mount Gregory Water and Mining Company afford the best exposures. The gold-bearing earth in the former is about 50 feet deep, lying in two strata and overlain with 30 feet of volcanic mud. An area of bed-rock has here been uncovered, about 50 by 100 feet. Work was suspended three years ago from lack of water. The average yield of the gravel was about one dollar per cubic yard. The gravel is mainly quartz, and contains many large, smooth bowlders, of half a ton weight. The claim covers, perhaps, 20 acres, and with sufficient water it will produce a large amount of gold. Adjoining this claim upon the west, the Mount Gregory Water and Mining Company has a continuous body of ground, similar in all characteristics, of one mile in length. Upon this side of the channel there is much coarse gold in nuggets, weighing from a pennyweight to two ounces.

On the northern side of the ridge the bank is precipitous, and the Middle Fork of the American here finds its bed, 1,500 feet below the rim-rock of the channel, affording unequal facilities for hydraulicking, the arrangement of tail-sluices, under-currents, &c. The claim of Bitters & Co., of 2,500 feet, and that of the Mount Gregory Water and Mining Company, of 1,000 feet frontage on the river, expose in slight workings the character of the drift. In the Bitters ground there is no exposure of more than 40 feet, but the gravel is all gold-bearing, the "color" being obtained in nearly each panful of dirt washed, while it has not been worked far enough toward the center of the ridge to encounter the overlying volcanic stratum. This gravel does not contain so much quartz as on the southern side, nor are the bowlders so large. The gold occurs in minuter particles. The material is not hard to wash, and would melt before a hydraulic pipe very rapidly. A pressure of nearly 400 feet could be obtained here; but only a very small head has been heretofore employed. The bank, at its greatest depth, must be nearly 380 feet deep; it is shallow only upon the extreme verge of the rim-rock. Its yield per cubic yard has been probably about 40 cents. The ground adjoining this upon the west, purchased by the Mount Gregory Water and Mining Company, was worked considerably, many years ago, with a small hydraulic. The bank exposed shows three strata of auriferous gravel, alternating with sedimentary deposits a few feet thick, and the whole overlain with volcanic mud. The aggregate thickness of the gold-bearing strata is about 35 feet. Though the portion exposed is not as easily "piped" as that disclosed on the face of the Bitters claim, it is, nevertheless, not invulnerable against attack by hydraulic force. The entire body of gravel "prospects to the pan," each panful generally yielding several good-sized scales of gold, besides numerous infinitesimal particles. It will probably produce nearly 60 cents per cubic yard.

Toward the west, down the ridge, are four or five "drift"-claims—diggings which properly should be worked by hydraulic power, but from which, in the absence of water, the owners are constrained to extract a portion of the lower stratum of gravel and wash it as rain occurs. The dirt so drifted out and washed will probably average $2 a car-load, the box of the car being about 2½ feet wide, 5 feet long, and 1½ feet deep. The most extensively worked of these "drift"-claims is upon the extreme end of the Mount Gregory Ridge channel at its embouchure into the Middle Fork. It is upon a knoll called Buckeye Hill, isolated from the main channel by a reef of serpentine rock, which here crosses the country, while the gravel-banks have mostly been precipitated toward the river below, leaving an intervening crescent of smooth rock. There are, perhaps, 40 acres covered by this gravel-deposit, 20 of which are included in the claim of A. W. Flora & Brother. These gentlemen have perseveringly worked here for many years, each season drifting out what dirt they could wash with the sparse amount of water they were able to procure, and waiting for a time when a regular supply would enable them to operate with hydraulic apparatus. The amount of dirt thus drifted and washed each year varies from 1,000 to 1,500 car-loads, which has thus far produced an average of $2.50 per load. Their sluicing capacity is not great, a few lengths of small boxes being deemed sufficient. Yet, by this primitive, and undoubtedly wasteful method, over $40,000 has been produced from the claim. The drift-channel has been prospected 950 feet from east to west for a width of 100 feet. It is supposed to be at least 200 feet wider. An attempt was once made to hydraulic the bank with 40 inches of water. That was in the better days of the Pilot Creek ditch, and this amount of water (which, later, could not be obtained) was found inadequate, though the operation was remunerative to the miners. By this hydraulic operation, the bank has been exposed on the west to the depth of 130 feet, showing several strata of gold-bearing gravel, alternating with sediment, precisely as described above in the claim of the Mount Gregory Company, adjoining the Bitters ground. It is estimated that the extreme depth of the deposit in the center of the hill is 240 feet. All the different strata, beside the volcanic mud and sedimentary strata, are found to contain gold in appreciable quantities, but the lower stratum only has been drifted upon. This has been exploited with reference rather to the convenience and facility of handling than to its richness or the pursuit of a systematic method of mining. The gravel has been taken out in thickness from 6 to 15 feet only; the chambers and galleries of the mine still exhibit, above, and on either hand, the immense bed of auriferous dirt, from every panful of which a fine "prospect" can be washed. In 1871, from about 1,200 car-loads of dirt, 320 ounces of gold were cleaned up. In 1872 the value of the gold taken out exceeded $3,000. These amounts represent the labor of two or three men who are doing little else than prospecting the ground, and who work but a small portion of the year.

The area of deep gravel-mines upon Mount Gregory Ridge is not less than four square miles. Upon the outer edges of the drift-channels the shallow placers have been exceedingly productive. The bed-rock is metamorphic slate, through which run many quartz-seams or small veins, some of which are rich in gold. A few have been opened, and a 10-stamp mill is now running upon ore taken from a vein near Volcanoville, a town upon the ridge. This quartz-mine is owned by Messrs. McKusick, Thomas & Jackson, and the rock yields about $13 per ton. Across the Middle Fork of the American from this ridge are the towns of Michigan Bluff, Sarahsville, and Forest Hill, all apparently located upon the gravel-beds of the same age.

At the eastern extremity of Mount Gregory Ridge, two more distinct gravel-channels, coming from the south, intersect it at right angles. The first of these is perhaps one mile square, with an average depth of about 40 feet, and was prospected many years ago with both tunnel and shaft; but it was never worked to any extent, being situated so high up toward the source of the cañons through which it finds drainage that difficulty is experienced in getting the required fall for tailings. Moreover, the lack of water previously spoken of has prevented the working of this ground. It can be opened upon the Middle Fork hill-side and made remunerative, as the gravel almost invariably shows gold in panning, and some that has been drifted out in several localities has been found rich. But the most extensive of these drift-channels is one which intersects the main ridge near the claim of Bowman & Worthingham. Its average width is nearly one mile, and its greatest depth about 200 feet. In length it is fully three miles. There are several openings upon it where hydraulicking upon a small scale has been carried on many years, that is, for a few months in each year, when water could be obtained by small ditches from the adjacent cañons. It crosses three branches of Otter Creek, where they flow through deep gorges, upon each bank of which the exposure of gravel has been made. The bottom stratum is principally quartz-gravel and sand, in some places covered with volcanic mud, and in others denuded of all but a few feet of reddish loam. In some of the openings immense bowlders of quartz are found, washed smooth as any pebble, some of which weigh over 25 tons. Large nuggets of gold are found occasionally in this channel. The principal openings upon the channel are near the center, at Kentucky Flat, tailing into the northern branch of Otter Creek, and upon its extreme southern end, at Tipton Hill, where the sluices tail into Rock Creek, a tributary of the South Fork of the American. Fully three square miles are covered by this deposit; and its gold-producing capacity can be judged by the following statement of the working and yield of the claim of Schlein Brothers, Tipton Hill.

This claim has been opened for a number of years; and with a small head of water, varying from 20 to 100 inches, a fall of 70 feet for hydraulicking, a short "string" of small sluices, and common duck-hose, and without the use of quicksilver, it has produced an average of $6 per day to each man employed. The owners of this claim estimate the length of this drift-channel, to one of the branches of Otter Creek, at 8,000 feet, and its width at 800 to 1,600 feet. There are ample facilities for extensive working; the fall for tailings is good, and a hydraulic pressure of 300 feet can be obtained at little outlay.

The channel from Tipton Hill, intersecting Mount Gregory Ridge near its eastern extremity, must have flowed, if the "ancient-river" theory is correct, from south to north, since at the northern end the rim-rock is perhaps 100 feet lower than at the southern.*

Parallel with Mount Gregory Ridge lies the divide between Otter Creek and Missouri Cañon, occupying an average width of one mile and in length about seven miles, the greater portion of which is covered with auriferous drift. Its main features are similar to those described in the Mount Gregory region, though the bottom stratum of gravel is generally not so thick, while in many places the volcanic mud or "cement" is thicker and harder. The strata above the bottom have been less prospected. The bottom stratum has in the main been exhausted by drifting. It was excessively rich, yielding in many instances from 10 to 50 ounces to the panful. In depth the drift is from 10 to 300 feet, but the small water-supply upon the ridge, the hardness of the stratum next to be attacked if work is continued, and the general decay of the section, have left all the upper layers nearly intact. In some localities some of these are known to contain gold enough to warrant hydraulic working; and the advent of water will lead to the washing away of much of this ground, the facilities for tailings being excellent. Upon this divide are located the diggings of Gopher Hill, Darling's, Harrison, Cement and Bottle Hills, Mount Calvary, and Jones's Hill. Large amounts of gold have been taken from each of these places. An exceedingly favorable place for hydraulic operations is Mount Calvary, where the gravel is less mixed with volcanic *débris* than in the other localities mentioned. The depth of gravel averages 75 feet, and covers an extent of perhaps 200 acres, of which the Mount Gregory Water and Mining Company owns an undivided one-half of 160 and C.

* "Perhaps after all," says Mr. Fairchild, "there may not have existed at a former period any ancient-river system, as some have theorized. To the writer it is quite as evident that some other cause than streams running at right angles with those of the present day, formed the immense banks of drift found along the lower Sierra. Certain it is, that in each hill containing such deposits are found basins deeper than the surrounding rim, with seldom a natural outlet as low by many feet as is the center of the basin. And while the rock of the center shows smoothness from attrition, the surrounding rim is quite the reverse, being rough and jagged." These features suggest to his mind icebergs and glaciers as possible agents. (See a subsequent chapter on this subject.)—R. W. R.

H. Calmes the remainder. From this gravel-bank prospects of 5 cents to the pan are not infrequent. In a few years the gold-product of El Dorado County will be greatly augmented from the divide between Otter and Cañon Creeks. It should be added that there is a small ditch now running water here; its length is about thirteen miles; capacity about 50 inches; owners, Barklage Brothers.

Upon the banks of the Middle Fork, at the base of Mount Gregory Ridge, and 60 to 100 feet above the bed of the stream, are many deep gravel-banks which pay well. That of Thomas McCall is the most noted. Its location is near Gray Eagle Bar; its area about 65 acres, with a depth of about 80 feet. A small hydraulic is operated there in winter, the water for which is obtained from a small, steep ravine coming down from the side of Mount Gregory. In summer, some drifting is done. It will probably average 80 cents per cubic yard, and is a valuable claim.

It is unnecessary to particularize further. This drift-deposit extends almost continuously for a distance of twelve miles east and west, and bears similar general characteristics. Isolated deposits, of a few acres each, occasionally occur farther to the westward, one being located at Centerville, near Pilot Hill, in which are found heavy quartz-bowlders, smoothly washed. A number of these have been found containing gold, from one of which, not long since, over $8,000 was extracted.

Almost the entire remainder of this region not covered by the deep drift is occupied by shallow placers, much worked, but not exhausted. This section embraces the towns of Centerville, Hogg's Diggings, Johntown, Kelsey, Spanish Dry Diggings, and many other small hamlets.

Throughout this entire section have been opened, to a limited extent, mines of a character new to the State, although they may not be strictly peculiar to the region. They are the seam-diggings already alluded to in this chapter. For a width of many miles there runs north and south a belt of metamorphic slate, soft and clayey, seamed with countless quartz-veins, varying in width from the thickness of a knife-blade to "bulges" of many feet, many of them being gold-bearing. Atmospheric action and other causes have disintegrated this rock and oxidized the sulphurets of base metals it contained, leaving the royal metal free in its matrix, and as easily brought by the placer-miner upon the surface as once were the river-bars. Some of these seam-diggings have been worked for years; a few of them have been opened to depths varying from 20 to 100 feet, while many have only been located, prospected, and held for the "good time coming" when there will be no lack of water. Several of these mines, where water could be procured for hydraulicking upon a limited plan, have yielded large amounts of gold; and the introduction of a plentiful quantity of water is expected to render this branch of mining exceedingly remunerative. The most noted claims of this character are Whiteside & Co.'s, at Crane's Gulch; Parsons's, at Georgia Slide; Hart & Co.'s, Jones's, Beebe & Co.'s, at Jones's Hill, and Nagler & Co.'s, at Greenwood. I have not been able to learn the product of any of these mines, but the aggregate every season must be large. The shipment of gold from Georgetown, which is the principal commercial town of the eastern extremity of the region spoken of, during the year 1871, (as obtained from Messrs. Sornberger & Lane,) by Wells, Fargo & Co.'s express, aggregated $155,582. During 1872, the same house shipped an aggregate of $230,482 gold-dust, as follows: January, $14,965; February, $13,895; March, $19,257; April, $25,445; May, $19,400; June, $10,610; July, $20,015; August, $16,450; September, $29,540; October, $18,850; November, $30,805; December, $11,250.

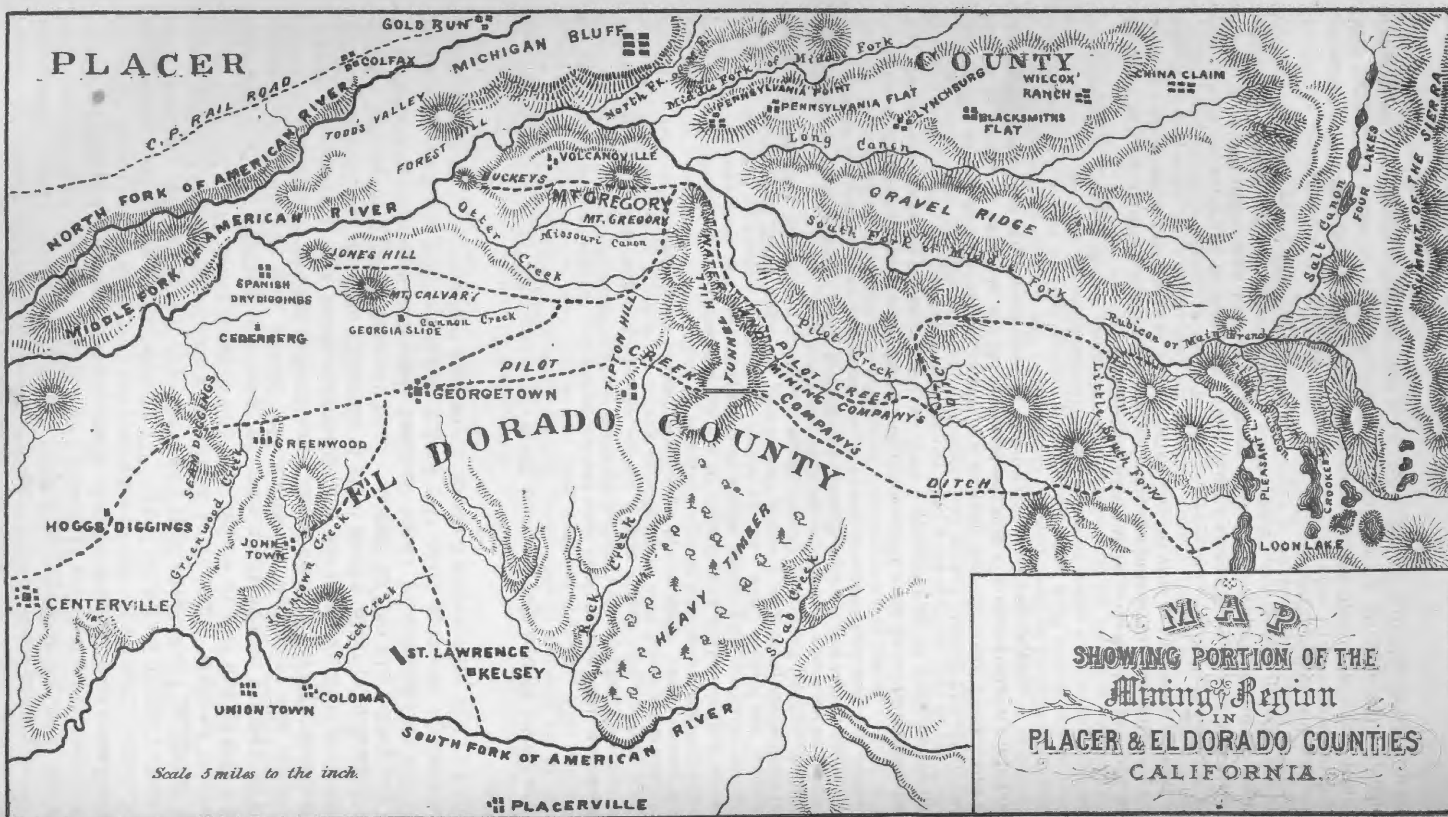
List of quartz-mills in El Dorado County, California. Reported by H. J. McKusick and J. L. Perkins.

Name of mill.	Location.	Owners.	Stamps.	Pans.	Power.	Remarks.
Pacific	Placerville	Unknown	10	....	Steam	Not running; run steadily for several years.
Shepherds'	......do	......do	10	....	Water	Running part of the time.
Pocahontas	Logtown	......do	15	....	Steam	Running all the time.
New York and El Dorado.	Loafer's Hollow	......do	10	....	..do	Running most of the time.
Church Union	Aurum City	......do	20	....	..do	Running part of the time.
Havillah	Nashville	......do	40	....	..do	Do.
Davidson's	Slate Creek	......do	20	...	..do	Do.
Pyramid	Davy Creek	......do	15	....	Water	Not running.
Mount Pleasant	Grizzly Flat	......do	20	....	Steam	Do.
Eagle	......do	......do	10	....	Water	Running occasionally.
Swan, McClain & Co.	Brownsville	Swan, McClain & Co.	10	....	..do	Idle.
Gamble & Richardson.	......do	Gamble & Richardson.	5	....	..do	Do.
Stillwagon & Norton's.	Near Brownsville	Unknown	5	....	..do	Do.
Maurice Dove	Volcanoville	Maurice Dove	10	1	Steam	Running occasionally.
Eureka	Georgetown	——— McClain	8	....	..do	Idle: rotary battery.
Saint Lawrence	Saint Lawrenceburgh.	MacNevin, Buell and Bateman & Co.	20	....	..do	Running all of the time.
Brewster	Lyonsdale	Brewster & Co.	10	....	..do	Running occasionally.
Taylor	Georgetown township.	W. G. Gibbs & Co.	10	....	..do	Idle.
Potter & Hunsucker.	Dutch Creek	Potter *et al*	5	....	..do	Running occasionally; custom-mill.
Beattie	Georgia Slide	Beattie & Co	5	....	Water	Runs on quartz from the seam-claims.
Blue Rock	......do	George Rau	10	....	..do	Do.
Parsons's	......do	Parsons & Co.	10	....	..do	Do.
Jones's Hill	Jones's Hill	Jones, Armstrong & Co.	5	....	..do	Do.
Cedarberg	Spanish Dry Diggings.	Corporation	10	....	Steam	Running steadily.
Sliger	......do	Hunter, Wade & Co.	5	....	Water	Idle; pending development of mine.
Soup Weed	Soup Weed Cañon.	Unknown	10	....	..do	Idle.

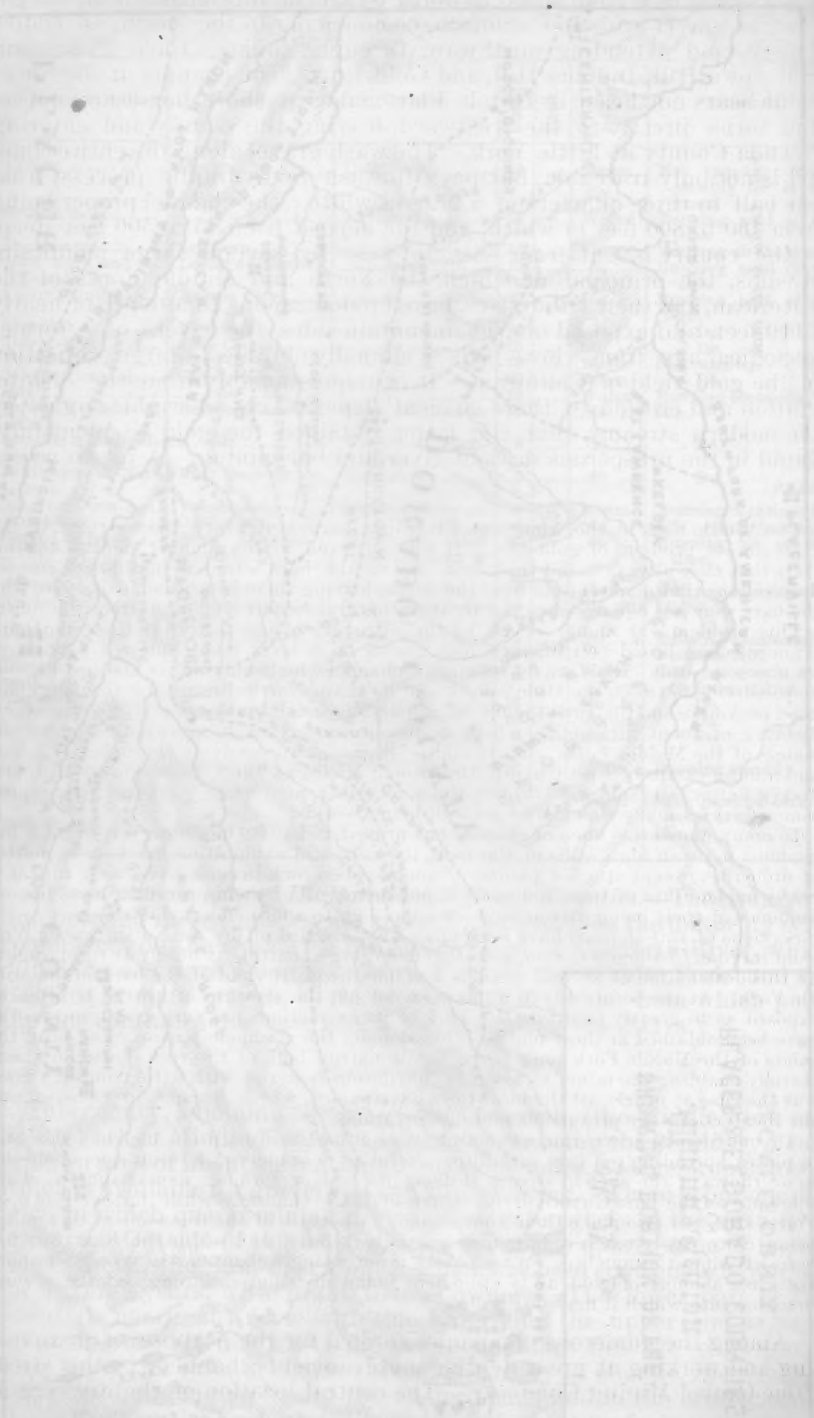
Note to precede map of El Dorado and Placer Counties.—The boundary-line between these counties, not specially indicated on the following map, commences on the west with the Middle Fork of American River, which it follows eastward along the South Fork of the Middle Fork and the Rubicos or main branch, to the mouth of Salt Cañon, from which point the line continues due east across the summit of the Sierra.

PLACER COUNTY.

This county, adjoining El Dorado on the north, (the Middle Fork and South Fork of Middle Fork of American River being the boundary,) contains an area of about eleven hundred square miles, a large proportion of which is available for gravel and hydraulic mining. There is but one district in which quartz-mining is carried on extensively in the vicinity of Auburn. Outside of this district there is but one quartz-mine of importance, the Rising Sun, near Colfax, which has been continuously worked for several years, with profit to the owners. The lower part of the county is nearly at a level with tide-water, and the upper end is high up among the Sierras, where the snow sometimes lies the year round. This being the case, of course there is a variety of climate, the weather being mild and spring-like in the western part, and in the center, while the eastern sections are buried in snow and swept by furious storms.



AM. PHOTO-LITHOGRAPHIC Co. N.Y. (OSBORNE'S PROCESS)



It is traversed from south to north by one of the most extensive auriferous gravel-leads in California, commencing in the south, at Todd's Valley, and extending northward through Yankee Jim's, Wisconsin Hill, Iowa Hill, Indiana Hill, and Gold Run. The channel at the latter point bears northeast to Dutch Flat, makes a short horseshoe curve, and turns directly to the westward, leaving the county and entering Nevada County at Little York. The wash-gravel along the entire channel is not only traceable, but pays to wash by hydraulic process, from one-half to three-quarters of a mile in width; the channel proper being from 100 to 800 feet in width, and the deposit from 75 to 500 feet deep.

The county is cut from east to west by several large mountain-streams, the principal of which, the North and Middle Forks of the American, and their tributaries, have eroded cañons to a depth of nearly 2,000 feet, and exposed on the mountain-sides the rivers of a former geological age, from whose beds is annually obtained a large proportion of the gold-yield of California. It is unquestionably from the disintegration and erosion of these ancient deposits, cut at right angles by the modern streams, that the latter obtained the gold so plentifully found in the prosperous days of river and bar mining. A recent writer says:

> The Middle Fork of the American River has surpassed every other stream in the State in its product of gold-dust. It was observed by the pioneer miners on this river that they always found their best pay on the bars situated just below certain deep cañons that made into it from the north, leaving them in a quandary as to why the bars were not equally enriched by these natural feeders coming in from the south.
>
> This problem was finally solved by the discovery of the fact that these northern branches cut a broad belt of auriferous gravel on a level many hundred feet above their present beds. This gravel occupies a channel which, making its first appearance on the divide between the Middle Fork and its main North Branch, in the neighborhood of American Hill, runs thence in a generally south-southwesterly direction for a distance of about fifty miles, where it disappears, having been swept away by the waters of the Middle Fork. In its course it passes successively through the towns and mining-camps of Last Chance, Deadwood, Michigan Bluff, Bath, Forest Hill, and Todd's Valley, all famous in former times for their product of gold, and at or near some of which many rich claims are still being worked.
>
> In many places this ancient channel has proved rich. Owing, however, to its being confined between high walls of rim-rock, its successful exploration has been a matter of difficulty, except at a few points. Numerous bed-rock tunnels have been run at a heavy expenditure of time and money; but nearly all of them proved failures in consequence of their being driven on a level too high to afford effectual drainage.
>
> Sections of this channel have been eroded and carried off by the North Branch, Volcano Ravine, El Dorado Cañon, and other deep gorges, cutting it nearly at right angles. To this destruction of several sections was due the great yield of the bars on the Middle Fork. At the points where it has been cut off, the stratum of gravel is often so exposed as to greatly facilitate the work of its extraction, and very gratifying results have been obtained at these places. Occasionally the channel approaches so near the cañon of the Middle Fork as to leave but a narrow belt of rim-rock between them, thereby enabling the miner to reach the auriferous material with little trouble. Such was the case at nearly all the localities above named, which became, in consequence, the theaters of very prosperous mining-operations.
>
> This auriferous gravel-range is not always confined to a single channel, but separates in places, spreading out into several parallel arms or branches; a result due, no doubt, to overflows of the ancient stream shifting its bed or forming new channels. Thus there are on the Last Chance divide three of these channels, while farther down, at Forest Hill, but two make their appearance. A portion of the front one at this point, being more easily reached, has been partially worked out, while the back one has been left almost untouched. Where there is but a single channel it often carries about the same amount of gold as is elsewhere found distributed throughout the several branches into which it may be divided.

Among the numerous companies formed for the purpose of prospecting and working at great depths these ancient channels is the Great Blue-Gravel Mining Company. The central location of the works is at

Pinkham Hill, some two and a half miles from the ranch of Peyton Powell, on the Forest Hill divide. The company have bonded the gravel-mining claims known as the Rough and Ready claims of Wiley & Co., the Big Channel Company's claims, the Wiley & Seifer claims, and the Spring Garden claims of H. S. Bryan, making from 900 to 1,000 acres, and extending along the gravel-channel of an old, dead river some two miles, which is about 1,500 feet between the rim-rocks, as determined by actual prospecting, for a full mile and a half. Many tunnels have penetrated the channel, and found good, paying gravel, but they were all too high to drain the basin or permit the small companies to fathom the bottom, or determine the depth and value of the deposit to and on the bed-rock. It is the belief of old miners that this channel, as defined by the rim-rock which has been cut and traced for the above distance, is the bed of one of the dead rivers of California. At one point on this ground a shaft has been sunk 160 feet deep, through pay-streaks of gravel, encountering drift-wood that showed plainly that it is the bed of some old river of greater magnitude than any of the living streams in these mountains of to-day. This ground the company proposes to drain by the aid of hoisting-works and pumps, propelled by a powerful engine, or at least to run an incline shaft to the bottom from the end of the tunnel at Pinkham Hill, and determine the depth and character of the deposit down to the bed-rock. The pay-channel, as superficially indicated by limited operations in numerous shafts, slopes, &c., has a width of 1,600 feet or more. Owing to its depth and position, power and perfect machinery are required to keep it free from water and prospect to the bottom and probably richest deposits.

Another similar but less extensive enterprise is being prosecuted a few miles farther up the same ridge. A San Francisco company is engaged in sinking a shaft at Baker's Ranch crossing of Volcano Cañon, for which purpose heavy machinery has recently been transported to the ground. This enterprise, if the company can overcome the water-difficulty and reach the bottom, will, for the first time, test the main ridge back of the claims at Bath, Michigan Bluff.

Nearly the whole area of the country between the North and Middle Forks of the American is auriferous, but its development has been retarded by the difficulty of bringing sufficient water on the ground to work it in accordance with the requirements of modern hydraulic mining, as practiced in more favored localities. The magnificent enterprise of Colonel Von Schmidt and his associates has, for some reason, been abandoned, temporarily at least, and no other project now in contemplation will have more than a local effect on the development of the resources of this divide. As a general rule, the method of drifting and crushing by mills, formerly so extensively carried on near Forest Hill and vicinity, has been abandoned with a view to working out the ground by hydraulic process, when the supply of water will permit; and, until then, the great resources of this part of Placer County will remain undeveloped.

Mr. G. W. Reamer, of Auburn, sends the following communication relative to a portion of this country:

There is in operation one 10-stamp quartz-mill (water-power) on the divide between the North and Middle Forks of American River, at the Powell and Lee mine. Results from crushing very good.

Todd's Valley district mines are mostly owned by Pond & Co. They have a ditch of twenty miles in length, running 1,200 inches of water. These mines pay very well. Forest Hill district has yielded since its discovery about $16,000,000 of gold-dust. At this time there is but little doing, on account of scarcity of water. None of these mines have been worked farther than a distance of 1,600 feet from the front. They have yielded as well, for the amount of work done, as any other gravel-mine in the State. The claims are from 4,000 to 5,000 feet from front to rear. They front on the Middle Fork of the American River. There is but one ditch in the district, the Miners' Ditch, carrying 1,800 inches of water.

The district contains 1,200 acres of mining-ground, not more than one-seventh of which has been worked. Most of the mining done here has been tunneling. At present there are but three or four claims working, as the 1,800 inches furnished by the ditch are not more than enough to make about three hydraulic sluice-heads. As much as 1,000 inches are used in a single head, when it can be had. If a large canal could be brought here this would be one of the best districts in the State. This gravel-deposit is from two to seven miles wide and thirty-five miles in length, and probably 400 feet in depth. Where it cannot be sluiced it can often be tunneled with profit.

North and east of the North Fork of the American are situated the active and prosperous districts of Gold Run, Dutch Flat, and vicinity, frequently described in former reports. The following description is condensed from the reports of Mr. L. P. McCarty, published in the Mining and Scientific Press of San Francisco:

The Dutch Flat Water Company is among the most important of its kind in the State. The company's ditches consist of the Placer County Canal, thirty miles long, and Cañon Creek and Little Bear River Ditches, about thirty miles more, including other ditches leading to reservoirs, all of which center at Dutch Flat and Gold Run, and have a capacity of furnishing daily 5,500 inches for twenty-four hours' run. This company owns twelve reservoirs, the largest of which will furnish the above-mentioned amount of water for one week, and all combined will furnish thirty days' water without a drop running into them. The farthest point in an air-line to where the water is taken up for these ditches is twenty-five miles easterly.

The water generally lasts from the middle of December to the middle of August, or from six to eight months. It is reduced at the latter end of the season, from August to December, to about 100 inches. The company is at present disposing of from 3,500 inches of water per day up to their full capacity. Prices received for the same are nine cents per inch for 12-hour water, or fifteen cents for 24-hour water. The measure is counted from the center of the issue with 7-inch pressure.

Leaving Little York and going eastward, the first claim is that of the Summit Mining Company, situated one and a half miles west by south from Dutch Flat. This company's possessions cover an area of 50 acres of mining-ground, and 190 more of timber-land, all of which is covered by United States patent. The improvements consist of one and a half miles of 14-inch pipe and 600 feet of 4-foot flume, 2 feet deep, with five under-currents; the claim is better located for using the latter than any other on the flat; working two of Hoskin's Little Giant monitors, with 3½ and 4 inch nozzles, running 350 inches of water under 175 feet pressure; 125 feet more pressure will be added to this after the first of next month. Four hundred feet fall is had from their flume to the lowest under-current, and 200 feet more of dump is obtained from there to Bear River, where the tailings fall. This claim is one of the few that is being cleaned to the bed-rock.

The Dutch Flat Blue-Gravel Company, a San Francisco incorporation, acquired by purchase, during the year 1871, the ground formerly owned by James Taeff, consisting of about 30 acres, and during the present year proceeded to open it on a scale unparalleled in the annals of hydraulic mining. Six-inch and eight-inch Little Giant monitors of the Hoskin's patent were used, running through the pipes from 1,000 to 1,200 inches of water, under a head of 400 feet; but as the ground was opened near the surface, where smaller streams would have been quite as effective, the yield was not commensurate with the expense, and operations were suspended. When again opened it will probably be by a bed-rock tunnel, run from Bear River, which will "bottom" the claim. The bed-rock under the principal portion of the channel in this claim has never been reached, but the known depth of gravel is 150 feet, and the top gravel is 2,000 feet wide.

Gold Run, four miles nearly west of Dutch Flat, on the line of the Central Pacific Railroad, contains about eight hundred inhabitants, and is one of the busy mining-towns of this county. Surrounding the town are a larger number of paying claims now working than at any other camp in the county. Beginning at the most southerly of these claims, distant one and a half miles southeast of the village, is the Cement Mill Company. The company's possessions consist of a bed of hard cement 1,600 by 400 feet, and 9 feet thick. In their improvement is comprised an 8-stamp mill, run by water-power, which can crush about 40 tons per day, and which is running to its full capacity. The average pay is about $4 per ton. They are at present engaged in drifting in a breast 100 feet wide, and are in 400 feet. Benches are left to support the mass above, and but very little timbering is done.

The Indiana Hill claim, of Judd, Brown & Miner, is a very extensive claim of about 40 acres, situated on the channel. It is being vigorously worked, using two monitors, running 500 inches of water.

The property owned by the Gold Run Hydraulic Mining Company, limited, was formerly known as the "Cedar claim," and consists of about 37 acres in the heart of this mining-section, the channel running the entire length of it. A deeper deposit of blue gravel is found here, probably, than at any other point on this celebrated channel. This property has recently been purchased by an English company for the sum of $60,000. The principal office is in London. This company owns no ditches, but purchases water. The improvements consist of about 1,400 feet of flume, 4 feet wide by 2 feet deep, blocked the entire length. The flume has a grade of 8 inches to 12 feet. They also have 1,500 feet of 16-inch pipe and the same amount of 11-inch pipe, and work two Little Giant monitors with 4 and 5 inch nozzles, using 500 inches of water under a pressure of 240 feet. The present working is at least 125 feet above bed-rock, with a bank of gravel above and facing them, 215 feet high. The average yield for thirty days' run has been from $6,000 to $8,000.

The Gold Run mining-claim, about one mile east of Gold Run station, and adjoining the above on the northeast, consists of 40 acres of mining-ground on the main channel, and the improvements are 650 feet of bed-rock tunnel, that cost $30 per foot to construct; also 1,300 feet of bed-rock flume, (doubled through the tunnel,) 4 feet wide by 2 feet deep. They have 1,600 feet of 30-inch and 900 feet of 16-inch pipe, and work two of Hoskin's Little Giant monitors of 3½ and 4 inch nozzles, lead pipes 11 inches in diameter, carrying 640 inches of water under 325 feet pressure. The bank of pay-gravel at present facing them is 130 feet high and fully 150 feet above bed-rock. Average receipts $6,000 per month.

The explorations of the Indiana Hill Cement Company, before alluded to, have demonstrated the richness of the lower or bed-rock strata of this channel. A tunnel has been projected and surveyed, from a point on Cañon Creek, and operations commenced with a view to the opening of the claims of this district. The deep cañon of the North Fork of the American, nearly 2,000 feet lower than the bed-rock of the ancient river, affords an opportunity, rarely found in the gold-region, of working out the entire gold-bearing strata of the ancient channel, the North Fork forming a receptacle for the tailings from above.

The quartz-interest of this county, after a long period of inactivity, is once more assuming some prominence, and since early days has never looked so promising as now Abandoned mines are being re-opened, and in many instances successfully worked; and new discoveries are made, particularly in the vicinity of Auburn.

The Solsic mine, recently discovered, has a shaft down 150 feet, showing a vein of from 1 to 2 feet. About 300 tons of ore have been extracted, which has yielded an average of $30 per ton. The country is metamorphic slate, and the lode is well defined in its encasing-walls.

The Auburn mine, a strong vein in the same formation, has, at a depth of 175 feet, a fine body of very rich ore. The lode has 30 inches average thickness. The general appearance of the vein, its character and surroundings, are sufficient to warrant the company in erecting a 10-stamp water-mill on the premises, which is now under contract.

For the foregoing information relative to quartz-mining in Auburn and Ophir districts I am indebted to Mr. C. H. Crossman.

The Greene mine, two and a half miles east of Auburn, has acquired notoriety from its persistent yield of high-grade rock. This mine has a length of 1,132 feet, the ledge running east and west and dipping south. The improvements consist of fine hoisting-works run by a 30-horse power engine; the pumps (Cornish) are run by a 40-horse power engine. The company also owns a mill, run by water-power, and used principally for reducing specimen rock. It contains four stamps and two Hepburn pans. The ledge is a little over 2 feet thick, and the rock from the 240-foot level will, it is thought, yield over $100 per ton. There have been, in all, more than 500 tons of rock crushed from this mine, the average yield of which has been about $100 per ton. Most of it was taken from and above the 125-foot level. In sinking the shaft from that level to its present depth, the rock has maintained its almost unsurpassed richness. This mine has never levied an assessment, having paid its way from the croppings down.

The mill and mine of the Saint Patrick Mining and Milling Company are three miles west of Auburn, and two and a half north of Newcastle. This company own fourteen ledges, varying in length from 1,200 to 2,000 feet each, working only four of them. The main shaft on one of these is down 300 feet, and has hoisting-works run by an 8-horse donkey-engine. The others are worked by windlass. The 15-stamp mill is run by a 40-horse engine, and will crush 24 tons per twenty-four hours. The company is also running on one of the ledges a tunnel 300 feet long, nearly completed, 5½ feet high and 4 feet wide. The formation is granite and metamorphic slate; the width of veins 2 to 10 feet.

The Saint Lawrence mine is one-quarter of a mile south of the Saint Patrick, and near Ophir. The claim is 1,200 feet in length. The 6-stamp mill, run by free water, can crush 12 tons per twenty-four hours. The two inclines, at an angle of 30°, show the ledge, at 50 feet depth, to be about 2 feet wide.

The Bellevue consists of a series of parallel veins in slate, small but well defined, coursing east and west, dipping south, and systematically worked by shafts and adits to the depth of 150 feet, for a distance of 1,000 feet on the main vein, with a view of cross-cutting and working the several veins from one line of permanent works. No ore is now extracted but such as is taken from the works of development. It has paid $30 per ton, for about 600 tons in all. There are good hoisting-works, run by water-power derived from the Bear River Ditch. The number of men engaged in all departments is about 20, taking out, on an average, about 40 tons of rock per week, which they crush at the Saint

Patrick Company's 15-stamp mill, located within half a mile of this mine. The rock costs 75 cents per ton for hauling, and $5 per ton to crush. The specimen ore for which this mine is noted runs very high. The company is running a tunnel on one of the ledges, parallel to the one on which the hoisting-works are situated, from Doty's Ravine on the west end, following the ledge right in.

The Peter Walter Mining Company is located about three miles west of Auburn. This company claim a ledge of 900 feet in length, which runs east and west and dips to the south. Their improvements consist of steam hoisting-works, which are run by an engine of 25 horse-power.

The Julian gold-mine is located near Newcastle. The claim is 2,500 feet. The ledge runs north and south, dips east, and is 3 to 8 feet thick. It is one of the largest ledges in this section, and the mine is one of the best developed in the country, showing a large amount of ore. There are four shafts, 800 feet apart, reaching a depth of 230 feet. At the 150-foot level connections are made giving a body of solid ore 100 feet in height, the vein being about 20 inches thick, and valued at $15 per ton. A first class 20-stamp mill has been erected, with hoisting and pumping works adequate to sink 500 feet and lift both water and ore.

At the Golden Eagle mine a new shaft is sinking. From and above the 80-foot level 150 tons of ore yielded over $20 per ton. At the present depth the ledge is wider and prospects richer. It is the calculation of this company to sink 100 feet lower, at which depth they anticipate, from present indications, a ledge that will pay them handsomely for their pains and labor. They have a 10 horse-power engine for hoisting. A full force of men is employed day and night.

Crater Hill contains a net-work of veins intersecting nearly at right angles, (east by west and north by south,) and has been noted for its richness. Work is regularly prosecuted on but one of them at present, the Crater vein. Shaft, 130 feet deep; level at this depth, 120 feet long; vein averages 12 inches; ore paying about $50 per ton; formation granitic.

The Shipley mine, west of the foregoing, has a shaft 150 feet deep. Levels are driving regularly. The ore is valued at $20 to $25 per ton. Vein 3 feet, encased in slate. Steam hoisting-works and 10-stamp mill, (water-power.)

The Mina Rica, west of the Greene mine, and supposed to be on the same ledge, is developed energetically, with fair prospects of reaching a pay-shoot.

North of the South Fork of the Middle Fork, and between that stream and the middle branch of the Middle Fork, is the interesting region known as Long Cañon Divide, extending about twenty five miles from east to west, with an average width of at least four miles—a deep, continuous deposit of gold-bearing gravel. Like the region south of it in El Dorado County it is covered with volcanic *débris*, but unlike that it is, on the higher eminences, overlaid with a lava-formation, which in some places is harder than the bed-rock beneath. Upon all the points, however, which on each side of the ridge shoot out on the occurrence of lateral cañons, the gravel has been denuded of all volcanic *débris*, and banks of beautiful quartz-gravel are alone to be seen. The depth of this vast deposit varies from 10 to 300 feet, and it is not infrequent to find a stratum of gravel 30 feet thick, which will pay 60 to 80 cents per cubic yard, while the other strata of gravel, which alternate with sand and volcanic ashes and lava, almost invariably show the "color" to each pan of dirt. In this locality but little mining has been done, so little as to amount only to prospecting. No ditches, other than two or three with a capacity of from 25 to 100 inches, have ever been constructed. The most extensive working has been done by a company of Chinese, who purchased a claim here some years ago for the sum of $5,500. They procure water from a small cañon called Chipmunk Ravine, and are only enabled to work during a portion of the winter and spring months. About an acre of ground has been washed off, to the greatest depth of perhaps 30 feet, with small sluices tailing into Long Cañon, and from which they are compelled to fork out the coarser stones, because of lack of fall to carry them away; and with two derricks to hoist out and pile up the large bowlders, the progress made is necessarily slow. And yet it is said by those who best ought to be informed that this company produces annually about $15,000 in gold-dust. Upon the north side of the ridge the line spoken of could be opened with a fall sufficiently great to send off everything below, provided there were a sufficient amount of water. A ditch, which is only seven miles long, above this claim, has been commenced by John Wilcox. If completed it will afford a fair supply for the whole divide, coming, as it does, from the Middle Fork of the American River. There is also a small ditch, owned by Richards Brothers, capable of supplying 1,000 inches if improved. It is taken from Long Cañon, several miles below the Chinese claim, and cannot be made avail- [illegible] for hydraulics until it reaches the vicinity of a place known as [illegible]smith Flat, seven or eight miles down the divide. It has at command a large area of rich auriferous country below. The extreme point of this divide, called Pennsylvania, embraces many acres of excellent gravel-banks showing gold. A mile or two from it is Pennsylvania Flat, where a small opening has been made, with water from a little cañon hard by. Last spring three men washed there with a small amount of water for a period of twenty-eight days, cutting down the bank to a depth of 20 feet, and cleaned up, as the result of their labor, $1,800 in gold-dust. Apparently there are thousands of acres of similar ground before them. It cannot be long before this section will receive the attention it deserves.

NEVADA COUNTY.

This county embraces undoubtedly one of the richest mining-regions in the world, and the district of Grass Valley, especially, stands first in rank among gold-producing localities. Mr. A. Delano, a banker of Grass Valley, who has resided and done business in that locality over twenty years, recently estimated in a lecture that the district of Grass Valley alone had produced, since 1849, over forty millions of gold, and that from 1852 to 1860 something like $300,000 per month had been taken out, nearly all of which came from placer mines. The few quartz-mills then in operation had very imperfect machinery, and their gold-saving apparatus was very defective.

At the present time Grass Valley is essentially a quartz-mining town, many of the placers having been reworked twice or three times, and being therefore practically worked out. There are entered on the records of the district 1,100 distinct quartz-ledges, at least 500 of which, Mr. Delano estimates, might be profitably worked, if the capital to do so was forthcoming. Instead of that there are now only ten or twelve actively worked, and instead of 25,000 miners, who might be employed in the district, there are only a little over 1,000 at work. These few produce, nevertheless, enough to cause monthly shipments of from $200,000 to $250,000 in gold. In the same lecture Mr. Delano estimates that the whole county of Nevada has produced, since mining-operations were begun, $105,000,000 in gold, which he divides as follows:

Grass Valley	$40,000,000
Nevada City	40,000,000
San Juan	10,000,000
Columbia Hill, North Bloomfield, Washington, Omega, Cherokee, and Woolsey's Flat	10,000,000
Other localities	5,000,000
	105,000,000

The Grass Valley Union gives the following list of quartz-mines which have been actually worked during the year in the district, though not all of these have been worked continually: Idaho, Coe, Eureka, Howard Hill, Empire, Greenhorn, Daisy Hill, Green Mountain, Jones, Slate Ledge, (Perrin's,) North Star, Independence Tunnel, Hunt & Talbot, Never Sweat, Knight of Malta, Sappho, Grass Valley Mining Company, Gashwiler, Reese, Schuylkill, Cedar, and others. Of gravel-mines, the Town Talk, Independent, Enterprise, Phil. Roberts & Co., Hope, Reuben Thomas, Dartmouth, Picayune, and others have been worked.

The Eureka Company, whose sudden misfortune in meeting very low-grade ores in the lower levels I stated in my last report, has done much better during the year than was expected, though it is far from being in the highly prosperous condition of former years.

From the superintendent's report I condense the following summary:

Report of the Eureka Company for the year ending September 30, 1872.

The company has driven 881 feet of drifts, 644 feet of cross-cuts, sunk 223 feet of main shaft, and also sunk 105 feet of winze, and run 363 feet of tunnel. The vertical depth of the main shaft is 961½ feet, or 1,072 feet on the incline. There have been hoisted 9,925 tons of quartz, and crushed 9,730 tons in 293 running-days, averaging 2.079 tons per day to each stamp. Of sulphurets 103 tons have been concentrated, [illegible] tons worked, and 30 tons remained on hand, worth about $3,900. During the year 9,925 tons of quartz were extracted from the various levels of the mine. There were upward of 4,000 tons of good pay-ore in sight, that the superintendent calculates will pay all ordinary expenses for the further development of the mine for the next six months at least.

The expense of mining has been higher than usual, owing to quartz from the intermediate level, 2,839 tons, having to be handled twice, and also the stringers taken out on tribute. The milling has also been higher owing to the company not being able to keep more than 15 stamps running, requiring the same number of amalgamators and engineers as 30 stamps do. The superintendent gives no decided opinion as to the future prospects of the mine.

The secretary's report shows the following items:

RECEIPTS.

Cash, October 1, 1871	$25,867 90
Bullion	220,010 31
Construction	50 00
Sulphuret-reduction works	4,872 24
Milling	150 00
Wood-ranch	1,068 00
Wood-account	6,072 13
Premium and discounts	415 75
McDougal works	771 13
Total	259,277 46

DISBURSEMENTS.

Dividends	$20,000 00
Mining	101,864 91
ing-account, (prospecting)	18,301 50
Milling	22,956 32
huret-reduction works	4,663 24
oannaise mine	6,617 50
Mobile mine	3,272 16
struction	8,885 00
e-purchase	6,008 50
uret-concentration	1,821 25
ugal works	612 00
Wood-ranch	1,018 25
General expenses	5,705 69
ion-expenses	843 44
iscount	53 16
Cash, September 30, 1872	56,654 54
Total	259,277 46

The assets are estimated at $150,599.31, of which the mill is calculated at $40,000, and the building and improvements at the mine, $30,000. There are no liabilities. The average value of the ore worked was $22.95 per ton, and the average yield of the sulphurets $127.22 per ton. Bullion from the mill was worth $17.56 per ounce, and that from the chlorination-works $19.74 per ounce. The cost of mining 9,175 tons was $101,184.07, or an average of $11.03 per ton. The cost of milling 9,730 tons was ,856.32, or an average of $2.35 per ton. The cost of concentrating sulphurets was .68 per ton, and of reducing them $28.06 per ton. The net profits were $61,799.86, of ch $20,000 was paid as dividends to stockholders, $8,885 for construction, and 08.50 for the Mobile mine.

rom the formation of the company, October 1, 1865, to September 30, 1872, the re- pts were $3,606,265.91, of which $3,585,543.85 were from bullion taken out. Of the bursements, $1,714,000 was paid out as dividends; $1,381,614.79 for mining and milling expenses; $301,906.50 for titles to property, &c., and $141,939.71 for construction. The net profits from October 1, 1865, to September 30, 1872, were $2,224,651.12.

Report of the North Star Mining Company for the year ending September 5, 1872.

From the report of this company I extract the following important items:

e company has worked 6,601 tons of ore, yielding 8,735 assay ounces gold, valued at 53,349, or $17.55 per ounce; net value of sulphurets worked, $8,324; from tributo $2,945; from ore-crushing, $2,495; from premium on bars, $296; from miscellaneous sources, $9,898, making total receipts of $177,307. Adding $1,243 for value of lies on hand at commencement of year, gives a grand total of $178,550. The total ursements for the year aggregate $182,687, or $4,137 in excess of the receipts, which is the amount of the present liabilities. At the commencement of the last fiscal year the pany owed $13,879. This indebtedness has not only been wiped out, but the sum f $18,644 has been expended in permanent improvements at the mine and mill hile dividends of $27,000 have been paid to stockholders. The other disbursements for mine and mill supplies, labor, taxes, insurance, &c., show an aggregate of 123,164. As there are 3,000 shares in the mine, of the par value of $100 each, stockholders have reaped 9 per cent. interest for the year on their investment. During the previous year stockholders received $76,500 in dividends, against $6,000 in 1869–'70, and 45,000 in 1868–'69. The mine paid its first dividend, after incorporation, in June, 1868. Thus in four years it has paid $154,500, but in the mean time it has collected $60,000 from stockholders, leaving a net profit of $94,500, or $31.50 per share. This is less than 8 per cent. interest per annum on the capital stock.

The Idaho Company has remodeled its works during the year, and has now a splendid establishment. This company stands at present first among the gold-mining companies of California.

Report of the Idaho Company for the year ending December, 1872.

The superintendent, Mr. Edward Coleman, says:

We now have a 35-stamp mill and two rock-breakers, with all the modern appliances for saving gold and sulphurets. These are driven by a 20-inch engine, 44 inches stroke, and it is believed that with the usual repairs incident to running a quartz-mill, but little expense will be incurred, in running the mill, for years to come. The hoisting-works are all complete and in good running order. There are two engines, 14 inches in diameter of cylinder, and 5 feet of stroke, for hoisting the cages. There are two 10-inch-cylinder engines, of 16-inch stroke, for hoisting tubs and for use in sinking the shaft. They are all set on solid foundations of masonry, as is also the mill-engine. The underground work connected with the new shaft has been pushed on continually during the past year. The timbers used in keeping the shaft open are as follows: 14 inches square from the 400-foot level to the 200-foot level; 12 inches square from the 200-foot level to about 80 feet from the surface, and thence to the surface timbers of 15 inches square are used. We have now on hand nearly all the timbers required to complete the shaft to the 600 level. These are 15 inches square. I again take pleasure in reporting the condition of the mine as encouraging, and with the increased facilities of working, it may reasonably be expected that the profits for the coming year will largely exceed the profits of any preceding year. I have also to report that all the business and the affairs whatsoever connected with the mine are in a satisfactory condition. I would also call your attention to the apparent increase in the working expenses of the milling and mining of the ore. This was caused, necessarily, by preparations for working the mine on a larger scale, and of which the future will get the benefit. During the past year we have run 590 feet of "drifts," made 189 feet of "raise," and completed 389 feet of new shaft. The shaft is now completed to the 400 level. We have, also, raised a small working shaft from the 500 level to the 400 level, and we are now opening out for the timber at the 500 level. During the year we have crushed 11,410 tons of ore. Of this 950¼ tons came from the 400 level, 7,805¼ tons from the 600 level, and 2,654½ tons from the 700 level. The 400-foot level is in to 286 feet from the new shaft; the 600 east level is in 584 feet from the line of the old shaft, or 414 feet from the new shaft, and the 600 west level is in to the line of the Eureka mine. The 700 west drift is in 74 feet from the old shaft, and the 700 east drift is in 192 feet from the old shaft, or 9 feet from the run of the new shaft. The yield of the mine has been—

Bullion, 22,331$\frac{46}{100}$ ounces, valued at	$390,830 50
Sulphurets 81¾ tons	8,872 10
Specimens and tailings	762 73
Total	400,465 42

or an average of $35.09 per ton.

COST OF MINING AND MILLING.

Surface labor	$21,482 75
Underground	80,323 49
Wood and poles	12,244 94
Candles and oil	3,477 13
Hardware and steel	4,328 02
Lumber and coal	2,310 08
Powder and fuse	1,071 56
Foundery	2,306 69
New ropes, and sundries	1,659 09
Superintendent's salary	3,000 00
Total	133,203 75

SULPHURETS.

Labor in saving 81¾ tons	$1,340 00
Reducing 78 tons	2,084 15
Grinding sand from creek	270 10
Total	3,694 25

CONSTRUCTION-ACCOUNT.—MILL.

Labor	$6,745 75
Lumber	3,706 42
Foundery	23,340 97
Hardware	2,099 46
Sundries	2,796 82
Total	38,689 42

Additional quicksilver	$690 00
Copper plates and hose	1,172 56
Total	1,862 56

DITCH AND RESERVOIR.

Labor, &c	$1,375 23

NEW SHAFT.

Labor, surface	$3,577 50
Labor, underground	16,954 75
Lumber and materials	9,264 89
Total	29,797 14

Ropes, cages, and cars for new shaft	$4,067 75
Retimbering old shafts and drifts	2,794 00
Total	6,861 75

HOISTING-WORKS.

Foundery	$12,561 15
Materials, &c	13,869 27
Total	26,430 42

GENERAL EXPENSE.

Insurance	$1,730 00
Law expense	450 00
Pump for old shaft	352 50
Estate of J. S. Henning	5,000 00
Expense on bullion	1,997 20
Prospecting east end of claim	144 00
Total	9,673 70

RECAPITULATION.

Mill and mining	$133,203 75
Sulphurets	3,694 25
Retimbering	2,794 00
General expense	9,673 70
Total	149,365 70

CONSTRUCTION-ACCOUNT.—AGGREGATE.

Construction—mill	$38,689 42
Hoisting-works	26,430 42
New shaft	29,797 14
Ditch and reservoir	1,375 23
Quicksilver, &c	1,862 56
Ropes, cages, and cars	4,067 75
Total cost of construction	102,222 52

RECEIPTS.

Cash on hand from last settlement	$16,972 40
Bullion, $22,331\frac{46}{100}$ ounces	390,830 59
Sulphurets, $81\frac{3}{4}$ tons	8,872 10
Specimens and tailings	762 73
Chinese lease	100 00
Water-rent	700 00
Pan-rent	270 00
Extraordinary	2,500 00
Total receipts	421,007 92
Total expenditures, including dividends	414,338 22
Balance on hand	6,669 70

The secretary, M. P. O'Connor, made a report which necessarily contains much that is not in the superintendent's report. I collate from the secretary's report the following:

Number of shares of stock 3,100, or one foot to the share. Of these 2,880 shares are owned in Grass Valley, and 220 owned by non-residents of this place. The par value of a share is $100.

The total receipts from all sources for the year 1872, to December 16, amount to	$404,035 52
Balance in treasury at commencement of the year	16,972 40
Total for the year	421,007 92

Expenditures for the year are as follows:

Dividends	$162,750 00
Other disbursements	251,588 22
Total	414,338 22

For the last four years the total earnings of the Idaho mine have been as follows:

1869, ending in December	$306,038 75
1870, ending in December	183,450 23
1871, ending in December	407,301 16
1872, ending in December	404,035 52
Total for four years	1,300,822 66

Dividends for the same years have been paid as follows:

1869, eleven dividends	$170,500 00
1870, eight dividends	37,200 00

The placer-mining interest of the county was extensively treated in my last report; I insert, however, the following descriptions of the most important works of that kind.

Dr. Henry DeGroot, of San Francisco, furnishes the following description of one of the most extensive hydraulic operations of Nevada County, that of the Little York Hydraulic Mining Company:

The property, which, considered as a whole, constitutes one of the most valuable mining-estates in California, is situated in Little York township, Nevada County, and but one mile from the Central Pacific Railroad. Besides a tract of 240 acres secured by United States patent, this company own a considerable extent of mineral-ground adjoining at different points, held under the local mining-laws, also nearly 2,000 acres of fine timber-land, with saw-mill, &c., contiguous, on the east. They have three ditches, aggregate length forty-five miles, and capable of carrying 3,000 inches of water, the sources of supply being Steep Hollow and Bear River, lying between the deep cañons cut by these two streams; they have an outlet with a fall of over 600 feet on each, giving superior facilities for washing-purposes. Three sets of hydraulic apparatus, very powerful and perfect, have been fitted up for washing here. Two of these are on the subdivision of the tract known as the Little York, and the other on the Liberty Hill claim, a third subdivision, called Christmas Hill, lying between them. The latter, though opened and ready for the reception of the gearing for washing, has not yet been furnished with any. From each of the three points fitted up for work a ravine extends to the deep cañon on either side, two of these opening on Bear River and one on Steep Hollow. Along these ravines nearly two miles of flume have been laid down, the whole fitted up with dumps, undercurrents, &c., the fall being such as to admit of some of the latter being over 30 feet high. At the head of each of these ravines a long tunnel, flumed throughout, has been cut through the bed-rock, furnishing a passage for the water and gravel, the old-river channel here lying in a basin with high river-rock on either side.

What is known as the "blue lead" runs through the whole extent of the company's ground, being here from 250 to 600 feet in width. While this, wherever worked, has been found extremely rich, the entire body of gravel, for the breadth of a mile or more, contains enough gold to pay for washing by hydraulics. The bank varies in depth from a few feet, where the bed-rock approaches the surface, to 200 feet in the deepest part of the channel. As usual the upper portions of the gravel are poorer and the gold finer, the latter gradually becoming coarser and more abundant toward the bottom, a very rich layer of gravel always being found on the bed-rock, especially in and on the sides of the main channel. Lying near the bed-rock is a stratum of hard cement from 10 to 40 feet thick. Formerly this was crushed with stamps and the gold saved by amalgamation in the batteries, but with the powerful nozzles and head of water now in use, from 200 to 300 feet, this cement can be sufficiently broken up to send it through the sluices, where it meets with final disintegration in its passage over the numerous dumps encountered on its way. The cement-mills of the company are therefore no longer in use, nor is it necessary to employ powder for breaking up the ground and preparing it for washing. Of this company it may be said that while they have as valuable a tract of mining-ground, perhaps, as any other in the State, their outfit and the general administration of their property are equal to any found elsewhere. Their extensive flumes and undercurrents, from 4 to 6 feet wide, are built of the most durable material and set with great care. Over four miles of heavy iron pipe, from 12 to 30 inches in diameter, (much of it lately substituted for wooden flumes,) has been laid down. Monitor nozzles, all of the largest size and latest plan, are in use in each of the mining-pits. Powerful derricks, operated by hurdy-gurdy wheels, have been provided, whereby immense bowlders can be expeditiously handled with small expenditure of manual labor. In short, all the most approved methods and machinery as well as labor-saving appliances extant have here been introduced; what were very acceptable styles of apparatus but a short time before having sometimes been laid aside, after short use, upon something more economical or efficient presenting itself, this company having been liberal patrons of inventors in this department of mechanism and discovery.

The ground of the Little York Company is not only extensive, but much of it is known to be extremely rich, the old "blue lead" having paid here enormously in the early day. Immense quantities of gold were taken out at points where the rim-rock had been broken away, and in cases where incline shafts were sunk on its inner side as far down as the water would admit. Large sums were extracted at these spots within the present limits of their claim, without the richest portions of the channel ever having been reached. As washing has progressed towards its center, at the few points where work has been carried on, the product of gold has been liberal and often very large.

The company only using a portion of its water, the balance being sold, and running but two of the hydraulics fitted up, washed out at the rate of $15,000 per month during the year 1872. The property having now passed into the hands of a London company, the new owners will not only make use of all the water their ditches afford, but increase the quantity, which can be easily done, and also start up the other hydraulic, and perhaps rig a fourth on the Christmas Hill ground. With these additional facilities for production the yield of these mines might be nearly doubled. The outlay required for so increasing the capacity of the works would not be large, nor would current expenses be materially augmented thereafter. In operating this class of mines the great item of expense is water, labor being only secondary, as but a small force of hands is required. To a company having their own water the profits resulting from the working of a property like this should be large—at least 75 per cent. of the gross earnings.

As to the time likely to be required for working out a body of gravel like this, it is useless to indulge in speculations, inasmuch as it must necessarily be so long as to deprive the question of all practical significance.

The Union gravel-mine is located at Relief Hill, three miles east of North Bloomfield and about nine miles north of Nevada City. The company own one and a quarter miles in length on the channel of the lead, which at this point is about one-half mile wide. There is no probability that the next generation will see it worked out. This claim has been worked for three years past, but hydraulic washing has been done but about six months of that time. The company's improvements consist in part of 2,000 feet of flume, 40 inches wide by 20 inches deep, with 10 inches grade to every 14 feet, all blocked with 20-inch square blocks, 6 inches thick; 2,175 feet of 15-inch pipe, and 800 feet of 18-inch pipe; also a reservoir built last year at a cost of $5,200, situated one mile from the present workings. This reservoir has a capacity of supplying 500 inches of water for forty-eight hours, when full, without receiving a drop. To get a lower grade of 152 feet below the present working, the company are engaged in running a large tunnel, which, when completed, will be 1,500 feet in length, 6 feet 4 inches high, by 6 feet wide, with a grade of 6 inches to every 12 feet. This tunnel was commenced August

18, 1870, and has been worked with from two to three shifts per day to within the last seven or eight weeks, by hand-drilling, but the rock was of such a character that it would have discouraged the most persistent set of men in the State. So slow was their progress that the distance made in the face of the tunnel for a month could be reached with a 10-foot pole. The company finally adopted one of Messrs. Severance & Holt's diamond drills, at a cost of $4,000. After many delays of an unavoidable nature, such as bad roads, caused by the inclemency of the weather, this drill was put in successful operation, and is making from 2¼ to 4 feet per day, with three shifts of eight hours each, in the kind of rock above mentioned. The drill is run by a hurdy-gurdy wheel, placed on the rear of the drill-carriage, which is driven by hydraulic pressure. The water is conducted 3,000 feet, through an 11-inch pipe, to the mouth of the tunnel, under a 274-foot pressure; from the mouth of the tunnel to the drill at its present position, 925 feet in, by a 7-inch pipe; there it is thrown into the hurdy-gurdy wheel, 4 feet in diameter, through a ⅞-inch nozzle which runs the drills, two in number. The blasting-agent used is giant-powder. The exploding is done by a "Fields electric battery," at the mouth of the tunnel, conducted by an insulated wire the whole length of the tunnel. Eleven men are employed in the mine.

In regard to the operations of the North Bloomfield Gravel-Mining Company, the Nevada Transcript says:

During the past year the North Bloomfield Gravel-Mining Company have extended their enterprise, until now they employ four hundred and fifty men, and they expect to add considerably to this force for the purpose of extending their ditch down into Bridgeport township. The operations of this company extend from Bowman's dam to Lake City, and they have given life and energy, more or less, to the business of every mining-camp within the range of their operations. They now have one hundred and fifty men employed at Bowman's, and the dam will, it is expected, be completed in two weeks. Their ditch conveys water from this dam to the township of Bloomfield.

The most important work of the company now is the bed-rock tunnel, which is to open the basin or channel at Bloomfield. This channel was opened to the bed-rock, 208 feet, and found to contain pay-gravel from the surface down. The company, having ascertained this, determined to run a bed-rock tunnel from Humbug Cañon to their claims, that sufficient fall might be obtained to work to advantage. The surveys were made by Hamilton Smith, superintendent of the company, and the work commenced about the 1st of last May. The tunnel will, when completed, be 8,000 feet in length. The mouth of the tunnel is 440 feet lower than the channel, and will, at the upper end, be about 75 feet lower than the gravel. A road was built by the company along the line of the tunnel, and eight hoisting-works put up, numbered from 1 to 8 inclusive, coming from the mouth of the tunnel. They are all built on the same plan, and are run by hurdy-gurdy wheels. The power is supplied from the company's reservoir, through 10,000 feet of iron pipe. The shafts are about 900 feet apart, and in all of them they are now sinking, and at the same time running the tunnel from the mouth.

No. 8 is on the rim-rock of the channel, and No. 1 the nearest to the tunnel-mouth. The shafts vary in depth from 178 to 195 feet, and the tunnel has been run 235 feet from the mouth. About 720 feet in the aggregate has been completed, out of a total of 1,550 that must be completed before the line for work upon the tunnel will be reached. When this is done the tunnel will be run from both faces in each shaft, and also work will be continued in the tunnel. It is expected that the entire work will be completed in the spring of 1875. This is to-day one of the most extensive mining-operations on the coast, and all the work is being done systematically and thoroughly. The channel to be opened is rich, and the bed-rock has only been reached for prospecting.

The principal mines on Manzanita Hill, one to two miles southwest of North San Juan, are those of the American Company, the Manzanita Company, and the Yuba Company. The average product of the American Company's mine for the past few years has been about $200,000 gross per year; the others are not washing on the bed-rock. The bullion-yield for 1872 from the hill will approximate $300,000. No stamps are used in gravel-crushing on the hill. There are no quartz-mines here; the entire mining-interest is in gravel. The area of this is about one mile in length, by 600 yards in width. This is estimated as worth, for the channel unworked up to the present, $1,000 to $1,500 per linear foot gross; the expense of taking out the gold should not exceed 50 per cent. Water costs twelve and a half cents per inch, but contracts can now be made for less. An inch of water is usually reckoned equal to 1,000 cubic feet.

Two deep tunnels are driving on Manzanita Hill; that of the American Company on the north end of the hill, now in about 2,100 feet, has to go about 2,000 feet further (300 feet in the bed-rock) to the first shaft; that of the Manzanita Mining Company, (recently merged in the Milton Company,) on the south end of the hill, is in 850 feet from Sweetland Creek, and lacks 550 feet of reaching the first shaft, (130 feet in bed-rock.) This tunnel has been driven diagonally across the rock in a straight line, 8 by 8 feet, over 700 feet since the 1st of August, 1871. They use only single-hand hammers, ¾-inch steel, and No. 2 giant-powder. The powder is kiln-dried before using, which is thought to be a decided advantage. The average cost of this tunnel is about $22.50 per linear foot.

In connection with some of the mining companies, the North Bloomfield Gravel-Mining Company are extending their ditches down the ridge, and will have them in operation within two months, at an estimated cost of $80,000. They will be able to supply an additional 2,000 inches of a steady stream to the mines from Badger Hill to French Corral. This nearly doubles the previous supply.

I am indebted for the information in the foregoing paragraphs to Mr. Newton C. Miller, of Manzanita Hill.

The Yuba Gravel-Mining Company has now a 30-horse engine and a pump that will raise 26 inches of water. The shaft is down 180 feet, and of this distance 6 to 8 feet is in gravel which prospects well. The first machinery used was not of sufficient power. A tram-road is being built to run wood, abundance of which is in the immediate vicinity, to the works. The mine is easy of access, and is about two miles from the town of North Bloomfield.

The possessions of the Birdseye Creek Gravel-Mining Company, (limited,) extend from near Hunt's Hill to the vicinity of Little York, and comprise all that portion of the "blue lead" at Red Dog, You Bet, and the vicinity beyond. The entire length of the company's claims is about four miles, all the bed-rock of which will not probably be seen for the next hundred years. The company is working three sets of claims, viz, the Uncle Sam, Brown's Hill, and the Neece & West. In these claims from twenty-five to thirty men are regularly employed, running from five to six hydraulic monitors, carrying from 250 to 400 inches of water each. The company is engaged in running a bed-rock tunnel to the Neece & West that will, when completed, drain both that and the Brown's Hill claims. The dimensions will be 1,100 feet long, 7 feet wide by 8 high, 260 feet of which is now completed. A hard slate-formation has been penetrated so far. The company owns also the Independence and Bunker Hill property, and extensive claims at Sweetland.

Carney & Goodspeed's cement mill and mine are also located at Hunt's Hill. They have an 8-stamp mill run by water-power, with a 24-foot hurdy-gurdy wheel on a cam-shaft, without other gearing. This mill has a capacity of, and is now crushing, 50 tons of cement every twenty hours, which averages $5 per ton. The company have a tunnel in 800 feet, at which point they are drifting in different directions, working regularly twenty-eight men. The gravel or cement is taken out of the tunnel by car to the mill, which is located at the mouth of the tunnel. This tunnel is rather badly ventilated at present, for the reason that but 15 feet fall can be had for the water to run the air-machinery with. Different arrangements will shortly be made for better ventilation.

Brown's cement-claim is one of the first-class claims in the vicinity of You Bet. It is owned by Judge G. S. Brown, and located about a quarter of a mile south of You Bet, and adjoins the claims of the English company, or Birdseye Creek Gravel-Mining Company. The main channel cuts it from northeast to southwest. It contains about 24 acres of mining-ground. About one-quarter of the surface has been washed to within 50 feet of the bed-rock, and one-quarter of the bed-rock has been drifted over. At present it is not being worked, but it paid well when in operation. The outlet to this celebrated claim is through Wilcox's Ravine. Mr. Brown owns about 4,000 feet of this ravine, and through it eventually all that portion of the Birdseye Creek Gravel-Mining Company's ground underlying the town of You Bet will have to be worked. From 1,500 to 2,000 acres more of mining-ground, lying in the direction of Chalk Bluff, will have to be worked through the same ravine. This claim has been worked successfully since 1865, and up to July, 1870, over $600,000 in gold was taken from it. Mr. Brown also owns an 8-stamp mill for crushing cement, which is run by a hurdy-gurdy wheel using 50 inches of water.

Mr. H. Powell writes from Birchville district:

The area of the auriferous deposits of this district averages one mile in length, 1,000 feet in width, and 80 feet in depth. About one-half of this has been worked, at an average yield of about thirty cents per cubic yard gross, and about fifteen cents net.

There are no quartz-mines in the district. There is in the course of construction, and now nearly completed, a tunnel in blasting-rock, of 2,300 feet in length. This is the only work of importance done this year in the district.

The ruling rates for water are twelve and a half cents per inch for ten hours' run. The prospect is at present that water in the future will be ten cents per inch for ten hours.

YUBA COUNTY.

The principal mining of Yuba is at the extensive hydraulic mines of Smartsville and vicinity, which are owned and worked by five different companies, the Pactolus, Rose's Bar, Blue Gravel, Blue Point, and Smartsville Hydraulic Mining Companies. The Pactolus Company has just completed, at a cost of $75,000, a bed-rock tunnel, 1,200 feet in length, upon which it has been at work for the last six years. This tunnel works the ancient-river channel which runs through this section, and which, in the Blue Point Company's ground, being opened deep enough to work to the bottom of the old-river bed, has paid over $1,000 per day's washing, and, during the present year, as much as $115,000 for less than one hundred days' washing. A shaft has been sunk on the Pactolus mine preparatory to opening the same channel.

The Rose's Bar Mining Company adjoins the Pactolus on the east. This company is also running a tunnel to work the deep channel. The tunnel will be 1,000 feet long. It has been in progress nearly three years, and is completed to about 800 feet. It will probably be completed within the present year. The company is now working the upper strata at a profit.

The Blue-Gravel Company is hydraulicking down the mountain south of these old-river claims. Its lower tunnel has been completed, after five years' labor and the expenditure of some $60,000, and it is now opening to the bed-rock, having a bank of some 30 feet of gravel to work, which could not be worked through the first tunnel.

The Blue Point Gravel-Mining Company, situated on the old-river channel, the tunnel to work which cost $146,000, has, during the past year, taken out gold at the rate of $1,000 for each day's washing.

The Smartsville Hydraulic Company still continues working on the upper strata, only stripping the surface gravel and cement off the old-river channel. It is now working a bank of cement 180 feet in height, all of which has to be blasted. The company pays $140 per day for water, and $1,000 per month for powder, but yields regular dividends to the stockholders.

At Mooney Flat a tunnel is in progress which will give an outlet for a large area of gravel-country that has prospected well. It will require about three years to complete this tunnel and open the ground.

Mr. D. W. C. Gaskill, of Forbestown, furnishes the following information relative to hydraulic mining operations carried on with the supposed disadvantages of slight fall:

The Ohio Flat Mining Company's claims are situated in Yuba County, near Forbestown at the head of a large flat, two miles long, with a very slight grade all the way. Our claims are 2,787 feet long, pay-dirt 300 to 400 feet wide, on bed-rock covered by 15 feet of a sedimentary clay-deposit, and 15 feet of vegetable mold, &c. We were compelled to commence a mile below our ground, on the surface of the flat, and pipe out a cut, laying our flume—2½ by 4 feet—on an inch grade to the rod. We were four years in piping out the cut and laying the flume, at an expense of $25,000. As the cut deepened to 20 and 30 feet, quicksand in the bottom, and the sliding in of the sides, gave us much trouble. In places the cut is 500 feet wide on the surface. With 500 inches of water there is no trouble in the flume carrying off all the top dirt from two pipes. When we clean up the bottom, which we do in summer—piping off top dirt all winter—we fork all the gravel that we can from the ground-sluice, letting as little heavy gravel as possible go into the flume. The flume is 4 feet in the soft granite bed-rock in the claim, and the pay-gravel is from 1 to 3 feet deep. As fast as the dirt accumulates around the mouth of the flume we add boxes, until we have on about 500 feet, and we have now as good a dump as ever and no trouble with the flume. We are now making our third clean-up. The first year we took out of 150 feet square of ground, $16,000; the second year, $19,000; and a good showing for $25,000 this year. We have twenty years of as good or better work ahead. This is the result of *our experiment.* Novices alone would have undertaken such a job. A scientific man would never have considered it practicable or invested a cent in such an enterprise.

The Marysville Appeal, of recent date, thus notices the resumption of operations on the quartz-ledges of Brown's Valley:

Some years since the quartz-mines at Brown's Valley, Yuba County, ranked among the best in the State, and yielded largely, but for various reasons, principally the general demoralization in the mining-share market a few years since, active operations were suspended, and these mines have for several years been lying idle. Recently a new organization has been formed under the name of the Brown's Valley Consolidated Mining Company, for the purpose of working those mines, and it has purchased the Jefferson, Pennsylvania, and Danebroge mines. The Jefferson, previous to 1865, paid large dividends. The Pennsylvania and Danebroge, located contiguous to the Jefferson, have taken out large amounts of gold, but we believe have not paid dividends. During the last month active operations have been resumed on these mines by the Brown's Valley Company, and we have good grounds for indulging in the hope that the results may amply reward the enterprise of the parties interested, and also restore the Brown's Valley mining-interests to the relative positions that they deserve. The new company is composed of San Francisco and eastern capitalists. The general superintendency of the mines is vested in Baron Von Stech, an eminent mining-engineer of great experience. The principal point of present operations is at the incline No. 1, of the Pennsylvania mine, where new and stronger hoisting and pumping works are being constructed. Knowles's patent self-acting pumps, capable of throwing 20,000 gallons per hour, are being introduced, and are supposed to be of sufficient capacity to free the mine from water during the time required to make repairs on the machinery. It is the intention of the company to retimber the inclines, sink them deeper, and extract ore from the bottoms of the shafts and from the side drifts. It will probably require some two months' time and the expenditure of some $25,000 to get these mines in working order, by which time the mill of 16 stamps will be ready for work, and it is anticipated that a plentiful supply of ore, yielding $20 per ton, will be obtained to keep it constantly employed. Large quantities of ore are known to exist in these mines, and it is proposed to work them up to their full capacity. Should the yield of ore be in excess of the capacity of the mill for crushing it, the company will erect one of Whelpley & Storer's ore-crushers and two pulverizers at hoisting-works No. 2, where there are now an engine and other appurtenances, which, with the proposed machinery, will give an additional crushing-capacity of 50 tons per day.

The Danebroge will be re-opened by a perpendicular shaft 150 feet in depth, which will strike the mine below the old works at a place where the vein of the Danebroge and Pennsylvania come together. From these works the drifts south into the Pennsylvania will open this mine at the place where the Pennsylvania hoisting-works No. 2 now stand, and where the mine was formerly opened by an incline 300 feet in depth. The new machinery is building at the Marysville Foundery. The re-opening of these valuable mines is a matter of great importance to Yuba County, and the company has the best wishes of the community in the success of an enterprise that will redound to the common benefit.

BUTTE COUNTY.

Cherokee.—The Table Mountain, in Butte County, is a prominent landmark in Northern California, and undoubtedly the finest representative of a basaltic covered table-land in the State. This formation rises to view on the northern bank of Feather River, opposite Oroville, and extends, as the eastern rim of the Sacramento Valley, up to Cherokee, a distance of eight miles.

Stratified gravel, beginning with the blue lead in the bottom, and rising in gradations to a height of 500 feet, forms the main bulk. Quartz-gravel and sand predominate so much that about three-fourths of the whole formation is composed of them.

The plateau of Table Mountain is a plane, with a double inclination, from north to south and from east to west, and covered with a basaltic cap from 50 to 80 feet in thickness. This basalt cover has been removed by the action of water at different localities, principally at Cherokee and Morris's Ravines, and hundreds of acres of the richest gravel-deposits were thus exposed to hydraulic action.

The isolated and elevated position of Table Mountain made the introduction of water a most difficult and expensive operation. It was, however, successfully done; and not only Cherokee can boast of stupendous water-works, introduced by the Spring Valley Canal and Mining Company, and already described in former reports, but also Morris's Ravine can lay claim to the same improvements, introduced by Messrs. Hendricks & Co. to their extensive and rich mine at said place. The reputation and public recognition of the almost unequaled mining-resources of Table Mountain and vicinity are principally due to these two great aqueducts.

Ever since mining commenced on the Table Mountain gravel-deposit, (at Cherokee,) diamonds have been found in panning the residue of the washings, either of a common gold-rocker or of the gigantic sluices of the present day. The diamonds are of excellent quality, and vary in weight from ¼ to 2 carats, a few having been found weighing about 5 carats. It is hardly possible to discover the particular stratum which contains them; but Mr. Charles Waldeyer, to whom I am indebted for these notes, believes, according to former observations, that they occur the oftenest where a small deposit of highly-colored yellow clay and siliceous breccia is found. Still there is evidence that diamonds were found in the blue gravel close to the bed-rock.

So far little has been done to save diamonds, partly for want of proper advice and partly for the reason that all attention was absorbed in gold-washing.

The principal mining-operations at Cherokee are carried on by the Spring Valley Canal and Mining Company, the Cherokee Mining Company, and the Cherokee Flat Blue-Gravel Company.

The Spring Valley Canal and Mining Company has expended in improvements, altogether, the enormous sum of $680,000, of which $500,000 were expended, since the spring of 1870, for introduction of water through pipes across the West Branch, and for reservoirs, ditches, tunnels, flumes, &c. The Cherokee Mining Company has expended in improvements the sum of $400,000 for ditches, reservoirs, and tunnels, including a ditch from Butte Creek, destined to furnish water through a long line of iron pipes. The Cherokee Flat Blue-Gravel Company has expended the sum of $175,000 for tunnels, shafts, incline, &c., and intends to introduce water from the North Fork of Feather River. Besides these larger sums at least $50,000 were expended by other mining companies, so that the total expenditure for improvements at Cherokee may be put down at $1,305,000.

The mining-season for the Spring Valley Canal and Mining Company was reduced to about six months—the break of an immense reservoir at Concow Valley causing the loss of three or four months' water. The result of hydraulic washings during these six months is reported at $225,000.

The Cherokee Mining Company, depending, so far, altogether on rain-water caught in large reservoirs, cleaned up $100,400 during the season.

The yield of other mines at Cherokee may be placed at $25,000, so that the results of about six months' washing amount to $350,000.

With the introduction of water by other mining companies, in quantities sufficient to work the whole year, the product of the Cherokee mines can be raised to at least $1,200,000, if not $1,500,000.

Morris's Ravine.—This camp, a few miles south from Cherokee, is situated in a bend of Table Mountain. Ever since the earliest times of gold-mining, in California, Morris's Ravine has been celebrated for its richness. The great drawback to mining on a large scale has been the scarcity of water, and it was left to Messrs. Hendricks & Co. to remedy this deficiency.

These mines are in the same great gravel-deposit which forms the Cherokee mines, but have the advantage of lying deeper in the basin or channel, and carrying, therefore, very large nuggets of gold. Pieces weighing from one to six and ten ounces are picked up almost every day, and perceptibly increase the profits of the miners.

The systematic opening of this mine is now in progress. One of the best tail-flumes ever built in the State is just completed. This flume is 6 feet wide, 3 feet deep, and a mile in length, provided with undercurrents, drops, &c., and paved with stone.

Messrs. Hendricks & Co. expended the sum of $318,000 up to December 1, 1872, on this great enterprise. The following statement gives interesting and valuable details:

DITCHES.

Main Ditch, commencing at point on West Branch of Feather River, near section 9, township 24 N., range 4 E.:

Grade, upper line, 12.8 inches per mile.
Grade, lower line, 6.4 inches per mile.
Size upper line 5 feet wide, 2 feet deep.
Size lower line 6 feet wide, 2 feet deep.
Length, total, 34 miles.
Cost, total............................ $119,400 00

Glen Beatson Ditch, from Glen to mine:

Length, 6 miles.
Cost, (grade and size same as above).... $11,750 00

Oregon Gulch Ditch, from Cañon Ranch:

Length, 6½ miles.
Cost, (same grade and size)............. 5,000 00

Total length of ditches, 46½ miles.
Total cost of ditches $136,150 00
Average cost per mile, $2,928.
Average cost per rod, $9.15.

PIPES.

Length, upper line, (reservoir,) ¾ of mile.
Length, Table Mountain reservoir, 1¼ miles.
Total, 2 miles.
Diameter 22 inches; lowest depression 310 feet.
Iron, size for pressure up to 150 feet, No. 16.
Size for pressure, from 150 feet to 250 feet, No. 14.
Size for pressure, from 250 feet to 310 feet, No. 12.
Head of upper line 40 feet above outlet.
Head of Table Mountain line 50 feet above outlet.
Cost, per foot, $2.86; total, (including making, grading, and putting down) 30,200 00

FLUMES.

Length, estimated, 4 miles.
Size, 5 feet wide, 2 feet deep.
Grade, same as ditches.
Cost per foot, 95 cents; total cost 20,100 00

Tail-flume, for outlet from mine, down Morris's Ravine, (with three undercurrents,) to Feather River:

Grade 5½ and 6 inches in 12 feet.
Length, 1½ miles, (nearly 1 mile completed.)
Size, 6 feet wide, 3 feet deep.
Size of each box 16 feet; 330 boxes in 1 mile.
Lumber, each box, 1½ inches for sides and bottoms.
Lumber, total, in each box, 590 feet.
Pavement in each box 10 inches deep of rock.
Pavement, total weight of each box 6 tons.
Total cost to date, (not completed)....................... 24,200 00

Total cost of permanent improvements............ 210,650 00

MINE AND EXPENSES.

Location, Morris's Ravine, Butte County, sections 17, 20, and 29, township 20 N., 4 E.:

Incorporated at Indianapolis, May 28, 1866.
Expended for claims, water-rights, &c ... $15,000 00
Repairs of ditches, pipes, and pumping .. 24,000 00
Developing mine and current expenses... 68,350 00
107,350 00

Total investment.................................. 318,000 00

Large as this outlay may seem, there is hardly any doubt that in a comparatively short time the productiveness of the mine will afford a nearly equivalent for its whole cost, and the extent of the ground being not less than a thousand acres, promises to repay the investment many times over.

Oregon Gulch.—The following interesting report on the quartz-mines of Oregon Gulch, in this county, was prepared by Mr. John Nisbet, of Oregon City, a resident miner of long experience:

The Oregon Gulch quartz-district occupies an irregular valley, sloping to the south, and opening on Feather River, about three miles above Oroville. It is bounded on the west by the table-land, on the east by the North Fork of Feather River, and drained through its entire extent of eight miles by Oregon Gulch and tributaries. From the main river on the south, to the West Branch at the north end of the district, can be traced croppings of gold-bearing quartz for a width of about two miles. The developments already made seem to show the existence of one or two continuous veins, with cross-veins intersecting at every possible angle.

The first company operating on the south is the Oroville Gold and Silver Mining Company, recently re-incorporated as the Minerva Gold and Silver Mining Company of San Francisco. The property comprises a number of different ledges, some of which contain rich but very refractory ores. This difficulty has, in a great measure, been overcome by the introduction of Paul's process, which has been in operation several weeks,* and gives great satisfaction to quartz-men in our district, and seems to aim at all that is possible in the mechanical treatment of sulphureted ores. The Minerva company had a 12-stamp mill, using copper plates, blankets, pans, &c., and with the aid of the new process alluded to, and the abundance of quartz at hand, expect to make large returns for the ensuing year.

The next company, about one mile north, is Grummet and Stemple, formerly working arrastras, but now erecting a 5-stamp water-power battery. They have been taking out, all summer, quartz that will yield over $20 per ton. The gold is entirely free, and they have no difficulty in saving it by the ordinary process.

Farther north, on the west bank of the gulch, is the mine of Perkins & Reese, which has yielded rich rock, of which there are about 200 tons on the dump. It has the same general characteristics as other quartz in the district; the course and dip of the vein also indicate that it belongs to the main lead that runs through the district. This company is putting up an 8-stamp mill, using water-power at first, and steam-power, if required, in the dry season.

Farther north, about four miles from the river, where the creek bends to the east, is Oregon City, a village that gives its name to the district. Here are the Nisbet company's mine and mill. The claim is 3,600 feet along the course of the vein, covered by United States patent. It embraces the White & Nutter, the Buffalo mine, on the main lead; the Cambria, a cross-vein from the west, and the Ned Lewis, another cross-vein from the east. These, with the exception of the Ned Lewis, have been worked to a depth of 120 feet. The Buffalo has yielded, to date, $130,000; the Cambria, and White and Nutter about half as much each, making a total yield of $260,000 for a vertical depth of less than 100 feet. The company has completed a new 16-stamp mill, on the site of the 8-stamp mill burned the previous year. It has two 20-horse engines, and two boilers are to be employed, one engine to hoist and pump, the other to run the battery. The free-gold ores are amalgamated in the battery discharging on silver and copper plates, with quicksilver-riffles and blanket-sluices. The blanket-washings, after natural oxidation, are ground in arrastras connected with the counter-shaft of the battery-engine. Next summer a furnace will be put up to roast the sulphides. Meanwhile, present arrangements are considered adequate to treat the oxidized ore near the surface. Last summer the company sunk the main slope over 100 feet in hard rock. Previous to this all the work had been in the overlying soft schistose rock, on a vein averaging 3 feet thick. After sinking, a level was run to the north, and the same vein was struck that paid so well in the softer rock above. The Ned Lewis mine has been worked to some extent; but water interfered, so that in future both mines will be worked by levels from the foot of the main shaft opening in the mill.

North of the Nisbet mine is the old White & Nutter; half a mile further is the Bloomingdale; both are on the main lead, but are not working at present. A mile further north is the Rock River, belonging to the Pioche estate, also lying idle. Next are the Louisiana and the Spring Valley Quartz mines, neither, at present, working.

The Spring Valley ledge is the largest, and probably the best mine in the district. There are 70 feet of croppings and *débris* on the slope below the vein, all of which will pay for milling. The facilities for working are excellent. The company has a United

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*This is too short a time for an absolutely conclusive test.—R. W. R.

States patent, but for some unaccountable reason, best known to itself, steadily refuses to do anything in the way of developing the property.

There are other veins in the district that promise very well, but are not sufficiently worked to prove their value. As a general thing operations have ceased on the minor claims when water or hard rock was met with.

The district now contains 41 stamps, against 25 in 1871; a better spirit prevails, and more confidence is felt in the ultimate success and permanence of the business.

I am indebted to Mr. M. H. Wells, of Yankee Hill, for the following history and report of quartz-operations in Concow district:

This quartz-district embraces all the township of Concow. It is bounded on the east and southeast by the North Fork of Feather River, on the west and northwest by the West Branch of Feather River, and on the north by the Plumas County line. It is nearly forty miles long, with an average width of sixteen miles, and an altitude above sea-level of 1,800 to 2,000 feet. The quartz was first struck in 1849, when some very rich pockets were found. The first mill was put up in 1856 on the Rich Gulch divide, on the east side, by the Virgin Quartz-Mining Company. A 20-horse engine ran ten stamps and four arrastras, with stone-drags. This mill ran six years, and paid well, but the company not knowing how to manage, and paying the then high prices for labor, and having old machinery, stopped work, and most of the members left for Nevada. The mill was afterward sold and removed by creditors.

The next mill was put up in 1856, on the south extension of the Virgin mine, by the Forty-nine and Fifty-six Quartz Company. A 25-horse engine drove fifteen stamps, with four stone arrastras. The ledge had been located in the same year by Mr. Wells, who sold out his interest (one-tenth) before the mill was completed for the sum of $35. One year later the same share sold for $32,000. In laying a tram-way to run the quartz to the mill a very rich pocket was struck near the surface, out of which it is believed that over $300,000 has been taken. As usual in quartz-mining in those days, the receipts were liberally expended in dividends, large salaries and wages, and grand improvements, while the bonanza continued; but when immediate profit ceased, assessments were required for dead work, and indifference, discouragement, dissension, and litigation were the result. The mill was idle eight years, was then purchased by San Francisco parties, and was burned down in 1869.

A tailing-mill was next built by G. Collins Shallcross & Wightman, containing two large ovens and six iron arrastras, driven by a 12-horse engine. This proving unsuccessful was sold and removed to Marysville.

A water-power mill was next built on a divide about a mile east of Oregon City, by Mr. Fuller. It was of improved form, with double stamp-rods, and worked well, but before doing much was burned down. The iron-work was bought by Mr. John C. Fall, who put it into another mill, erected on the Venus mine, at Oregon City. The vein proved rich, and the mill was profitable; but it was again destroyed by fire. Mr. Fall then removed the iron-work to Unionville, Nevada, when it became part of the Pioneer Mill. About $500 in gold was found under the dies of the old batteries.

A 12-stamp mill (one pan, 25-horse engine) was erected on the Porter mine, at Jordan Hill, six miles north of Oregon City. This mill is now standing, and the only one in this district. It has paid well, but for the last eight years all operations have been suspended on account of litigation—recently compromised. The property is now owned in Marysville.

The Virgin mine was re-incorporated in 1857, and called the Venus. After the mill was burned all operations were suspended for four years. This summer S. P. Kimball, one of the present owners, opened a large shaft on the mine, 6 by 13, and timbered it for working-purposes. A mill will shortly be erected.

About all the numerous veins of this district run northeast and southwest, and dip 45°. The greatest depth reached on any of them has not exceeded 120 feet. The rock will pay, on an average, $12, with a chance of striking rich pockets.

According to many assays from the mint and various assay-offices, the fineness of the gold runs from 755 to 790; silver is mixed with it. The base metals are arsenic with a little sulphur and very little copper.

The river-veins are worked out, except some banks of gravel, which pay $1.50 per day to the hand. The gulches and placers are nearly all exhausted.

SIERRA COUNTY.

This county contains within its limits some of the most extensive and profitable hydraulic and drifting ground in California, as well as numerous veins of quartz. It has not heretofore received the attention it deserved, either from the press or the reports of the Mining Commissioner. This year I am enabled to present a full and accurate description and report of its resources, from the pen of Mr. C. W. Hendel, United States deputy mineral-surveyor, whose practice of his profession as civil and mining engineer, during a period of twenty years' residence in Sierra County, renders him eminently fit for this task. The calculations of yield per ton, or per cubic yard, have been made from personal knowledge or from examination of the books of the various companies.

Sierra County is situated between latitude 39° 22′ and 39° 40′ north, and between longitude 120° and 121° west from Greenwich, and is bounded on the north by Plumas County, on the east by the State of Nevada, on the south by Nevada County, and on the west by Yuba and Plumas Counties. Its greatest longitudinal distance is from southwest to northeast, about fifty-four to sixty miles, and its average transverse distance is about fifteen to twenty miles, thus including about one thousand square miles. Its lowest point is located on the North Yuba River, in its southwest corner, being about 2,000 feet above sea-level, while its highest point is the culminating rocky summit of the Sierra Buttes Mountain, near Sierra City, sometimes called the Downieville Buttes, being about thirteen miles east of Downieville, the county-seat, and about 8,500 feet above sea-level. The estimated population is about 6,000, having 2,665 domiciled registered voters. The total assessed valuation of property is about $2,000,000. Of the 640,000 acres there were, in 1871, 22,310 acres inclosed, and 2,560 acres cultivated; of which 945 acres produced 13,441 bushels of wheat; 860 acres, 19,022 bushels of barley; 515 acres, 11,785 bushels of oats; 11 acres, 250 bushels of rye; 89 acres, 8,410 bushels of potatoes; 6,820 acres, 7,110 tons of hay. The county produced also 7 tons of beets, 18 tons of turnips, 9 tons of pumpkins and squashes, 72,300 pounds of butter, 14,000 pounds of cheese, 1,200 pounds of wool, and 3,100 pounds of honey. It had also last year, of growing trees, 7,810 apple, [illegible],100 peach, 981 pear, 389 plum, 390 cherry, 87 nectarine, 107 quince, 40 apricot, 11 fig, 2 lemon, 1 orange, 17 prune, 20 mulberry, 12 almond, and 20 walnut trees; 24,200 gooseberry and 11,000 raspberry bushes, and 5,700 strawberry and 1,220 grape vines, the latter producing 1,200 gallons of wine. There are 19 ditches for irrigating purposes in this county, to irrigate 320 acres of land.

The country is well timbered and rich in forests of beautiful and stately sugar-pine, (*Pinus Lambertiana*,) from 18 to 25 feet in circumference; yellow pine, (*P. ponderosa;*) little sugar-pine, (*P. monticola;*) digger or scrub pine, (*P. Sabiniana;*) tamarack, (*P. contorta;*) white fir, (*Picea grandis ;*) red fir, (*P. amabilis ;*) spruce, (*Abies Pattoni ;*) cedar, (*Libo cedrus decarreus ;*) live-oak, (*Quercus Wislizeni ;*) black oak, (*Q. Sonomensis,*) covering the mountain-slopes, from their lowest points on Yuba River and its tributaries, up to the summits of the various ridges between the many cañons, to an elevation of 8,000 feet, and all valuable for lumbering and mining purposes. There are 9 steam and 12 water-power saw-mills in operation, having produced last year 6,000,000 feet of lumber.

The climate is very salubrious, most deaths occurring from great intemperance, exposure, accidents, and violence. The spring, summer, and autumn months are similar in climate to those of Northern Italy. The excessive heat prevailing in the valleys lasts but a few days, and then only for a few hours during each afternoon. The winter-months are often very severe and terrible during the prevalence of the great storms; still, the cold is not as great as in the Eastern States in the same latitudes and at less altitude, or even at the sea-shore of the Atlantic. The snow-fall, in localities of great altitudes, is from 10 to 20 feet in depth.

Mineral resources.—In mineral-resources Sierra County may justly claim to be second to none, in fact to be the leading county of California in regard to drift, hydraulic, and vein mining. The mines were in the early days easily worked and prolific in their yield; and they still continue to be among the most remunerative and productive in the State.

Gold is found at all altitudes, from the lowest point in the beds of the rivers to the very summits of the divides. The deep beds of auriferous gravel and the quartz-deposits will not be exhausted for centuries.

Gravel-mines.—Sierra County is considered the principal drift-mining county of California. Several well-defined and far-famed ancient-river channels run across this county in a general north and south course, from 500 to 2,000 feet higher than the present parallel-running creeks and rivers—some of them so high that the introduction of water to them has hitherto been considered of doubtful possibility, and, if practicable, too costly for poor miners. It is a well-established fact in regard to placer-mining that without ditches these rich and extensive auriferous gravel-channels are insignificant in value. No gold can be obtained from them without *water.* The streams run past these deposits far below, in deep, steep, and often very abrupt cañons, which have, however, a great fall, and extend high up into the snowy regions, so that by taking the water from near their sources this indispensable requisite for hydraulic operations can be obtained. There are at present fifty mining-ditches in this county, with an aggregate length of two hundred and twenty miles, costing about $750,000. There is still demand for more water, as the present supply lasts only from four to eight months.

Although many millions of ounces of gold have been taken from the edges of these channels, where they have overflowed their beds, they have been, so far, scarcely more than touched. The most eastern of these channels appears to come from Plumas County, in the north. It crosses Feather River near Beckwith's Pass, continues thence, in conjunction with a channel coming from the northwest, (passing Gold Lake,) as one grand river in a southwesterly course, passes the Keystone quartz-mine and Milton's Ranch, crosses the old Henness Pass wagon-road, near the "middle waters"—having been so far but very little opened—thence along the mining-camps of Nebraska and American Hill, both of which have proved its richness, and finally on toward Eureka, south, in Nevada County, where it is extensively opened and worked with great success and profit by many mining companies. Here the celebrated North Bloomfield Company (at an expenditure said to have been, for some time past, $60,000 per month for labor and material alone) is now opening this channel with a bed-rock tunnel one and a half miles long, in order to work and wash out the lower rich strata of the company's extensive mining-ground, located on the above-described grand gravel-channel or dead river. This channel is in Sierra County, about twenty-five miles in length, and averages one mile in width.

The channel lying next west enters Sierra County near its northeast corner, on the dividing ridge of the heads of Hopkins and Nelson Creeks, in Plumas County, and Cañon Creek, in Sierra County; runs a southerly course, and is covered to great depth by heavy layers of lava andvolcanic sand, (conglomerate,) or "mountain-cement," as it is generally termed by the miners. The main channel has been tested by partial working in the following rich places through which it passes, viz: Cañon Creek, Poker Flat, Deadwood, Sebastopol, Excelsior, Fir Gap, Monte Cristo, City of Six, Rock Creek, Forest City, West Ravine, Alleghany, Chip's Flat, and Minnesota, all in Sierra County; and Orleans and Moore's Flat, &c., in Nevada County on the south. In all these places, with the exception of the four last named, the deposit has been worked by means of shafts or tunnels, by drifting, and in most instances the front of it only has been hydraulicked, where water could be obtained, with a satisfactory result. The four last-named places are still worked with great success by hydraulic process. All these mining-camps paid richly in early days, producing many millions; and this channel has of late proved as rich as formerly wherever followed and opened low enough into the center of the overlying hills. This has been demonstrated at the mining-ground of the Bald Mountain Company, at Forest City, and the Highland and Masonic Company, situated between West Ravine and Alleghany.

This channel has several branches, which have proved equally rich in several places, as, for instance, the celebrated "blue lead" or "blue banks," near Downieville, situated on the left bank of the North Fork of the North Yuba River, which is apparently a different gold-bearing channel from that of the ancient-river beds before described.

Without its branches the above-mentioned channel is over twenty miles long in Sierra County, and more than one mile wide, containing an area of over twenty square miles, having a grade of 70 feet per mile in average. Farther west comes the celebrated and more extensively developed so-called "Slate Creek Basin," on each side of which is a well-proved and very rich auriferous gravel-range or dead-river channel. These run nearly parallel to each other in a southwesterly course from the northeast, uniting, however, again near Bald Mountain, in the neighborhood of Scales Diggings and Poverty Hill. The eastern of these two, lying between Cañon Creek on the east and Slate Creek on the west, apparently enters Sierra County in its northwest corner, under Pilot Peak. This isolated mountain is over 7,000 feet high, of volcanic origin, its northeastern slope heaved up and walled with basaltic columns, while its lofty summit, commanding a sublime panoramic view of the Sierra Nevada Mountains for hundreds of miles distance, Sacramento Valley, and the Coast Range, is capped with a bed of lava 600 to 700 feet thick. This channel has an average fall from the base of Pilot Peak (where it is worked by the North American Mining Company) down to Scales Diggings, near the junction of the western channels, of 84 feet per mile, reckoning these two points as twelve miles apart, as they are in an air-line. The course of the channel is, however, very crooked, like all our present streams. It passes from under Pilot Peak, through the Pilot Company's claim, where it has also been recently discovered in their late and lowest tunnel, at a distance of 800 feet from its mouth, and at an altitude of about 6,400 feet above sea-level. It then passes through the North American Company's claim, a consolidation of many well-known mines, containing 2[illegible] acres of very valuable and rich mining-lands, which has already yield $325,000 to $350,000 from one-fiftieth of the whole area, and was purchased a year ago by an English company. Thence it passes eastward, east of Slate Creek House, the head of Slate Creek, near or under Staffa Mountain. Here it takes a southeast course under Mount Fillmore or Alturas Mountain, where its existence has already been proved by a tunnel driven on the east or Cañon Creek side by a German company. This tunnel proved, however, to be too high, and a new one has since been started much lower and is expected to strike the bottom of this channel ere long. Thence it trends toward Table Rock, passing between Potosi and Cold Cañon, in which places it has for many years past been extensively worked with great profit by drifting in the direction quartering toward each place, or in a more southerly course. The Fashion and Sierra Companies, in Cold Cañon, have driven their tunnel southwest to reach the channel in their ground, (both companies having thus far taken out over $750,000 of gold,) while the first companies working in Potosi had to drive their tunnels southeast to reach the same channel in their ground. The Pittsburgh and Hawkeye Companies, in Potosi, have thus far taken out over $1,000,000 of gold. Recently the Monumental Company, also in Potosi, lying north of the former mines, has also tapped the same channel, and is now declaring dividends of $5,000 to $6,000 per month. The Empire Company, owned by San Francisco capitalists, lying still further north, is driving energetically toward the same rich channel known to exist in its ground.

We find this channel going thence southward toward Howland Flat, as proved by the connection of the Pittsburgh and Hawkeye Companies' underground works with those of the Union Mining Company and others in Howland Flat, at an altitude of 5,750 feet, (the town being 5,850 feet in altitude,) making a difference of elevation from the channel at Pilot Peak to Howland Flat of 650 feet. The Hawkeye Company in Potosi, in opening out its claim, ran first a tunnel, at a cost of over $30,000, from the northwest or upper side. This proving too high to work the bottom of the ground in the channel to advantage, having no drainage, they made a drain-tunnel from the Union mine in Howland Flat, at an expense of $20,000. But this drain-tunnel going through the so-called "swell"-rock it closed up again, soon after its completion, to such an extent that fifteen months afterward, when the Union Company crossed the line of it, no appearance of the old tunnel could be found, save the firmly-imbedded timbers. Having completed, at a cost of over $40,000, a new drain-tunnel from the southwest, over 2,500 feet in length, the company has since worked very rich ground, having taken out as much as 80 ounces of gold per week to thirty men working.

The Union Company, also in Howland Flat, has thus far taken out over $1,000,000, and is now driving a lower tunnel for the so-called "back channel," under Table Rock, a mountain 7,200 feet in altitude. The front ground of Howland Flat has all been drifted out, having yielded several millions. This ground has, of late, been consolidated into one company, known as the Last Chance Placer-Mining Company; and an application for a United States patent to the lands (33 acres) has been made. In the report to the United States surveyor-general of

California, by the United States deputy mineral-surveyor, C. W. Hendel, who made the survey of said mine under special instructions of September 28, 1872, he says:

This mine is a consolidation of the once celebrated rich mining-grounds of the following mining-companies, viz, the Saint Louis, Golden Gate, Minnesota, Wabash, and other companies now defunct, which have spent not less than $50,000 in opening the ground, either by tunnel or shafts; and it is believed that not less than $1,000,000 in gold-dust has been obtained from the bed-rock, while the remaining top-gravel, which is about 50 to 60 feet high, to near the surface, will pay a large sum of gold by working by hydraulic process. The whole bank being an auriferous gravel-deposit, containing plenty of free gold throughout, to near the surface, which is covered by a bed of heavy lava, tufa, or volcanic sand, offers excellent opportunity for hydraulic mining. This mine is but a small portion of the celebrated gold-bearing gravel-channel or ancient-river bed, which comes from Pilot Peak in a southeasterly course, and extends through Sierra County, by way of Pine Grove, Chandlerville, &c.

This channel is then traced further south by its exposed edges in several places on each side, having been worked with great profit by either drifting or hydraulic process in the camps of Pine Grove, Rabbit Point, Chandlerville, Sacket's Gulch, Saint Louis, Greenwood, Cedar Grove, Gardner's Point, Grass Flat, Slopeville, Queen City, and Portwine, all on the west side of the channel; by two mining companies east of Howland Flat, and at Wahoo on the east side.

At Pine Grove, the Comet is the only company at present working. It does not use the late and most approved appliances, which have, within a few years, made a revolution in hydraulic mining, by which this branch of mining has become a regular and legitimate business. Notwithstanding this drawback, and the fact that the shareholders, who are in this case the workmen, receive higher wages than is customary for hired help in the same locality, they have been washing their ground by hydraulic process with considerable success. They have, in 1872, sluiced away a piece (a great part of which had been drifted out by former companies years ago) containing 33,970 square feet or 1,188,950 cubic feet of ground, (the bank being about 30 to 35 feet deep at present,) by using only 300 to 500 inches of water, for which they paid this season's rent, $4,250, at the rate of $40.85 per cubic yard of gravel throughout. Allowing 150 pounds for the weight of the gravel per cubic foot, the company had moved 178,342,500 pounds, or 89,171¼ tons, including the immense bowlders which had to be turned over, and obtained a yield of $17,921 or $20.1 per ton. Their mining-appliances consisted of 500 feet of iron pipes, of 11-inch diameter, and 700 feet of 9-inch diameter, having a pressure of 115 feet fall. With but little expense they could have obtained over 160 feet pressure. They were using two pipes, one with a 2½-inch and the other with a 2¾-inch nozzle. After the gravel-bank had been caved down by the stream of water from the pipes, the caved and broken-up gravel was carried in ground-sluices into and through 400 feet of sluices, paved with rock, set on or above the bed-rock, thence dropping down a perpendicular shaft, 25 feet deep, into their sluice-tunnel, in which they have a flume 2½ feet wide by 2½ feet deep, set at a grade of 1 foot in 12, paved also with rock, and 300 feet long, this tunnel having cost, on an average, not quite $10 per linear foot. The tailings, after passing out of the tunnel, ran thence through a flume of the same size along the hill-side of Slate Creek for 300 feet, then dropped into a ravine through 100 feet of ground-sluice, where they are yearly worked over again by other parties, with excellent results, and are finally carried into Slate Creek, as are all the tailings from the surrounding hills. Here they lodge and are carried off by freshets, to some extent, into the Yuba.

The gravel-claims of this place and the surrounding country are of the class known as deep-placer or drift diggings; their value depends upon the richness of an auriferous stratum covering the bed-rock to a greater or less extent. In the Pine Grove mines this stratum is about 20 to 30 feet thick. The bed-rock on which this pay-streak rests is soft yellow metamorphic slate, having a blue color a few feet below the surface, and becoming hard in going down. The appearance of the gravel in all these mines is very favorable for hydraulic mining, unless too much lava or barren top-dirt makes it unprofitable to "pipe off" or strip. In that case it must be worked by drifting, in the progress of which it is generally the case that the pay-stratum becomes thinner, but richer in gold on the bed-rock per cubic foot. The open banks show a beautiful quartz-wash. The gravel is mingled quite freely on the bottom with smooth-washed quartz-bowlders, weighing often some tons, well rounded; and the remainder is composed of smaller, well-washed, round, and smooth quartz-pebbles, mixed in yellowish and whitish clay, sand, and other earthy matter. The rocks, when taken from their virgin places, leave a smooth bed behind, a sign which is held by all observing miners as an indication of rich pay. The gold is about .910 to .920 fine. At Chandlerville, now mostly owned by the Sears Union Water Company, under the management of Mr. George Cox, that company worked, last year, gravel considered the poorest in the neighborhood for miles around, being so hard that only the best kind of a hydraulic ram, "Chief" or "Dictator," would make an impression in their gravel or rather cement (conglomerate) bank, and paying only 7 cents per cubic yard; but they washed such an enormous body of ground that they still realized a handsome dividend over and above getting paid for their water, where other parties before them, even in somewhat richer ground, but with no business qualifications, could not make expenses under the old system of working, and in consequence had become bankrupt. This company uses a flume 5 feet wide, 3 feet deep, set in a bed-rock cut and tunnel, at a grade of 6 inches in 12 feet, using 1,200 inches of water, part of it running through a 15-inch pipe, made of No. 16 sheet-iron, with a 4½-inch nozzle, and a Dictator with an 11-inch inlet, under a pressure of 150 feet. They have also an old-fashioned 3-inch nozzle, throwing 300 inches of water. A few white men, at $3.50 per day, are employed to oversee the Chinese laborers, who only receive $1.40 per day, to wheel up into the ground-sluices the balance of the gravel on the bed-rock. In eleven weeks' run this company moved 350,000 cubic yards of gravel, the bank being only about 25 feet high.

At Saint Louis, where, in former years, the ground was owned in very small parcels by many companies, about two dozen of which were usually at work by hydraulic washing, the ground has of late been more consolidated and reduced to about half a dozen ownerships, claiming from 300 to 500 acres of mining-land. Four of these companies, possessing all the water-privileges, are Morgan & Co., Emory & Co., Stahl & Brother, and McCrory & Co. They are beginning to use the modern appliances for hydraulic mining, having ground enough left for fifty years, which will pay from $2,000 to $10,000 per 100 feet square.

At Greenwood, and adjoining Cedar Grove, are the Star, Caledonia, and Exchange Companies, having a frontage of about 4,000 feet on this channel, and running into the main channel, which is at this point about one and a half miles wide between Slate and Cañon Creeks. The front ground of Cedar Grove paid well in early days for washing in sluice-boxes. McCrory & Co. took out from 1¼ claims (at 100 feet square) in one season $42,000, and out of 1½ claims $30,000. There have been over

$250,000 taken out from about 12 acres of low ground in that place, from banks not over 40 feet deep.

At Gardner's Point, formerly a mining-camp of some note, having yielded about $500,000 of gold, but dormant for about ten years, the property was lately purchased by Colonel B. F. Baker, from the San Francisco owners, for the sum of $3,000, and consolidated with surrounding mines. The purchaser had last season hardly time to repair dilapidated ditches and old cuts; but by using proper hydraulics and patching up ditches, &c., he managed to wash a piece of ground of 100 feet square. There were about 5 feet of soft blue gravel on the bed-rock, and on top of that about 45 feet white gravel, mixed with blue quartz-bowlders, all washed smooth and well rounded, and 30 feet of soft lava on top of that, making the face of the bank about 80 feet high. Out of this piece he realized, at the expense of a few thousand dollars, the sum of $30,000. In this claim he found two diamonds, the first of which was, it is said, lost by his foreman, who did not know its value, while the second and smaller one, found and preserved by Colonel Baker, has been pronounced by lapidaries a diamond of the first water without any flaw, and valued at $165.

Thence we trace the channel through Grass Flat, where it is over one and a half miles wide, and where the Pioneer Company and others to be consolidated have made an application for a United States patent to 360 acres of mining-lands, which they own. This company is now running its third tunnel, having made the common mistake of starting their former tunnels too high and running them only for drifting purposes on a small grade. It now becomes necessary and very remunerative to work this mine, and afterward the whole district to the north, containing over 1,000 acres, through the outlet of the tunnels, by drifting or hydraulic process as the case may be. This can be done with a deep tunnel by following the channel up with cuts or tunnels, having the great advantage of soft rock and its natural grade from north to south, instead of running a separate tunnel through the hard rim-rock for each company, at an enormous expense. Mines in a contiguous row on the same channel are too often worked independently, while one general tunnel, following the channel, would allow the water to run off by its natural flow to the lowest from all the mines, at great saving of expense. The Pioneer Tunnel would be the nearest and most accessible outlet for a large range of country on the channel. The claims of the Pacific, Union, and Monte Cristo Companies, containing hundreds of acres, lying south of Grass Flat, and having poor facilities for drainage, could all be washed through this tunnel by the hydraulic process, since their bed-rock, strange to say, pitches heavily toward the north. Unfortunately the Pioneer Company went to work with false economy, without proper surveys, which, compiled and studied by an experienced engineer, would have established to a certainty the bearings and differences of grade of the different channels. They have lately consulted an engineer, to ascertain how much lower they could start a sluice-tunnel, and its necessary length; and the result is that after blasting a tunnel 1,500 feet through very hard rock, costing on an average $20 per linear foot, and yet worthless for hydraulic purposes, they find that they could have run a sluice-tunnel, for nearly the same amount of money, more than 150 feet lower, by commencing a few hundred feet southwest of the mouth of the old one, and that by the surveyed route the deep tunnel would have been only 276 feet longer. The rock would have been more favorable, not costing over $15 per foot; and a splendid sluice-grade would have been obtained, with the drainage of a section of mining-ground not to be worked out for many years. The present tunnel started over ten years ago, cost over $60,000, and is now 3,500 feet long and nearly 3,000 feet in the above channel, with gravel now demonstrated to a certainty to yield great profit when sluiced away by hydraulic process. The first shaft raised for air from the branch tunnel, about 900 feet from the mouth of the main tunnel, passed through 58 feet high in gravel, with the 5 feet of loam on the surface, and the second air-shaft, in the main tunnel, 1,680 feet from its mouth, passed through 80 feet of gravel, with 6 feet of loam. The gravel in these shafts contained free gold; and throughout the whole mine, as prospected, it is heavily impregnated with gold-bearing sulphurets, these having assayed as much as $160 per ton. The branch tunnel, where in gravel, for a distance of 421 feet and 18 feet above bed-rock, paid an average of 86½ cents per cubic yard; and for 1,200 feet in the main tunnel, where the same has been excavated in gravel, (over half the distance being about 10 feet above bed-rock,) the gravel paid an average of $1.04 per cubic yard, notwithstanding the gold could not all be obtained. The difficulty is that the gravel is loose, the free gold easily washed, and the ground very wet, (over 50 inches of water running out of the main tunnel in the dryest time of the season;) hence, before the gravel is shoveled into the cars, the gold has already to a great extent been washed down to the bottom of the tunnel. This company recently let another contract for 500 feet of tunnel, expecting to strike into the richest part of this great gravel-channel, worked by more than six companies farther south toward Portwine, and also by this company on its north side, and having paid as high as $2.12 per cubic yard.

Farther south from Grass Flat we have in operation the Union Company, north of Portwine, which has a claim 2,290 feet long by 850 feet wide on this great gravel-channel. The ground is opened by drifts; and after having been raised in loaded cars upon a double track 96 feet in length from the incline by water-power, the gravel is transported through a tunnel, 2,500 feet, by mule-power, one mule hauling 10 to 12 cars out of the tunnel at each trip. This company has washed in ten years past 37,810 cubic yards of gravel, which yielded $463,343.99, giving the astonishing average per cubic yard of $12.25. The ground is very deep. A shaft, sunk in early days 209 feet deep, with 30-horse steam-power, and still prevented from reaching bed-rock by the quantity of water, showed beautiful "quartz-wash" from top to bottom.

The adjoining Monte Cristo Company on the south, on the same channel—the only company which has worked through to the east side of the channel on the Cañon Creek side—hoists the dirt to the surface by means of an incline with a 15-horse engine, and has drainage through the Union Tunnel. This company has washed in the last ten years 83,959 cubic yards of gravel, which yielded $543,648.79, or $6.47 per cubic yard.

In Portwine this channel has been worked extensively and profitably by hydraulic process, by the Queen, Golden Gate, Erie, Eagle, Sailor, and several French companies, having produced millions of dollars. About a mile below Portwine, at Bunker Hill, the overflow of the channel over its rim-rock is plainly seen, and has been partly worked. Thence for about four miles, toward Mount Pleasant district, little prospecting has been done.

In following the course of the channel after crossing the Gap of the summit of Bald Mountain, (5,500 feet altitude,) we pass to the right of Hard Scrabble mining-district, which is very extensive, but very little worked for want of water and capital.

Next comes Mount Pleasant Ranch mining-district lying southeast of Poverty Hill, and known to contain very deep placers, as extensive, and supposed to be as rich for hydraulic washing, as the famous Blue-Gravel mines at Smartsville, in Yuba County. The Iowa Company, in attempting to reach bed-rock, sunk a double shaft 154 feet deep, using a large overshot water-wheel; but disagreements led to bankruptcy, and the property was sold under the hammer. The new company started, without a survey, a drain-tunnel from Rock Creek, to strike the bottom of the shaft. After they had run a considerable distance, they found that they would miss the shaft 150 feet to the left, and were 12 feet higher than its bottom. This tunnel to the shaft was run 1,162 feet, at a cost of $8,000. The company then purchased a 30-horse engine and steam-pump, and sunk the shaft to a depth of 220 feet, about 40 feet into bed-rock, at a cost of over $18,000. Getting hard rock, they started a drift, but in 50 feet they lost the bed-rock, the shaft having been sunk on the rim-rock. After running the tunnel 200 feet from the bottom of the shaft into the hill, through gravel that prospected well for hydraulics, the company attempted to sink to the bed-rock; but when 12 feet down further progress in that direction was stopped by the inability of the workmen to get rid of the water as fast as it came in, in the back shaft, although they were able to raise some 1,600 gallons per hour. The members of the company being working-men, their means became soon exhausted, and they finally quit work, and all the mines in that district have lain dormant ever since.

Next to the Iowa Company is the Washington Company, which, more than ten years ago, ran two tunnels, and at the back end of each sunk shafts to a considerable depth, spending no less than $25,000, but was unable to reach bed-rock.

Farther south we have the Mount Pleasant, Ladies', and Lincoln Companies. The first one of these has made a start in the right direction, by commencing a sluice-tunnel from a steep ravine emptying into Cañon Creek; to be about 1,500 feet long, and to constitute the only available outlet to drain and wash off several miles of this gravel-channel. The estimated cost was $40,000 to $50,000. This company being, like the rest, not abundantly supplied with money, is working but little on this great enterprise. If half the money spent in this district on petty shafts and tunnels had been used on this tunnel, opening nearly 1,000 acres, the owners of the ground would have been well rewarded.

In this neighborhood the western channel of the Slate Creek Basin unites with the main channel, which continues on its course southward to Scales diggings. Here the Cleveland and Sierra Hydraulic Mining Company is using 2,000 inches of water, and running night and day, employing twelve men. They use one of Craig's old and one of the new universal-joint pipes, with a nozzle of 5½ inches and a stream under 200 feet pressure. This company has about 130 acres in the old channel. Where they are now working it is from 40 to 200 feet deep, and but a small portion has been worked.

The same company works another set of hydraulic claims at Council Hill, about two miles from Scales's and four miles from Brandy City, where 1,000 inches of water are used, in two streams, one with a 3½-inch and the other with a 4½-inch nozzle, (old style of pipe,) under 275 feet pressure, employing five men. The company owns several ditches supplying an abundance of water.

At Fair Play, between Scales's and Council Hill, Boyce & Brother own their own water, which is conveyed through two ridges in tunnels, one

1,000 feet and the other 600 feet long. They also own several hundred acres of rich, blue hydraulic ground.

At Brandy City, on a ridge between Cañon Creek and the North Yuba, this channel is successfully worked by Messrs. Zellerbach and Hickey, Jenkins & Co., and others. The former property was bought a year ago for $72,000. After introducing all modern appliances the new company, sixty days after commencing work, cleaned up $32,000. This company owns two ditches, each of a capacity of 1,200 inches.

This channel extends thence south, past Young's Hill, Camptonville, San Juan, Birchville, and French Corrall to Smartsville, &c.

The most westerly channel of the celebrated Slate Creek Basin, lying between Slate Creek on the east and Little Feather River, in Plumas County, on the west, enters Sierra County (like the before-described channel) in its northwest corner, under Pilot Peak, passing from Hepsidam along the main dividing ridge through Whisky Diggings, thence through Gibsonville. In both places the front portion of this channel has been worked with satisfactory results by many drifting and hydraulic companies. About a mile below Gibsonville, near Wallis Ravine, the Go-Ahead Company sunk a shaft 351 feet, with a steam-engine, to bed-rock. In sinking they passed through seventy-five different strata of different texture, and also found a petrified elm-tree imbedded in the gravel. This work was done under contract, to sink until bed-rock was struck, and a few pans of gravel were tested with fair results; but the bed-rock apparently pitched rapidly into the hill, threatening to require further dead work, and the members of the company being scattered, work was stopped and the shaft suffered to fill up with water.

The channel enters thence Plumas County, and for miles has not been developed until it reaches La Porte, which formerly belonged to Sierra County.

The mining-ground in and around La Porte has been more consolidated and is owned now by but few companies, who all have their own water. The principal mining companies are Conly & Gowell, Gard & Orr, Bald Mountain, and Bordwell's.

Conly & Gowell hold a large and valuable claim, by United States patent, said to be the first one ever obtained for a gravel-mine. They have expended a large amount of money on the ground. In four months' run of ground-sluicing, or hydraulic washing, they cleared off about 6½ acres, averaging about 65 feet in depth. Allowing 150 pounds as the weight of gravel to the cubic foot, this company moved in that period the enormous amount of 1,380,807 tons of gravel and started it on its way to the Yuba River, through Slate Creek. They have an abundance of water during the washing-season, running all their pipes, using an 8-inch nozzle, and 800 inches of water, miners' measure. This is believed to be the largest nozzle in use, and is of the kind known as the Monitor. Before it the banks of gravel melt away like snow before the sun. Rocks weighing each a ton or more are moved by the force of the stream, when turned against or under them, and rolled high and dry on the bank out of the way.

Heretofore, in mining of this nature, hose and pipes were used which would carry a large body of water under a pressure of 50 to 60 feet. The Monitor will stand a pressure of 200 to 300 feet; with it miners can tear the hardest cement, even cutting a ground-sluice through the bed-rock with it, where plenty of water and pressure can be obtained. The bottom of this claim is covered with a hard cement crust, from 2 to 12 inches in thickness, resting on the bed-rock, which, before the introduction of the Monitor, was found extremely difficult to work. Moreover it seriously impeded the saving of the gold washed out from the earth above. This cement itself is rich in precious metals, the extraction of which its extreme hardness prevented. It is a mass, formed under the petrifying influences of the water in the channel, of iron pyrites, black sand, and fine-ground or pulverized quartz. In working it with the Monitor these difficulties disappear. A stream is turned against it, striking on the bed-rock. In an instant it cuts a hole under and turns up large flakes of the cement, breaking it into fragments which are almost entirely disintegrated before they reach the end of the flume. The flume of this company is 4,500 feet long, and riffled the whole distance with stone paving. The tailings run into Slate Creek, where they are carried away to some extent by the annual floods, the residue being washed over and over again by the several companies owning and working Slate Creek for this purpose. To clean up such a flume and cut is a large job, requiring several weeks, but the most pleasing work of the miners' season. To avoid loss of time they run continuously through the season, as long as the water holds out in their ditches, cleaning up only once a year. They cleaned up last year over $125,000 for the season's run.

What has been stated of the above mine is applicable also to Gard & Orr in the same place, who also own several hundred acres of equally rich gravel.

Next come Spanish Flat, Secret Diggings, and Bernard Diggings, on the same channel, where it makes a horseshoe bend, from which several million dollars have been taken.

Farther on this channel is found in Poverty Hill, east of Slate Creek, cut in twain by the creek. This part yielded about $2,000,000 before it became necessary to drive costly tunnels to work the deeper and still richer channel, covering over 1,000 acres. Messrs. Judson and others, of San Francisco, are now running a tunnel 7 feet wide from Gold Run Ravine, low enough to work the surrounding country. Westall & Eberle have finished their sluice and drain tunnel, which it took six men ten years to complete, and are now piping their rich, long-neglected ground. Kingdon & Brother are profitably working their ground, as far as their small amount of fall permits. Here the channel unites with the other branch, as before described, and bears on toward Brandy City, Camptonville, &c. This channel has an average fall, from Hepsidam to La Porte, of 182 feet per mile, being seven miles long in an air-line, and on an average one mile wide, giving, in Sierra County, an area of about fifteen square miles of mining-ground to be worked in the future. In both the before-mentioned channels the auriferous gravel is exposed on the surface for many miles in Sierra County.

Fluming-claims or gravel-tailing mines.—The value of the beds of all the streams in the gold-bearing sections of the State, and particularly of the Great Slate Creek Basin of this county, was never understood until recently. A few years ago, when the bed of a stream had been worked out, it was thought to be of little future value, and not worth working over again. Now it is conceded that tailings in the channels of the rivers, creeks, and ravines will pay to rework as often as they are filled up with gravel, cement, and sulphurets from the deep hill-diggings. This class of mining-property now proves the safest for investment. In many cases the owners are at no expense whatever; the hydraulic and drift mines above them fill up their claims gratis every year, and give them also, in most instances, free water to wash the accumulated tailings.

The ravine and creek claims are generally the first recipients of the tailings from the sluices and tail-flumes. These ravines in Slate Creek Basin are generally very steep, and have a fall of 300 to 600 feet, until they reach Slate Creek, which empties into the North Yuba River.

Such a ravine is found below almost every mining-camp, with about 60° descent, varied with falls over which a large body of water and gravel runs for several months of the year. The bed of the ravine, immediately above each fall, is comparatively level, or may be made so by artificial dams, and is often covered with flumes, varying in size from 4 feet to 16 feet wide, and, in some places, two flumes alongside each other, paved generally with pieces of rock. These are used for two purposes, viz, to preserve the wood-work from the gravel which runs over it, and also to act as "riffles," to save the gold. These flumes in steep ravines catch the tailings from hydraulic diggings themselves. Tailings in these creeks have always proved profitable. By miners who have used all kinds of riffles in this part of the country, those above described are considered far superior to all others in efficiency, durability, and economy. The object in using two flumes is that, when it is necessary to "clean up," the stream of water which accompanies the tailings can be used in one without inconveniencing the operations of the other.

The utility of the falls is not apparent at the first glance, but when the vast amount of iron and other metallic forms of cement, found so extensively all through the mines in this vicinity, is taken into consideration the necessity for them will be perceived. Some of the cements, after having rolled through sluice-boxes for a long distance, and after attrition with sharp rocks, and being ground by contact therewith, still retain the gold with the same tenacity as if it were imbedded in a solid quartz-rock. Tumbling over the falls with a heavy body of water falling on it, has a tendency to crush or break up the cement, and to release the gold. The supply of gravel reaching these ravines is now as great as it ever was, and, with the new developments making in the surrounding hills, it may reasonably be expected to continue for a long period. So long as the placers are productive, so long will these ravines and creeks continue to accumulate the auriferous *débris* of the hydraulic and drift banks above them.

Slate Creek.—This has been for over twenty-two years a reservoir for the deposit of *all the tailings* washed from the hills around. It is also a large natural flume, through which the rich, gold-bearing earth from thousands of acres has passed; and it is so situated that it will be fed for hundreds of years to come by the tailings from rich hill-diggings. These creek-diggings have facilities for drainage that are often wanting in other localities of similar character, and which may be artificially still further improved. They have also sufficient free water to work all the time, both for milling and mining purposes. For miles along the stream the tailings-deposits are scores of feet in depth, and from 150 to 800 feet in width, with the exception of one point at the falls below Rabbit Creek. They reach over twenty miles to the Yuba River, being the most extensive in the State; and a large proportion of them came from diggings of exceeding richness.

To give an idea of the value of the sulphurets and black sands of these mines, which have been heretofore considered worthless, it may be mentioned that Mr. Cox, superintendent of the Sears Union Water and Mining Company, at Chandlerville and Pine Grove, ordered this year a portion of the sulphurets and sands to be saved out of a piece of ground he was working. They saved fifty-one candle-boxes full, (the boxes being of uniform size, 12 inches long, 9 inches wide, and 6 inches deep,) and had them hauled to a little arrastra, when, to his surprise, they yielded $736. From observations made by Mr. Gowell, an intelligent mine-owner at La Porte, it is estimated that, in early days, when mining was done in sluices with heavy grades, the loss of quicksilver was from 50 to 65 per cent. Since then, using less grade, the loss has been about 33 per cent. of quicksilver. This quicksilver is scattered on the surface of the ground to be washed. The original formation of gold-bearing gravel in this creek, about 1 to 10 feet deep, also proved very rich in coarse gold.

In the spring of 1853 the miners commenced pouring in the secondary deposits from their hydraulic operations above, since which time no work has been done in the original formation, nor in the secondary deposits of the creek. The artificial deposits came so fast, and spread so wide, that there was not sufficient grade to work them. The ownership of over five and one-third miles of this valuable tailing-creek has become, in the course of time, consolidated in the hands of two companies.

From below Pine Grove, where Slate Creek becomes very flat, down to Saint Louis Bridge, a distance of two miles and 800 feet, the Eureka Tunnel and Mining Company is the sole owner. It has made a tunnel, through a point under the Saint Louis and La Porte wagon-road grade, 269 feet long, 11 feet wide, and 7 feet high. By this some 15 feet in depth was gained—not enough to work the tailings too near the bed-rock. It contains two flumes, one 5 feet wide and the other 3¾ feet. The improvements cost about $18,500. But not having sufficient fall for discharge below the tunnel, the tailings "backed up" upon this claim from Portwine Bridge, where the falls commence, and continue down the cañon. This company will have to wait until the lower company shall sluice out these backed-up tailings by utilizing the fall at the lower end.

Below this the Alturas Gold-Mining Company is sole possessor of three miles and 1,022 feet of the creek, its claim reaching over 1,000 feet below Portwine Bridge, and including the falls and the only outlet of the tailings of both the gravel-channels of this Grand Slate Creek Basin. At Portwine Bridge this company "brought up" some falls in the creek below, and ran a tunnel 12 feet wide and 16 feet high, thereby gaining considerable grade, but still not enough, while, with an outlay of little more capital, it could obtain all necessary fall for all the tailings of the whole creek and all mines above. This company has taken out of ground, which it was able to work by virtue of its permanent improvements, over $40,000. The lower end of this ground, having a good fall, has been worked almost yearly for the last fifteen or twenty years, Chinese having paid $1,000 rent per year for the lower 1,000 feet. Last year the company rented to a Chinese company, for $5,060, a piece of ground most of which had been once worked.

Failures in working tailing-mines are very unusual, and, when they do occur, are always attributable either to the cost of water, which is the chief item of expenditure, or, more frequently, to mismanagement. There is scarcely an instance known where large profits have not been made, when, as in this locality, the water-property and the mines have been in the same hands.

Work on these claims has not been vigorously prosecuted, on account of disagreements among the partners.

In working a creek like this one, a face of work of a proper width in the creek should be brought up at a regular grade, and retained by removing the big bowlders and projecting bed-rock points in the natural channel of the creek, and by blasting from the falls a bed-rock cut or flume, confining the tailings to a limited channel, and thereby gaining more velocity in their flow. Operations should be so conducted as to leave a solidly built-up channel, say 100 feet wide between the walls, with a bed-rock cut or flume of 6 to 12 feet wide. The former gives ample room for freshets, and the small cut is of proper width to carry all the tailings away during the low stage of water in the dry season. It should have an even grade, and be as straight as practicable. These preliminaries secured, the banks may be worked out. At the same time a strong dam, several miles above the lower end of the mine, should be built from the bed-rock, instead of the top of the tailings, as has been the usage of this company heretofore, a practice always involving heavy repairs, since it is hard to make a dam stand built on the top of the ever-shifting tailings. The object of this dam is to control the flow of the tailings at pleasure.

The channel left open as advanced would be a tailing-flume, not liable to expenses like a wooden flume. In fact the continual flow of tailings at and near the bed-rock in a confined bed would, to some extent, deepen the cut. Once a year, or once in two years, this cut could very easily be cleaned up by shoveling the residue into sluices. The cost of such an enterprise would be small in the event of the creek-bed being properly worked out. It would require only the opening and walling up of the channel for the waters and tailings to run in, and it would pay for itself after the first few hundred feet would have been completed, since these could be cleaned up year by year in sections, or rented to the Chinese. In working past the mouth of any ravine, bringing water and tailings from the hills, a side feeder to the main cut or bed-rock flume should be left open, and its sides walled up, to conduct the water and tailings into the main stream. Thus, year by year, a system of works would be extended, that would yield large returns on cleaning up at the low-water stage.

This system would be greatly aided by building the dam above alluded to, enabling the company to control the amount of tailings to be admitted to the bed-rock flume, or artificial channel, by gates built in it, according to the volume and force of the water at any period of the year, with the exception of the great floods, when they should all be opened.

From such a dam, ditches could be dug down the sides of the creek for hydraulic washing of its tailings and banks into the main flume through sluices, saving most of the gold in the latter, and also furnishing power to saw-mills, derricks, and grinding-apparatus for sulphurets, black sand, and cement.

It is reported by Dr. Brewster, of La Porte, who has been for the last eighteen years engaged in the transportation of the United States mails between La Porte, in Plumas County, and Marysville, in Yuba County, and also in the transportation of gold-dust and bullion for the different banking and express companies, that from account-books in his possession, he finds that there has been transported for the banking-house of John Conly & Co. over $40,000,000 of gold-dust and bullion, valuing the dust at $20,000 for the 100 pounds, or 100 tons of treasure for that house alone. The banking-houses of Evarts, Wilson & Co., Eve & Crew, Wells, Fargo & Co.'s Express, and the Union Express Company have shipped at least $20,000,000; and he says it is a safe estimate that one-fourth the product of this mining-region has passed over the road in private hands, of which, of course, no account is kept. Nine-tenths of this aggregate have been taken from the above described Slate Creek Basin.

Iron-fields.—In the northern part of Sierra County, on the head-waters of the North and Middle Forks of the North Yuba River, about twelve miles northeast from Downieville, the county-seat, the Sierra Buttes, near Gold Valley, at an elevation of about 6,000 feet above sea-level, contain very valuable deposits of different kinds of iron-ore, which are in extent and position in the highest degree available for easy working. The Sierra Iron Company of San Francisco, under the management of Mr. W. S. Day, is about to apply for a United States patent to their valuable mine.

The course of the iron-deposits is from northwest to southeast, and is inclosed by syenite on the northeast, and a limestone belt on the south-west. According to Baron von Righthofer, who examined these mines years ago,* and reported very favorably upon the same, the ore in sight amounted to 1,400,000 tons, averaging 40 per cent. of iron, of which 800,000 tons are in one cropping alone, and 50,000 tons in another, which can be obtained by simple quarrying. The deposit is of good quality, and remarkably pure. It occurs in three different conditions:

1. Massive, nearly pure magnetic-iron ore, fine-grained, having the appearance of steel, containing 60 to 75 per cent., not only attracting the magnetic needle, but also capable of magnetizing steel.

2. A mixture of pure magnetic-iron ore with carbonate of lime, considered as rich as the ore of the first class.

3. Chlorite and talcose slate, containing innumerable crystals of magnetic iron, in regular octahedrons, forming as pretty cabinet specimens as can be desired, and yielding about 50 per cent.

The necessary flux required for smelting is mixed with the ore itself, or found in the vicinity, and an unlimited, cheap supply of charcoal may be had from the extensive surrounding forests.

Quartz-mines.—The principal quartz-mines of this county have been mentioned in former reports; and lack of space compels me to omit a discussion of their recent history. I am convinced that the comparatively large space devoted to the placer and gravel mines of Sierra has been well bestowed, since these important and enormously productive industries have not received in former reports their proper share of attention.

PLUMAS AND LASSEN COUNTIES.

These two counties, situated in the high Sierra, possess much undeveloped mineral wealth. The sources of the ancient rivers were probably in these counties, not far from the volcanic peaks west of the main range of the Sierra; thence their general winding course was southerly, for a distance of two hundred miles or more, to the edge of the San Joaquin Valley, fed by many tributaries from both east and west.

Plumas County is approachable by three routes, all crossing high mountainous ranges: one by way of the *Northern Pacific Railroad, via* [illegible]ville, by Oroville and Greenville stage line; another via Marysville [illegible] La Porte, and the third by Central Pacific Railroad via Truckee, Jamison City, and Sierra Valley. This route is preferable in the winter-season, as the approach is by a series of valleys below the snow-line.

This county has an area of 4,200 square miles, and its topography embraces the rugged grandeur of the Sierras, combined with a number of beautiful and productive valleys, not inferior to Sonoma, Berryessa, and other *of the noted valleys of the Coast Range, either in attractive* scenery or the richness of the soil. *The main ranges rise to an alti-*

* See my report of March, 1870, p. 59.

tude above sea-level of from 6,000 to 7,000 feet, while many peaks rear their snow-clad, lava-capped tops to a height of from 8,000 to 10,000 feet. Among the most noted of these are Lassen Butte, Pilot Peak, Alturas and Spanish Peaks. Among these mountains rise the various branches of Feather River, (the Rio Plumas of the Spaniards,) irrigating the valleys, and furnishing the miner with unfailing streams of water during nine months of the year.

The principal valleys are American Valley, Meadow Valley, Indian Valley, Sierra Valley, Mohawk Valley, Butte Valley, Grizzly Valley, and Red Clover Valley. Some of these valleys embrace about one hundred square miles of the finest land in the State, capable of producing in profusion all the cereals as well as fruit and the grape. Wheat at 50 bushels to the acre is not uncommon, and the size and flavor of the fruit are unsurpassed. The altitude of these valleys rarely exceeds 4,000 feet above sea-level; Quincy, in American Valley, having an elevation of 3,700 feet. Here the snow rarely falls over 12 inches in depth, and remains but a short time on the ground, while on the surrounding ranges it falls from 12 to 18 feet, and continues a great portion of the year, to the great benefit of the miner and agriculturist. The climate of the valleys is genial, neither excessive heat nor cold being known. The country is essentially self-sustaining, and raises all the wheat and vegetables consumed, with a capacity of sustaining a population of 40,000 or 50,000. At present the population does not exceed 5,000 souls, a majority of whom are engaged in mining, but (except in quartz at some localities) on a small and insignificant scale compared with the resources of the country.

The agricultural capacities of the country are sufficient to support a large population, but as export is impracticable until a railroad shall be built through Beckworth Pass, it is not probable that farming will be carried on extensively for many years. The mineral-resources of the country are, however, unsurpassed, and deserve the attention of capitalists and mining-operators. The mountain-ranges are cut by large and continued ledges of quartz, frequently of immense width and promising appearance. Only two districts have so far been opened on an extensive scale—Indian Valley and Eureka districts. In the last-named district is the celebrated Plumas Eureka mine, recently purchased by a London company for $1,000,000. The quartz-veins of the county have not been prospected, or even located, and the traveler is surprised at times to find the "color" in ledges cut by the grading of the roads—ledges which are unlocated, unprospected, and undeveloped.

Of the extent of the placer, hydraulic, and gravel mining-ground in this county but little is known. Exploration, so far, has only demonstrated the richness of this class of ground, but its area seemingly is unlimited. At some remote era, prior to the volcanic period, the disintegrating action of torrents of water, of such volume as to be unappreciable at the present day, has covered the then rivers, valleys, and level-lands with an immense deposit of the comminuted particles and fragments which form the sedimentary gold-bearing deposits of the California gravel-ranges and ancient river-beds. The theory of "ancient channels" can, however, scarcely be reconciled with the wide spread and almost universal sweep of debrital matter which has covered this portion of the State. That such channels or beds of former years do exist in counties farther south is undoubted, but in this portion of the State either the whole of the then surface was covered, or numerous streams existed flowing from north to south, and uniting further south in one or two great rivers carrying more water than the combined waer-system of the present day. This question can only be solved by the labors of the Geological Survey.

The extensive auriferous deposits of Slate Creek Basin, on the line of Sierra and Plumas Counties, have been described in detail under the head of Sierra County.

The rivers, creeks, and bars of the modern streams were extensively worked at an early day, with an astonishing result in the production of gold; but they were abandoned during the Frazer River excitement, and the subsequent discovery of silver in Nevada has drawn off most of the mining population. These shallow placers are not, however, wholly worked out, and good wages may yet be made in this class of diggings. Many of the small creeks have not been worked, and locations are shown, opened the present year, where from $5 to $10 per day is made in placer-mining, with no other appliance than the sluice-box. The gravel and hydraulic ground has only been worked in spots, and on a small scale, (except at La Porte, which is more generally identified with Sierra County, and was incorporated in Plumas County a few years since.) The Maxwell Mining and Ditch Company, on Spanish Creek, has commenced a mining enterprise which bids fair to be profitable. The company has claimed the water of Spanish Creek, and the ditch leaves the the river at the falls, about a mile above the mouth of Blackhawk. The ditch can carry about 4,000 inches, and for a good portion of the season the water privilege is sufficient to keep it full. The company intends to work first at Brown's Point, just below the Spanish Creek bridge. Good prospects have been obtained at this place and it is thought that a large amount of paying ground will be found here. The ditch will be extended down the river as fast as possible, as it is known that several high bars under the line of the survey will pay well for working. It is not improbable that diamonds may be found in this region, and will some day be systematically sought for. One veritable crude stone weighing one karat has been found in Slate Creek, just over the county line, and is now in the possession of a gentleman in La Porte.

Quartz-mining.—The principal quartz-mining of the county is in the vicinity of Jamieson City and Indian Valley. Near the first-named locality is situated the celebrated Plumas Eureka mine, now owned in London. From a report of Mr. J. S. Phillips, of San Francisco, made at the request of the former proprietors, immediately prior to the transfer to the English owners, the following description of this valuable property is extracted and condensed:

The Plumas Eureka mine lies within six miles of the general axis of the Sierra Nevada, but in a region where the range is traversed by the sinuous valley called Beckworth's Pass, at an elevation of 4,800 feet above the sea, leaving several isolated, syenitic peaks, around which are the tilted secondary strata of talcose slate, carbonates of lime, magnesia, &c. Dikes of fine grained felspathic mixtures and greenstones also occur.

This property comprises the Eureka, the Seventy-six, and the Rough and Ready veins, cropping on the precipitous eastern declivity of Eureka Peak, one of the isolated elevations above mentioned. The veins are in the stratified formations flanking the syenitic core. Other veins, said to occur in the primitive rock, have not been sufficiently explored to prove their value. Much work has been done on the Eureka vein, and its general character has been well exposed. It is a strong lode, varying in course from S. 20° W. to S. 36° W.; and in dip from 46° S. to 60° W. Its width varies also, as the result of these irregularities and of movement of the walls. Mr. Phillips mentions the latter as distinct and generally "unctuous," and refers to a peculiarly well-marked corrugated face of quartz, seen in all the workings, from 2 to 3 feet in the vein from the foot-wall, and dipping about 45° mountainward, which he thinks indicates that the sides have slid extensively on each other. The foot-wall, he says, is a very congenial syenitic greenstone, and the hanging-wall, at times a superlatively generous talcose slate, at others a blue carbonate of lime, or yellow mixture of lime and magnesia, which also form frequent splices and horses in the vein, near the best paying quartz.*

The lode in the most advanced workings is 24 feet wide and well defined; the quartz is here stained with the oxide of iron and speckled with sulphurets of iron and lead. As a general rule the vein has carried disseminated gold pretty equally. Large pieces have been rare. For some distance behind the breast just mentioned the formation is disturbed by "horses;" and though the branches contain considerable reserves of paying quartz, these are far from equal to the outside deposit, from which at least $2,000,000 has been already produced.

Seven levels have been driven on the Eureka vein. The railroad or engine tunnel, through which the mine is now worked, has been driven nearly 1,000 feet into the mountain, attaining a vertical depth below the surface of nearly 400 feet. At its inner end the breast of quartz already alluded to of 24 feet in width has been discovered. Above this, the Rhoda tunnel has been driven 480 feet, and communication obtained by a winze sunk on the vein from level to level, affording excellent ventilation, and opening a back of 170 feet of paying lode, from 2 feet to 5 feet wide. In this part, between the large outside deposit and the interesting new discovery in the railway tunnel, stoping has lately been carried on. Again, 140 feet above the Rhoda tunnel, the upper tunnel has been driven some 210 feet. Both of these fall considerably short of the region of the new discovery below them. About 150 feet from the entrance to the railway tunnel, and 600 feet behind these stopes, a shaft has been sunk 243 feet and four levels have been driven, one called Harper's, being 55 feet deep, 730 feet long, and containing seams of $10 rock.

The value of the quartz from the 24-foot breast is estimated from five average assays at $22 per ton; the 4-foot vein, in upper works, yielded $20 to $21.60; the outside deposits along the outcrop, $35.28, $12.80, and $8.60; concentrated sulphurets from all parts of the lode, $4.86 per ton.

Little has been expended on common roads, but a tram-road has been constructed to convey the quartz from the railway to the mills, which lie about three-quarters of a mile distant, by a descending track around the artificial lake. This lake has been created by damming back, at great expense, the water from the dissolved snow during the spring and summer months, into a natural hollow of sufficient size to supply two mills, of 16 and 12 stamps respectively, and a Chilian mill. These are driven by separate water-wheels, and the long ravine would permit the erection of other mills to be worked in succession by the same water. A small roasting and chloridizing apparatus has been erected for the treatment of the sulphurets, which have, however, not been thus far beneficiated, but await the coming summer. Dwelling and boarding houses, offices, and workshops have been erected near the mill and at the mine, and a moderately good running supply of materials is kept in stock. These have cost little short of $300,000.

Indian Valley.—The mining interests of Indian Valley have suffered during the past year from one of those periodical depressions to which this branch of business is subject. Two or three hundred men have dwindled to one-quarter that number. Three of the principal mines, the Crescent, the Indian Valley, and the Kettle, have changed hands, and the former have not yet recommenced operations. Of the other mines, the Union and Bachelor's have been running long tunnels to strike their ledges at a considerable depth.

The main lode or fissure of this district runs northwest and southeast, incased in granite, and averaging 15 feet in width, with very distinct walls. It has been located for a distance of five or six miles. Commencing at the eastern end, the Crescent is the first. In this part of the ledge the walls are broken up and the quartz forms a distinct breccia; the gold is very coarse, and in the upper levels the quartz paid well; latterly, however, the yield has decreased. This mine, if ever again worked, will require a large amout of capital to put it in shape, most of the upper works having caved in through neglect of the timbers, and all the pay-rock below, as far as the shaft is sunk, (about 400 feet,) being mostly worked out. Following the course of the fissure westward, the next mine is the Bon Accord. This has great natural facilities for working, of which the former owner, Mr. C. Cahalan, took advantage in pros-

* As I cannot fully comprehend, I am unable either to accept or reject the nomenclature, and what might be called the *geognosis*, of this description.—R. W. R.

pecting the claim, having run five tunnels in on the ledge from 75 to 120 feet below one another, thus opening out a large supply of rock, and obviating the necessity of hoisting or pumping gear for years to come. The vein here courses about 60° north of west, and dips almost vertical. It shows in the lowest level a width of 16 feet, but, so far as tested, the rock does not yield over $5 or $6 per ton. There has never been a mill on the ground; the mine has been sold by the sheriff, and since then nothing has been done.

The next mine on the lode is the Pennsylvania, likewise idle at present; formerly it paid well, and the owners had a 12-stamp steam-mill, but the property was sold by the sheriff.

The next is the best mine on this lode, both in development and in steady paying quartz, namely, the Indian Valley mine. The lode courses about north 65° west, and is 26 feet wide at the bottom of the 650-foot shaft. This shaft was used for pumping and hoisting, but was partly caved in September, 1871, in consequence of the hoisting-works burning down, since which time the mine has been worked through a tunnel, cutting the ledge at a depth of about 300 feet at the east end of the claim. The ore now extracted pays on an average $12 per ton; but the ore from the pay-chimney at the southwest end is of a much higher grade.

Joining the line of the Indian Valley is the Union mine, which has paid well in the upper works, the rock averaging $25 per ton. During the past year the company has run a tunnel over a thousand feet to strike the pay-rock in depth. In the mean time a convenient and complete steam-mill, with 24 heavy stamps, has been erected at the mouth of the tunnel, thus obviating the hitherto expensive hauling. This mine ends the series of workings on the main lode of the district.

On the south side of this main-fissure are a series of smaller ledges that have been worked at different times with varied results. The most important of these are the Green Mountain (Bachelor's) and the Kettle. They are likewise in granite, the former about 4 feet in width; the latter, 3 feet. The Green Mountain averaged for a long time $50 per ton. At present the mill is not running, the owner, Mr. Bachelor, being engaged in running a deep adit. The Kettle mine has not been in operation since its transfer to the present owners in England. The whole of this district is supplied with wood and water. The price of wood is $3 a cord, delivered; lumber, $20 per M.; wages, $2 a day and board.

The Haydon Hill mines, in Lassen County, California.—These mines were accidentally discovered in the fall of 1870, and since that time numerous locations have been made. The principal are the Old Providence, the Haydon Hill Company, Haydon's mine, and the Providence. The country-rock is of sedimentary origin, greatly broken up by volcanic action, and partly metamorphose. In this the fissures are found without any apparent regularity, coursing both north and south and east and west. The gold is of very fine grain, indeed so much so that it will float on water. It is likewise strongly alloyed with silver. The veins are from 1 to 6 feet in width.

The Old Providence is the oldest location. The ledge runs east and west, is opened by a shaft 75 feet deep, and from it a short cross-cut to the vein, on which some drifting has been done. The company is at present putting up a horse-whim, with the intention of sinking 60 feet farther. It is hard to tell what the rock has averaged, no uniform method having been used in working. At one time the ore was treated in an arrastra; then the loose crevice-dirt was run through sluices; and finally an 8-stamp steam-mill, with two pans and a settler, was erected and run for a short time last winter, with poor success. About $40,000 has been extracted. The mine has changed hands, and is being worked systematically. The new company has started 4 stamps to prospect the mine, and so far the rock has averaged $20 per ton. The only spring of water for some distance around issues from this ledge. The company employs at present six men at the mine and four at the mill.

The Haydon Hill Company has three tunnel-claims of 3,000 feet each on the west side of the hill. On one of these the tunnel is in 250 feet. It has not struck any pay as yet, but has run through some fine white clay.

Haydon's mine is on the north side of the mountain, and consists of two tunnels, cutting the ledge. Some of the rock out of this claim was shipped to the English mills in Reno last fall and paid at the rate of $100 a ton in gold and silver. The owners, Messrs. Haydon and Lewis, are working alone in this claim.

The Providence Company has sunk a shaft about 75 feet on its ledge and commenced to drift. Different samples of their rock, sent to San Francisco, have given very good results. The country is pretty well supplied with timber, but the lack of sufficient water is rather a drawback.

List of quartz-mills in Indian Valley district, Plumas County, California.

Name of mill.	Location.	Owners.	No. stamps.	No. pans.	Power—steam or water.	Remarks.
Crescent	Indian Valley.	English limited liability company.	32	1	Steam.	Has not been running any time during the year, on account of transfer to present owners, who have not yet commenced operations.
Indian Valley.	....do	Messrs. Applegrath & Drake.	24	2	Steam.	Has been running about seven months. It shut down in the spring to put pans in and to develop a new pay-chute, the main pay-chimney being under water at present, in consequence of the destruction of the hoisting-works by fire.
Union	....do	Incorporated companies; office, San Francisco.	24	—	Steam.	Has just been completed, and expects to start up in November. The old mill, driven by steam, contained 12 stamps and 1 pan, and worked about four months in the beginning of the year.
Kettle	North Cañon..	English limited liability company.	16	1	Water.	Has run a couple of months on custom-rock; the owners have not commenced to work their mine.
Bachelor's	Dixie Cañon ..	Bachelor	4	—	Water.	

Gravel-mining.—In the summer of 1872 there was discovered, in Lassen County, twelve miles south of Susanville, on the very summit of the Sierra Nevada, an extensive body of auriferous gravel, which has since been tested and found to be of high grade. This mass occupies a sort of basin, granite on one side and volcanic tufa on the other, is five miles long and half a mile wide, and at the only point exposed, a break in the granite rim on the west, shows a vertical depth of 500 feet. What imparts additional interest to this discovery is the fact that this deposit is not only isolated in position, being many miles to the east of the main gold-field, but that it lies at an altitude of more than 8,000 feet above the level of the sea. The gravel here, though mixed with volcanic mud and ashes, appears to be free from the more tenacious clay and hard cement, often so troublesome in that found in the old-river channels. It is quite loose, and can therefore be easily disposed of with water, of which there is plenty at hand, there being three small lakes in the ground, besides great quantities when the snow melts in the spring. The gold is coarse-grained, but of fair quality, worth $18 per ounce; and in all respects identical with that found on the upper waters of Feather River.

The parties locating this basin of gravel have procured surveys to be made with a view to obtaining a United States patent therefor. They have also made preparations to work it by hydraulic washing in the spring of 1873.

THE NORTHERN COUNTIES.

The mining-region of the northern part of the State covers great portions of the counties of Shasta, Siskiyou, Trinity, and Del Norte. Within these limits are embraced large areas of auriferous ground in placers and lodes of gold-bearing quartz and of cinnabar. The placers have been profitably worked, on a comparatively small scale, for more than twenty years by a sparse population; and the mining-industry is in a backward state, both laborers and capitalists having been repelled by the remoteness of the region from the ordinary channels of travel. With the near approach of the Oregon and California Railroad, this condition of things seems likely to change. All classes are beginning to turn their attention in that direction, and many new and important mining enterprises have lately been inaugurated.

Dr. Henry De Groot, of San Francisco, has recently visited this portion of the State, and furnishes the following account of his observations:

The mines here, though similar to those in the main mineral-range, which occupies the foot-hills and westerly slopes of the Sierra Nevada, have not been so extensively worked as the latter. Only the surface-earth has been washed, while little has been done at hydraulic, deep-placer, or vein mining, this class of deposits being still almost in a virgin state. Here remain immense bars, forming high benches along the rivers. These have been but little disturbed by the miner, it being difficult to get the dirt down to the water and expensive to construct ditches for bringing water on the bars. These benches were formed from material deposited by the adjacent rivers at a time when they ran in much more elevated beds than at present. Many of them are not only high—from 100 to 300 feet—but cover a large area, often a hundred acres or more. Having been deposited by the action of water alone, and without any intermixture of volcanic matter, the gravel here is loose, and free from cement, pipe-clay, and large bowlders. It can therefore be broken down and washed readily with a moderate head of water, and without the use of powder. The dirt uniformly pays well; moderately at top, and steadily increasing to the bed-rock, where, as usual, it is richer. The gravel throughout will average half a cent to the pan; more than double that in the large hydraulic claims at Cherokee Flat and Smartsville. Water in these northern mines is very abundant, and can be brought on the most of these bars at a moderate cost. In some cases water from mountain-streams can be conducted on these bars without being carried a great distance. In others it can, in like manner, be taken from the main river, the descent of which is generally such that a sufficient head for hydraulic washing can be obtained, with only a few miles of ditching. The conditions for hydraulic operations are therefore generally favorable.

There also occur, at numerous points in this part of the State, auriferous deposits in old-river beds, not, perhaps, the channels of pliocene streams, as along the slopes of the Sierras, but those of the present day, the waters of which, dammed up by land-slides or by material brought down by some great flood, have been forced to find a new passage to the sea, the old one having afterward been filled up by the deposits made at high water and the wash from the neighboring hills.

At some points on the Klamath River this filling up and shifting of the stream appears to have been comparatively recent. At Klamath Bluffs, thirty miles from its mouth, the river, obstructed by an immense land-slide, has been compelled to make for itself another passage a quarter of a mile farther south, through which it now runs, a high ridge of bed-rock separating the two channels, the old one being now occupied by a rich and extensive bar, upon which large mining-operations are about to be commenced by a San Francisco company.

Both north and south of this locality, sometimes at points nearer the sea, and sometimes farther inland, fragments of these old-river bars and obstructed channels are met with under the names of "gold-beaches," given under the impression that they indicated the site of ancient shore-lines, and had been thrown up by the ocean surf. But the manner in which the larger rivers of that section are observed to have been diverted from their beds and the latter afterwards filled up, forming deposits exactly like these, seems to argue for both a similar origin. That they have all been formed at periods more or less remote, some of them in the distant past, is evident from the magnitude of many of these deposits, the mass of which could have been gathered only by slow accumulation, and from the deep alluvial soil, often growing stately forests, that covers most of them.

The formation of the "gold-bluffs" found on the sea-shore in the neighborhood of these "beaches" is due, no doubt, to a like cause, their greater elevation being explained by the fact that the level of the river-beds was much higher formerly than at present. The principal, and what is known as the original "Gold Bluff," lies twelve miles south from the present mouth of the Klamath River. At a point fifteen miles up that stream a deep depression sets in, and running in a westerly course (the present river bearing northwest) terminates in Gold Bluff, abutting on the sea, and here several hundred feet high. Through this depression, the bottom of which is much higher than the present river-bed, the Klamath once ran; the channel having afterward been filled up and its banks obliterated by the gravel and sediment brought down the stream at high water and washed from the slopes of the steep and lofty mountains adjacent; and we have only to suppose the latter process continued for a great number of years to produce here another of those subterranean gold-bearing channels met with elsewhere in this section of country.

As is well known, auriferous beaches occur at intervals along the sea-shore from Humboldt Bay for a distance of more than two hundred miles to the north. These have been formed in part from the gold brought down by the several large streams that disembogue along this section of the coast, and in part by the washing away of the gold bluffs also met with here, which perhaps at one time extended much farther into the sea than at present, the accident of the gold being deposited at these particular localities being due to the ocean eddies and currents that prevail in the neighborhood.

The manner in which the outlet of these rivers might have been filled up is shown by the state of things existing now at the mouth of the Klamath. This river and its tributaries run through an exceedingly mountainous country, usually subject to heavy rains in the winter. During very wet seasons, like the past, the water, confined to a narrow channel, rises to a great height, bringing down vast quantities of sand, gravel, and drift-wood, swept into it from its steep and heavily-timbered banks. Having reached the mouth of the river this material is there deposited, forming sand banks and bars that sometimes extend so nearly across it as to leave only a very narrow open passage for the water, most of which makes its way at low stages through these beds of sand and gravel. To such an extent had these been accumulated at this point by the floods of the preceding winter that in the fall of 1872 a person could almost walk across the Klamath, though it carried a volume of water equal to the Sacramento above its junction with Feather River.

Besides the various forms of placer-mines above described this region contains vein-deposits of great extent and variety, the more important consisting of gold, cinnabar, and copper; all of which exist under favorable conditions for cheap development, the country being full of fine streams, affording a vast amount of water-power, and abounding everywhere in magnificent forests of pine, cedar, and spruce. Many of the gold-bearing quartz-lodes have been more or less tested, a few quite extensively worked, and generally with good results or encouraging prospects.

The copper veins, some of which have been opened to a depth of 300 feet, show promising indications of permanent wealth. Of this class of lodes the most extensively developed are situated at Low Divide, eighteen miles north of Crescent City, from which several hundred tons of ore have been extracted and shipped to San Francisco. It is of the gray variety and assays from 18 to 20 per cent. of metal.

At Trinity Center, Trinity County, what seems a valuable deposit of cinnabar has lately been discovered, the ore here occurring in veins and distributed in small fragments throughout the soil and along the gulches, where it has been carried by the action of water, exhibiting the rare example of quicksilver placers. This cinnabar-bearing tract, which lies on a high ridge between two forks of Trinity River, is about one mile long and a quarter of a mile wide, the formation being a sandstone covered with a clayey soil. Through it run in every direction innumerable small but exceedingly rich veins of this ore, to the disintegration of which is due the enrichment of the gulches and surface-soil adjacent. Scarcely a pan of the latter taken at random fails to show a little and frequently a large "prospect" of cinnabar, while the gulch dirt will yield from one to two pounds of 60 or 70 per cent. ore to the pan. It is the intention of the owners of this property to wash the top earth in sluices. In the meantime the net-work of small veins will be explored in the hope that they can be traced to a main central lode, believed to exist in the neighborhood.

TRINITY COUNTY.

Mr. B. C. Wattles, of Weaverville, Trinity County, writes as follows concerning the progress of mining in that vicinity:

Our mining operations are principally hydraulic. About forty claims are being worked, the most noted of which are the Bolt's Hill, the Holmes, and the Red Hill. The depth of ground varies from 60 to 100 feet, and the average yield of the dirt is probably higher than elsewhere in the State. The product of the county for the past year has been estimated at $1,000,000. It is impossible to estimate with any degree of accuracy the quantity or proportion of ground worked out. In some claims from 75,000 to 100,000 square feet of bed-rock has been stripped; while in others but a small extent has been exposed. We have in this county a range of gravel extending from Trinity Center to the North Fork of Trinity River. This range is about fifty miles in length, with an average width of over five miles, and a probable average depth of 60 feet. The only point at which mining has been prosecuted with vigor has been at Weaver; there has so far been a lack of water elsewhere. Recently a company has been formed and operations commenced to bring water on this range from Stewart's Fork, and another for bringing water from the North Fork to the Holmes and Red Hill ground. The latter ditch will have a capacity of 10,000 inches. The great drawback to the success of our hydraulic mines has been this want of water; and with the construction of these ditches a new era of prosperity will dawn for Trinity County.

SHASTA COUNTY.

The Dry Creek Tunnel and Fluming Company, in Shasta County, own about 1,600 acres of mining-ground near Horsetown, extending for a distance of three miles along the bed of Dry Creek, and averaging half a mile in width. A considerable portion of the surface of their ground has been mined at different times, with fair results, by the old-fashioned methods; but on account of water and lack of fall for tailings no work of any moment was done on the dam until the fall of 1870, when the company now in possession commenced operations for the purpose of opening the mine in such a manner that it might be worked on a large scale, and all the modern improvements in hydraulic mining applied to its development. In order to accomplish this the company found it necessary to excavate an open cut 1,200 feet and a tunnel 2,400 feet in length from Clear Creek, a stream running parallel to Dry Creek, but several hundred feet below the level of the latter, for the purpose of gaining access to their ground at a sufficient depth, and also of obtaining a convenient tail-race through which to carry on their washings. This tunnel runs upon a grade of three feet to every hundred, through a gravelly ridge, and terminates near the center of the company's claim in a bed of auriferous blue gravel, at a depth of 100 feet from the surface. Water for hydraulicking is obtained partly from a ditch carried along the adjoining ridge and partly by utilizing the waters of Dry Creek. The improvements already made upon this mine have occupied two years' time and been effected at a cost of nearly $50,000. The preparatory work upon the mine is all completed, and actual mining is just commencing.

The Piety Hill Blue-Gravel Company's claim consists of a bed of auriferous gravel about 800 acres in extent, and averaging 50 feet in depth.

An excellent tail-race has been obtained by a deep cutting, 1,500 feet in length, from Clear Creek to the center of the claim, excavated through hard rim-rock at an expense of over $2,500. The ditches supplying the company with water are twenty-three miles in length, and afford 800 inches of water during eight months in the year. There is no non-paying top-dirt in this claim to contend with. The deposit is extensive and yields more or less gold from surface to bed-rock. A washing of 2,000 cubic yards from a bank 30 feet in height in June, 1872, yielded $741.26, or an average of 37 cents per cubic yard. The present company have been in possession since December, 1871, and by means of a liberal outlay in money and labor have everything ready for vigorous work during the coming season. Two "Little Giant" hydraulic machines are used by the company, water being supplied to them through 1,100 feet of 15-inch iron pipe, under a pressure-head of 100 feet.

The Chicago mill and mine are situated in a granite range about two miles north of Piety Hill. The ledge is silver-bearing, and of an average thickness of 2 feet. The rock carries, besides the precious metals, considerable lead and zinc, and requires roasting. While the amount of prospecting work done on the vein is small, the rock is remarkably rich, paying from $300 to $500 per ton. Mr. Butterfield, the owner, has had to contend against want of capital and many other difficulties, and as yet has only a 5-stamp mill and small furnace at work, but he is gradually emerging from his troubles. In this vicinity many fine-looking ledges crop out, and on several shafts have been sunk to a depth of 80 feet or more. The base character of the ore extracted renders it impossible to treat it by ordinary mill process, and as yet no proper works have been erected to thoroughly test the veins.

KLAMATH COUNTY.

This is a rugged, mountainous region,* heavily timbered, extending from the coast easterly to within thirty miles of the base of Mount Shasta. Without attracting much outside attention, it has been a very lucrative field for gold-mining operations of a diversified nature. It commences at the famous Gold Bluffs, and extends up the Klamath and Salmon Rivers, with their large extent of river and bar diggings, to the head-waters of the latter, where, contiguous to the sources of the Scott and Trinity Rivers, both noted for their large yield of gold, are situated the Klamath and Black Bear quartz-mines, the latter ranking with the best mines in the State, and the former a very promising property in process of development.

The Klamath River traverses the country from the boundary of Del Norte County to the coast, and furnishes river and bar diggings for the whole distance. Early Indian disturbances and general isolation have combined to retard their development; but within the past two or three years, as all danger from the former source has disappeared, considerable attention is being attracted to the many large bars and hill-sides of auriferous gravel to be found at intervals, all the way from the mouth of the Klamath, through Klamath, Del Norte, and Siskiyou Counties, a distance of about two hundred miles.

Orleans Bar, on the Klamath River, the county-seat, has been the field of extensive mining-operations; and as the waters of Camp Creek are to be brought in by a ditch, now in progress, a large area of valuable ground will be made productive.

* The description of this county is furnished through the courtesy of J. F. Nesmith, esq., of San Francisco.—R. W. R.

The Salmon River empties into the Klamath eight miles above Orleans Bar, and has supported a large mining-population since 1850; but, as in other mining-localities throughout the State, the most accessible points have been exhausted, and the fruits spent in the usual style of miners, without leaving capital to open up the equally valuable but more expensive diggings that still remain on the main stream and the North and South Forks, for a distance of about fifty miles.

The North Fork, with all the streams emptying into it in the neighborhood of Sawyer's Bar, has especially been a profitable field for mining, having produced its millions. It is in this vicinity that, in 1860, quartz was first discovered on the head-waters of Eddy's Gulch, and a mill of 8 stamps erected on what was called the Live Yankee mine, which was worked, with varying success, for three years, paying dividends to its first owners. Subsequently, becoming involved from bad management and want of proper development, the property declined, and has now passed into the hands of a single individual. It bids fair to become again a valuable mine.

About a mile to the southward, in the same belt of slates, which seem to extend east and west, parallel to the North Salmon, the Klamath mine is situated on a large, well-defined vein, varying in width from 3 to 7 feet, and sometimes attaining the great width of 20 feet. Its direction is northeast and southwest, and its dip 20° E.; it carries free gold and sulphurets throughout an extent of 3,000 feet of croppings, a portion only of which has been opened and worked in depth. With a 12-stamp mill the yield has for the past two and a half years been a trifle over $10 per ton. No sulphurets have been reduced, though the rock carries about 2 per cent. of a fine character that assay about $100 per ton.

Timber suitable for mining and lumber purposes abounds in this whole region, and the mine is susceptible of drainage for a great number of years by an adit already commenced and running on the vein, which it will ultimately open up to the depth of 1,500 feet.

The ownership has lately been concentrated into few hands, and the crushing capacity increased to 32 stamps, which will be driven half the year by water and the rest by water and steam, when, with proper sulphuret reduction-works, the Klamath, having a large amount of rock ready to stope, some 30,000 tons by actual measurement, cannot fail to become very productive and valuable. The extent of the company's ground is 4,200 feet.

The northeast extension is owned by a company of three persons, who have a promising vein, from 3 to 5 feet in width, and opened to the depth of about 150 feet, showing gold freely. Farther on, for a distance of two miles, croppings appear at intervals above the soil, and float-rock of a rich character is found in abundance; but capital, even for prospecting purposes, has been too limited in this region to prove by development the value of these indications.

Southward, and about three miles from the Klamath, is the Black Bear, situated on the head-waters of Black Bear Gulch, at an elevation of about 4,000 feet above sea-level. This property had the usual history of bad management and ignorance of mining and milling from the period of its discovery, in 1860, to 1866, at which time it was purchased at a small figure by a company of three, who commenced operations with a 12-stamp mill erected by the old company, and by careful management succeeded in developing a mine which now ranks with the best in the State.

The company own 5,200 feet of ground, about 1,000 feet of which has been opened, the greatest depth yet reached being about 400 feet, where the vein is fully 15 feet wide. It has generally a due north and south direction, and dips 45°, sometimes assuming an angle of 20°, as is the case in one of its most productive parts. It is inclosed in black slate, of the same nature as the Amador mines, and, like all the veins in this region, has the same characteristics and general features, except that it contains about 3 per cent. of very fine sulphurets, generally inclosed between the laminæ of the vein-matter, which is of the "ribbon" variety, with a white and bluish-black cast. The sulphurets also contain about 18 per cent. of arsenic, and yield, by chlorination, about $75 per ton. Most of the rock shows gold freely, and requires hot water for amalgamation. The yield for the past four years has been about $25 per ton, except one chute of rock in the north end, known as the Yellow-Jacket ground, where the rock has for several months in succession yielded from $40 to $60 per ton. The lower tunnel was driven a distance of 900 feet through the country, at right angles to the vein, and when driven thereon about 800 feet north will open up the Yellow-Jacket ground at a depth below the present workings of about 250 feet. The average width of the whole vein is 5 feet, and a peculiarity of the mine is the ease with which the rock is extracted, and its general profitable character from the hanging to the foot wall.

The entire property was sold last July to a company of San Francisco capitalists, who have made an addition to their mill of 16 stamps, which will run by water and steam; and, although the rock has to be hauled two miles, cheap wood, water-power, and drainage to mine combine to permit the working of the mine and mill upon a very economical scale.

A wagon-road is building, about twenty-five miles long, over the Salmon Mountains to connect with Scott Valley, a very rich agricultural region, and thus furnish all kinds of produce, flour, and beef at as reasonable rates as can be obtained in any part of the State. Moreover, the California and Oregon Railroad will pass a point within forty-five miles of the mine, furnishing all the needed facilities for transportation, the want of which is one of the greatest retarding influences heretofore operating against this little known but highly promising mining-region.

GENERAL LIST OF MINING-CLAIMS.

The following is a list of mining-claims in the State of California, plats of which have been made and copies transmitted to the Commissioner of the General Land-Office and to the register of the United States General Land-Office, during the year 1872:

Quartz-mines.

Name of mine.	County.	Character.	Length of lode.
			Chains
Lady Franklin	Alpine	Gold and silver quartz	30.30
Clyde	Amador	Gold-quartz	18.18
D. B. Spagnoli	Do	do	19.69
Eclipse	Do	do	7.48
El Dorado	Do	do	18.18
Gover	Do	do	13.32
Hardenbergh	Do	do	32.24
Hazard	Do	do	20.08
Italian	Do	do	4.58
Last Chance	Do	do	18.48

Quartz-mines—Continued.

Name of mine.	County.	Character.	Length of lode.
			Chains.
North Star	Amador	Gold-quartz	16.87
Oaks	Do	do	18.18
Summit	Do	do	17.66
Nevada	Do	do	25.59
Nisbet	Butte	do	44.80
Angels	Calaveras	do	14.07
Bovee	Do	do	6.90
Carson Creek	Do	do	15.16
Chaparral Hill	Do	do	19.67
Dead Horse	Do	do	4.55
Everlasting	Do	do	45.45
Finnegan	Do	do	16.28
Gwin and Coleman	Do	do	57.57
Hudson	Do	do	36.37
North Paloma	Do	do	18.18
Mineral Mountain	Do	do	40.74
Plymouth Rock	Do	do	18.18
Reserve	Do	do	13.78
San Bruno	Do	do	12.12
Santa Cruz	Do	do	30.30
Stickle	Do	do	6.06
Melones or Point Rock	Do	do	29.30
Tecumseh	Do	do	45.45
Union Company's	Do	do	36.36
Woodhouse	Do	do	45.45
Wolverine	Do	do	15.15
Poor Man	Do	do	18.18
Bobby Burns	El Dorado	do	21.21
Chouleur	Do	do	23.50
El Dorado	Do	do	24.48
Eureka	Do	do	22.80
Coyote Hill	Do	do	9.09
German	Do	do	30.30
Gopher	Do	do	54.62
Greenwood	Do	do	22.72
La Moille	Do	do	24.45
Maryland	Do	do	42.42
Pacific	Do	do	28.70
Fort Yuma	Do	do	23.36
Sliger	Do	do	8.03
Sugar-Loaf	Do	do	15.14
Swansea	Do	do	27.27
Rocky Bend	Do	do	27.27
Yellow-Jacket	Do	do	37.00
Diltz	Mariposa	do	13.03
Eddy	Nevada	do	19.10
J. M. English	Do	do	44.40
Lone Jack	Do	do	16.66
Marietta	Do	Gold and silver quartz	45.45
Nevada	Do	Gold-quartz	45.75
New York Hill	Do	do	43.10
Norambagua	Do	do	48.48
Saint John	Do	do	37.88
Sulphuret	Do	Gold and silver quartz	33.33
Wisconsin	Do	do	37.87
Wisconsin	Do	Gold-quartz	12.95
Morehouse	Do	do	27.27
Baker	Placer	do	15.15
Butcher Boy	Do	do	12.12
Crœsus	Do	do	22.73
Empire	Do	do	30.30
Empire	Do	do	22.72
Eclipse	Do	do	37.50

Quartz-mines—Continued.

Name of mine.	County.	Character.	Length of lode.
			Chains.
Greene Walter	Placer	Gold-quartz	24.02
Ophir	Do	do	25.30
Sally Jones	Do	do	22.72
Salsig Extension No. 1	Do	do	13.75
Secret Cañon	Do	do	30.30
Olio	San Bernardino	do	18.20
San Bernardino	Do	do	15.22
Mammoth	Do	do	18.21
Banghart	Shasta	do	45.45
Independence	Sierra	do	75.75
Independent	Do	do	24.24
Keystone	Do	do	45.45
Shores	Siskiyou	do	27.27
App	Tuolumne	do	14.82
Confidence	Do	do	16.22
North Confidence	Do	do	17.34
Mammoth	Do	do	33.35
Patterson	Do	do	27.79
Waters	Do	do	21.22
Lucan	Yuba	do	45.44

Total number of quartz-mines, 93.

Placer-mines.

Name of mine.	County.	Character.	Area.
			Acres.
Hall & Co.	Amador	Gold-placer	40.00
Sorocco	Do	do	40.00
Clear Creek	Butte	do	160.00
Cataract	Calaveras	do	160.00
Chile Gulch Fluming Co.	Do	do	10.82
Red Hill	Do	do	40.00
Wide West	Do	do	160.00
Crane's Gulch	El Dorado	do	80.00
Dead-Head	Do	do	160.00
Georgia Slide	Do	do	158.50
Grigg's Ranch	Do	do	128.16
O'Brien & Tulley	Do	do	20.00
Olsen & Donaldson	Do	do	60.14
Railroad	Do	do	30.00
Rising Hope	Do	do	100.00
Rowe & Co.'s	Do	do	40.00
Sailor Slide	Do	do	29.66
Shoemaker	Do	do	80.00
Badger Hill and Cherokee	Nevada	do	116.82
Baltic Gravel-Mining Company	Do	do	110.00
Bed-Rock Tunnel	Do	do	43.52
Biggs	Do	do	215.24
Central	Do	do	163.13
Enterprise	Do	do	179.61
Horace Kilham	Do	do	356.47
Harmony Co.'s	Do	do	138.53
Keystone	Do	do	155.53
Montreal	Do	do	89.23
Murchie	Do	do	100.00
San Juan Union	Do	do	136.44
Simon H. Dikeman	Do	do	60.00

Placer-mines—Continued.

Name of mine.	County.	Character.	Area.
			Acres.
South Yuba Canal Company	Nevada	Gold-placer	130.00
Wolcott	Do	do	149.10
North Fork and Bear River	Nevada and Placer.	do	160.00
Middle Yuba	Nevada and Sierra.	do	90.35
Ada Bell	Placer	do	74.98
Bear River	Do	do	137.86
Big Channel	Do	do	365.55
Big Spring	Do	do	116.53
Bradley & Garduer	Do	do	88.36
Bumpus Cañon	Do	do	127.95
Church and Golden Gate	Do	do	334.14
Dutch Flat and Franklin	Do	do	155.00
Dutch Flat Cañon	Do	do	117.43
Elmore Hill	Do	do	44.64
Frank Hoffman	Do	do	160.77
Franklin Miner	Do	do	103.11
Garland Mill Slope	Do	do	158.14
Green Spring	Do	do	59.00
Indiana Hill Hydraulic	Do	do	63.70
Manhattan	Do	do	157.39
Mutual	Do	do	21.08
Mary Red	Do	do	224.32
Oro & Dardanelles	Do	do	312.77
Pond & Constable	Do	do	206.41
Powell	Do	do	140.10
Red Hill	Do	do	24.66
Sailor or Brown & Co.	Do	do	91.46
United States	Do	do	229.42
Weske	Do	do	156.34
Yule & Willey	Do	do	145.24
Harvey	San Bernardino	do	141.75
Dixon & Cooper	Shasta	do	20.00
McMullin & Reese	Do	do	110.00
Anderson Gulch	Siskiyou	do	28.23
Benton Gulch	Do	do	15.83
Brown & Murray	Do	do	27.64
Goodale & Williams	Do	do	60.00
Hull Gulch	Do	do	81.36
James William Fox	Do	do	84.40
Jourdan Gulch	Do	do	62 64
Leduc	Do	do	105.00
Marfield & Co	Do	do	37.50
Pellet & Truitt	Do	do	35.29
Smith & Hand	Do	do	13.23
Sucker Flat	Do	do	57.12
Wright & Co.	Do	do	58.86
Van Doozer Gulch	Do	do	95.24
Tuttle Gulch	Do	do	159.68
Bed-Rock Tunnel	Trinity	do	12.35
Dannenbrink	Do	do	39.94
Garden Gulch	Do	do	86.07
H. C. Wilt	Do	do	53.10
Oregon Gulch Mountain	Do	do	159.43
Tom Bell	Do	do	39.86
Finn	Tuolumne	do	30.00
Hilton & McPherson	Do	do	60.00
Richards	Do	do	140.00
Nevada Mining Company	Yuba	do	154.86
Ohio Flat	Do	do	60.00

Total number of placer-mines, 90.

Placer-mine with quartz-lode.

Name of mine.	County.	Character.	Length of lode, (quartz.)
Wet Gulch	Calaveras.	Quartz and placer gold....	33. 33 chains. Area, (placer,) 78. 20 acres.

Total number of placer-mines with quartz-lode, 1.

Quicksilver-mines.

Name of mine.	County.	Character.	Length of lode.
			Chains.
Gem	Lake	Quicksilver	45. 45
Pittsburgh	Do	..... do	68. 68
Don Juan	Monterey	..... do	45. 45
Don Miguel	Do	..... do	45. 45
New York	Do	..... do	45. 45
Pennsylvania	Do	..... do	45. 45
Napa	Napa	..... do	45. 45
Pope	Do	..... do	45 45
Silver Bow	Do	..... do	27. 27
Valley	Do	..... do	45. 45

Total number of quicksilver mines, 10.

Copper-mines.

Name of mine.	County.	Character.	Length of lode.
			Chains.
Cosumnes	Amador	Copper	71. 09
Calaveras	Calaveras	....do	45. 45
Keystone	Do	....do	50. 00
Union	Do	....do	28. 75
Last Chance	Nevada	....do	36. 36

Total number of copper-mines, 5.

Iron and copper mine combined.

Name of mine.	County.	Character.	Length of lode.
			Chains.
Tyson	Tuolumne	Iron and copper	13. 64

Total number of iron and copper mines, 1.

RECAPITULATION.

Quartz-mines	93
Placer-mines	90
Placer-mine with quartz-lode	1
Quicksilver-mines	10
Copper-mines	5
Iron and copper mine combined	1
Total	200

List of United States deputy mineral-surveyors for the State of California, appointed under the provisions of the act of Congress approved May 10, 1872.

Name.	Address.	County.	Date.
Thomas J. Dewoody	Napa	Napa	June 1, 1872.
Andrew B. Beauvais	Columbia	Tuolumne	June 1, 1872.
William L. McKim	Jackson	Amador	June 1, 1872.
James M. Anderson	Placerville	El Dorado	June 1, 1872.
Henry F. Terry	Mokelumne Hill	Calaveras	June 1, 1872.
Charles W. Hendel	Downieville	Sierra	June 1, 1872.
James McGann	Chico	Butte	June 1, 1872.
William Magee	Shasta	Shasta	June 1, 1872.
J. C. Partridge	Susanville	Lassen	June 1, 1872.
W. L. Lowden	Weaverville	Trinity	June 1, 1872.
William Sharp	Yreka	Siskiyou	June 1, 1872.
A. M. Jones	Yreka	Siskiyou	June 1, 1872.
Samuel Bethell	Auburn	Placer	June 1, 1872.
John Goldsworthy	Los Angeles	Los Angeles	June 1, 1872.
William P. Reynold	Los Angeles	Los Angeles	June 1, 1872.
Jarvis Kiel	Mariposa	Mariposa	June 1, 1872.
Edward C. Uren	Dutch Flat	Placer	June 1, 1872.
Benjamin Ross	Volcano	Amador	June 1, 1872.
Lucius F. Cooper	Yreka	Siskiyou	June 1, 1872.
Edward B. Eddy	Nevada City	Nevada	June 1, 1872.
Newton C. Miller	North San Juan	Nevada	June 1, 1872.
W. S. Cooper	Sonora	Tuolumne	June 1, 1872.
J. A. Benson	Auburn	Placer	June 1, 1872.
William Jabine	Placerville	El Dorado	June 1, 1872.
M. A. Wallace	San Bernardino	San Bernardino	June 1, 1872.
Arthur W. Keddie	Quincy	Plumas	June 1, 1872.
George Tucker	Lakeport	Lake	June 1, 1872.
M. V. Bennett	Santa Cruz	Santa Cruz	June 1, 1872.
Henry Powell	Sweetland	Nevada	June 1, 1872.
John T. Stockton	Red Bluff	Tehama	June 1, 1872.
H. H. Sandford	Woodland	Yolo	June 1, 1872.
Alexander McElroy	Hornitos	Mariposa	June 1, 1872.
Robert R. Harris	San Luis Obispo	San Luis Obispo	June 1, 1872.
J. A. Rousseau	San Bernardino	San Bernardino	June 1, 1872.
Ross E. Browne	San Francisco	San Francisco	June 1, 1872.
Charles F. Hoffman	San Francisco	San Francisco	June 1, 1872.
C. S. Bulkley	San Francisco	Sau Francisco	June 1, 1872.
H. S. Craven	San Francisco	San Francisco	June 1, 1872.
Alfred Craven	San Francisco	San Francisco	June 1, 1872.
John B. Treadwell	San Francisco	San Francisco	June 1, 1872.
Hugh Barker	Placerville	El Dorado	June 1, 1872.
A. A. Smith	Susanville	Lassen	June 1, 1872.
Gustavus Cox	San Francisco	San Francisco	September 10, 1872
M. G. King	San Francisco	San Fraucisco	June 1, 1872.
Isaac G. Jones	Downieville	Sierra	October 14, 1872.
G. F. Deetkin	Grass Valley	Nevada	September 1, 1872.
Elijah W. Brown	Smartsville	Nevada	October 21, 1872.
William Edmunds	Oroville	Butte	October 21, 1872.

CHAPTER II.

NEVADA.

The mining-industry of this State has been more productive during the year 1872 than in any former year, bringing the State to the foremost position in its yield of precious metals. Detailed accounts of the different districts are given below. It may be said, on the whole, that the smelting-works of Nevada have not been so prosperous as in the preceding year, owing partly to increased scarcity and dearness of charcoal, partly to vexatious litigations, causing stoppage of operations; and, in one case, to the diminution in value of the ores smelted. These losses have been more than compensated by the great activity of the stamp-mills, and particularly the productiveness of the Comstock and Pioche mines. The outlook for 1873 is favorable.

The bullion product, as given by Mr. Valentine, superintendent of Wells, Fargo & Co.'s Express, is $25,548,811, an estimate which I regard as a close approximation. The following table, compiled from sources independent of the express shipments, corroborates Mr. Valentine's estimate, and indicates at the same time the distribution of this production:

Comstock mines and tailings	$13, 569, 724
Lincoln County	5, 500, 000
Lander County	3, 495, 000
Humboldt County	600, 000
White Pine County	785, 000
Nye County	450, 000
Elko County	450, 000
Esmeralda County	93, 000
	24, 942, 724

The difference of $606,087 is probably to be ascribed to the shipments from Virginia and Gold Hill, which are always much larger than the aggregate of the reports obtained from separate mines. The elements of the estimate above given of $13,569,724 for the Comstock are given below; and it will be seen that many small outlying mines are not included.

THE COMSTOCK MINES.

I am indebted for the facts given below to the reports of the various companies, and to the admirable notes furnished me by Mr. Cesar Luckhardt, a resident of San Francisco, formerly an engineer on the Comstock, and thoroughly familiar with every foot of the mines. Mr. Luckhardt visited Virginia City at my request for the express purpose of making personal examinations.

To facilitate description, the division of the explored ground on the Comstock given in former reports is adhered to in the present, viz:

1. The northern portion, from the Utah mine to the Chollar, 12,200 linear feet.

2. The middle portion, from Chollar to the Imperial North, 1,795 feet.

3. The southern portion, from Imperial North southward, to the extent of 6,000 feet.

Since the commencement of 1872, extensive explorations have been carried on, amounting in the aggregate, as near as can be ascertained, to 5,600 feet of shaft and incline and 35,400 feet of drifts, which have been run in the 21,000 feet of ground, as above divided.

I. *The northern portion of the vein.*—Beginning with the Utah mine and passing southward, we have to deal so far with eight separate ore bodies.

1. The first, which was explored in the Utah and afterward in the Sierra Nevada, proved to extend over 340 feet in length, yielding ores of a mill-value of $4 to $12 per ton, carrying principally free gold. The main bulk of this body existed in the Sierra Nevada, which company has extracted a large amount of ore from it, and has still much unworked ground; but, owing to the irregularity of the occurrence of its ores, it is impossible to estimate, with any degree of accuracy, the amount still standing. In all probability the smaller tributaries to this body will keep the Sierra Nevada Company at work for some time to come, making profitable mining a possibility through the company's mill, which is situated at the mine. The ground below this body has been explored to a depth of 700 feet vertically. The present shaft-bottom is now 60 feet east of the west wall of the Comstock. Cross-sections have been made for 230 feet east and west, and 900 feet north and south, but without success in discovering any new body of ore. The vein was found 200 feet wide, consisting of porphyritic material, with intersections of small seams of quartz. At a place 150 feet vertically below the mouth of the shaft, and 200 feet northeast of it, in what is called the Cedar Hill Tunnel, 60 feet of quartz-width has been cut through, barren of ores, but looking favorable for the finding of ore.

2. Going northwestward from the above, that is, following the outcrop of the Comstock, work was commenced on a large mass of low-grade ores by the Sacramento, Texas, and other companies, (all of which ground is now owned by the Sierra Nevada Company.) This ore-mass does not stand in direct connection with the above body, but lies west of it, has been worked for 100 feet vertically, and is known to descend over 250 feet below the outcrop. Its ores carry also principally gold, and vary from $7 to $9 per ton in mill-yield. The Sierra Nevada Company has explored these two bodies of ore for nearly 2,000 feet north and south, and in all probability will have over one year's ore, varying from $4 to $9 per ton, to work upon.

3. Going south, we come to the third ore-body, (in my former report of 1869 called No. 2,) which coursed through a portion of the North Ophir, Central, South Ophir, and part of the California ground, where it yielded formerly ores of extraordinary richness. It is practically exhausted; some low-grade ores, slides from the main body, are still standing, but no attention has as yet been paid to them, and their extent is not known. Its extension northward has never been explored. Beyond 300 feet north of the Mexican Company's north line to a depth of 250 feet, its ores become "base," carrying much zinc-blende, manganese, and in places galena, and are unfit for treatment at present. The Ophir Company has carried on explorations from its new shaft to a vertical depth of 1,465 feet, and has cut east for 350 feet, not meeting the east boundary as yet, showing the vein, so far, 300 feet wide. The western portion, for 175 feet, is porphyritic material, intermixed with quartz.* Bounding this on the east are 75 feet width of quartz, followed further east by the same material, which is found to the west. This quartz has

*This western mass is found all along the vein wherever prospected.

been explored for 100 feet north and south, and for 45 feet vertically, and is an entirely new feature. It carries from $2 to $6 in gold and silver—¼ gold, ¾ silver. It has a southeast dip, and, so far as explored, shows an inclination southward identical with that of the upper body, (which pinched out 1,010 feet vertically above this point,) described in former report. It looks favorable for ore, and is, without a doubt, the prolongation northward of the quartz which carries the ore-body lately found in the Virginia Consolidated, (see below, No. 4.) Although the vein has been explored at this depth for 164 feet north and south, nothing of value has as yet been found. Northward, this quartz becomes intermixed with much porphyry, and the vein shows much irregularity. The 1,300-foot level of Ophir has been explored for 80 feet northeast, to find this quartz-body of the lower level, but without success. The 1,100-foot level exposed the vein for 830 feet north and south by 200 feet east and west, showing 64 feet vein-width, of which the western portion (50 feet) consisted of porphyritic material with narrow quartz seams, while the eastern portion is quartz, assaying from $1 to $7 per ton in gold and silver. This is the quartz of the 1,465-foot level, but only 14 to 15 feet wide here in the 1,100 level; it has a dip east, inclination south, and has been followed here south to within 50 feet of the Ophir south line, and downward, its dip showing indications of ore all the way, but not any pay-ore as yet.

4. Farther south, the ground from the Central Company to the Gould & Curry, about 1,400 feet in length, which had been left entirely unprospected to within a short period, (except a little work done by the California Company and White & Murphy Company in former years to a depth of 400 to 500 feet, vertically,) has been proven to contain an entirely new ore-body. The Sides, White & Murphy, Kinney, and California Companies' grounds form the present Virginia Consolidated Company, which commenced work vigorously, both by sinking a vertical shaft and exploring the ground from the 1,167-foot levels (measured from the shaft-mouth) of the Gould & Curry mine. The Virginia Company's shaft proper, 700 feet north of the company's south line, is 715 feet deep at present. At a depth of 500 feet the ground was explored westward for 900 feet, and 1,100 feet north and south, showing the vein 150 feet wide on the south, and 170 feet directly west of the shaft, carrying quartz and quartzose material, intermixed with porphyries, but barren of ore. The drift coming from the Gould & Curry 1,167-foot level has penetrated thus far 260 feet directly north into the Virginia Consolidated Company's ground. The connection of this with the shaft, requiring 310 feet drifting, and 380 feet sinking of shaft, will occupy three and a half months yet. The drift has exposed, 180 feet north of the company's line, the quartz of this ore-body 3 feet wide, running northeast, and dipping east. It has been followed, so far, for 280 feet horizontally; cross-sections show it to widen gradually to 48 feet at the northernmost point yet reached. This longitudinal drift run in it produced 800 tons of $23 milling-ore, whence it may be inferred that this body is two-thirds waste and one-third ore. As work progresses north it continues to widen, and has every appearance of forming into a very valuable ore-body, judging from its length already developed, and considering that the lowest level of Ophir, 1,200 feet northeastward, shows this identical quartz. There are over 800 feet of height and over 1,200 feet in length to prospect yet above this 1,167-foot level of the Virginia Company.

5. South from the above, starting in the Gould & Curry, and extending for 2,400 feet horizontally into the Hale & Norcross, we have

that body, enumerated as No. 3 in my report of 1870, which has produced over $17,000,000 during the past five years. Although in 1870 considered exhausted at a vertical depth of 1,100 feet below the croppings, it has yielded, and still continues to yield, from its parallel seams and tributaries. For instance, the Savage Company realized over 50,000 tons of milling-ore from it in 1872; and the daily product from it now (March, 1873) varies from 900 to 1,000 tons of ore of $19 to $21 milling value. The Gould & Curry are now at work on their old second level near the Savage line, in order to extract some ore left standing there from this body; but it has ceased to yield ores in depth in that mine.

The Gould & Curry ran 5,300 feet of drifts and sank 440 feet of shaft and incline during the past year, reaching 1,794 feet, (measured from the cropping,) *i. e.*, 1,500 feet vertically, and 294 feet on an incline below. The vein has been explored at 1,600-feet depth for 200 feet north and south; for 200 feet east it proved to dip 60° east. The principal portion of the vein consists of porphyries with small seams of quartz. The 1,500-foot level explored the ground for 600 feet north and south, and proved the vein to be over 400 feet wide. An eastern cross-cut of 430 feet in length disclosed mostly porphyritic material with small quartz-seams; but at the face 6 feet of quartz with some good ore-spots has been found, which looks promising for ore. Work is in progress north on it. This quartz is divided from the western porphyritic masses by a little clay. The 1,300-foot level has been extended all along the vein from the north to the south line of the company's ground, and prospected for 150 feet east, but nothing but porphyritic material was found. The 1,167-foot level has also longitudinal drifts from north to south line; western cross-drifts from 200 to 300 feet long exposed much more quartz and porphyry than any of the other levels did; 260 feet north of the shaft the quartz is 100 feet wide, carrying but traces of ore. When followed northward, crossing the Best & Belcher ground, it led into the ore-body lately developed in the Virginia Consolidated ground, and above described.

The Savage mine has penetrated 1,500 feet vertically, and thence followed the west wall to a depth of 250 feet, at an angle of 38°. The lowest or 1,700-foot level has followed the vein 120 feet south so far, where several feet of quartz were encountered, hugging a clay seam to the eastward, both of the same character as that of the Gould & Curry. The extent of this quartz is as yet unknown, as is also the width of the vein. It is evident that the ore which occurs in this quartz does not belong to that of the ore-body enumerated as No. 5. The 1,600-foot level has explored the vein along its course for 730 feet north and south, and, so far, 120 feet east, without finding the east boundary as yet. The northern portion of the mine here shows the matrix to consist chiefly of porphyries, while the southern portion (*i. e.*, south of the shaft) consists mostly of quartz and quartzose material for 100 feet in width, and, so far, 190 feet in length, with seams of good ore, assaying from $10 to $20 per ton. Mr. Luckhardt thinks this is the same quartz as that of the lower level, and also that of the Hale & Norcross tenth and twelfth levels, (see No. 6 below,) but is not certain. Explorations are now going on east and west in this ore-bearing quartz, and very good ore-seams are encountered at intervals. Taking into consideration the developments of these two levels—namely, the width of the quartz, indicating strength, the straightening of the quartz below the 1,600-foot level, the difference of the character of the ore here from that of the upper levels belonging to ore-body No. 5—it cannot well be denied that the prospect for a new ore-body is good; but the explorations are as yet too limited to warrant a decisive conclusion. The twelfth, or 1,500-foot level, met ore 60 feet north of the company's shaft-line—but only 10 feet wide—and 58 feet below this level it closed out. It extends upward to the eleventh station and 50 feet above it, where it closes out also, making a vertical ore-depth at the company's south line of 200 feet. The eleventh or 1,400-level showed ore, poor and in seams, for 30 feet wide in places, nearly all of which has been extracted; the month of March, 1873, only producing 41 tons of $27 (assay) from this 1,400-foot level. Neither the 1,400 nor 1,500-foot levels showed any new developments in the workings of 430 feet north and south on the course of the vein by 140 feet in width. The tenth or 1,300-foot level followed the vein 420 feet, north and south, showing it 210 feet wide, but barren of ore. Above this level ore-body No. 5 gave out.

During the past year much ore has been extracted from the upper portion of body No. 5 out of the works of the north mine of Savage, (second and sixth levels,) where even now 1,000 to 1,100 tons are extracted monthly, of an average assay-value of $50 per ton.

6. The Hale & Norcross Company has attained a total depth of 1,760 feet; the shaft is vertical for 1,208 feet. The bottom of the incline is 600 feet east of the vertical shaft. During the past year the ninth, tenth, eleventh, and twelfth stations have been opened. The old ore-body, No. 5, has been worked out, and the parallel body which showed itself in the seventh level, north mine, for 300 feet in length from the company's north line, varying from 20 to 40 feet in ore-width, and which Savage worked to 60 feet below their twelfth level at their south boundary-line, (see No. 5 above,) has also been worked in the eighth level 180 feet long, north and south, varying from 20 to 25 feet of ore-width, and on the ninth level was 10 feet wide; but in two patches, lying very irregularly below this level, trailed itself out against its western clay, which forms the dividing line between the ore-body and the quartzose porphyritic material immediately overlying the west wall. One detached small body was found and extracted 50 feet south of the main incline. All of this ore lay in the north portion of the company's mine, and yielded the principal product of the year. Only a small quantity of ore, of $20 to $25 assay-value, is left standing. At a point 100 feet south of the Savage south line, and 50 feet below the ninth level, the two clays, which bound this quartz-body on the east and west, came in close neighborhood; the quartz was not over 8 inches wide between them; but as it was followed downward it widened again from 6 to 8 feet, carrying ore of $20 to $35 assay-value, which has been followed by an incline down to the twelfth, or lowest level, and now yields ores from the tenth and twelfth levels. The irregularities of this new body are probably produced by a dike of hard, dark, compact porphyry, (foreign to the porphyries which have heretofore formed part of the vein-stuff above,) which has just been encountered in the lowest level lying to the east. It seems to be a mass of considerable size, but nothing can be said as to its position and extent as yet. The South mine, in these lower levels, (*i. e.*, from the ninth to the twelfth levels,) has developed nothing so far. The ninth level was run for 100 feet south, showing quartzose material, but principally porphyries, filling the vein. Eastward much clayey matter was encountered and an abundance of water; and for fear of swamping the mine prospecting east was abandoned, although no east wall had been developed. Further prospecting eastward would possibly develop the "lap" of the upper body. Northward this level was extended to the Savage line where the quartz began to concentrate more, until it became 60 feet wide, showing ore in spots and narrow seams, (assay-

ing often over $200 per ton,) until at last the above-described body was found, below where the clays united. The tenth level also was run south without good results. The vein was found 75 feet wide; northward the ore-body from above was found to widen. The eleventh level was opened westward for 60 feet west of this ore-body, showing no new features, and no work has been done north or south in this level as yet. The twelfth level (lowest) was opened along the vein for 315 feet, north and south, to within 40 feet of the Savage line, principally eastward from the ore-body, and connected with the upper levels by the winze. An east cross-cut has been run, showing thus far 80 feet width of vein-matter, bounded on the east by the above-mentioned dike or intrusion of hard porphyry, having no clay division between it and the matrix, and resembling much those horses which occur in the Empire, Imperial, and Justis mines, at and south of Gold Hill. This mass has, perhaps, caused the coming together of the two clays below the ninth level, and the apparent irregularity north in this twelfth level, and will by its size, shape, and dimensions govern the position of the quartz and ore body west of it. This ore-body, although followed downward for 300 feet by incline, has not been laid open to view sufficiently to permit an estimate as to the quality and quantity of its ores; but it is doubtless the same body as that which has been penetrated in the Savage Company's two lower levels, east of the western quartz.

7. Within the past year work has been carried on in the old stopes, and into the old upper mine of the Hale & Norcross, in search of parallel seams of the ore-body enumerated as No. 5, and the product of both has been, for the year, 24,000 to 25,000 tons of ore of $25 assay value. In the second or 810-foot level occurs a repetition of the phenomenon of the Savage "Potosi Chimney," described in 1870, lying parallel with the main body No. 5. A distance of 63 feet eastward from it, and divided by quartz and clayey material, another body of ore was encountered 120 feet from the Chollar Potosi Company's north line. It yielded ore in seams for 8 to 40 feet in width, not of as good a quality as that of the main body, but resembling the latter in character, and entirely different from the ores of the tenth to the twelfth station. It has been opened for 156 feet vertically and 132 feet north and south so far, and has, like the other body, a southern inclination. Explorations from the level above and below the 810-foot level are in progress to determine its extent. It has thus far yielded 1,400 tons of the 25,000 tons above enumerated, and will continue to yield large quantities of ore.

8. Passing to the Chollar Potosi, we have that ore-body, which has been worked for years from the surface, to a depth of 650 feet, and over 1,000 feet horizontally. It was in places 300 feet wide from east to west, and was in 1868 abandoned as exhausted; but it yielded last year over 41,000 tons of $24 to $28 mill-ore, and will from present developments yield at least 15,000 to 18,000 tons more.

The east shaft has been connected with the works of this body, and used as an exit for its ores. During the process of overhauling the old works, many ore-chambers were developed. For instance, in the northern portion of the mine, in what is known as the "Piute Chamber," a patch of ore was worked for 96 feet vertically and 15 to 30 feet wide, yielding $20 mill-ore. Lying parallel with the body called "Blue Wing," a western seam was attacked which yielded ore for 200 feet vertically. Going south from here, the Belvidere ore-chamber was found, which alone has yielded over $2,000,000; it extends from the surface to the 178-foot level of the new shaft, (making over 300 feet on its dip,) and to within 400 feet north of the Bullion Company's ground, and has proved to be 50 feet wide. Below this 178-foot level, one seam from it, now followed downward, shows 2 feet wide of $50 ore, which promises also a large yield. In all this western work, the Chollar Company has at least 15,000 tons of $20 ore left; a closely correct estimate cannot well be made. After the destruction of the hoisting-works by fire in 1869, work in depth had been abandoned; but since their re-erection the vein has been prospected through the first and second levels further east than it had been before, but without success in finding anything of value there. The 725-foot level was re-opened and work pushed north, in search of ore-body No. 7, which was left 45 feet wide in the Hale & Norcross second level, but so far no developments of note have been made. The distance to explore is 353 feet to the company's north line.

II. *The middle portion of the vein.*—This reaches from the Chollar Potosi Company's ground to the Imperial North, (1,800 linear feet,) including the Bullion, Exchequer, Alpha, Treglone, and Imperial North.

The two existing ore-bodies here have been exhausted, except in the Imperial North, which still produces a few tons daily from the westerly body, but of low grade. No new ore-developments have been made in this ground within the past year.

The Bullion having attained a depth of 1,400 feet, showing 50 feet quartz-width, but carrying little or no ores, except in spots, the lower works were abandoned. At the 800-foot level the ground was explored for 500 feet east, disclosing the vein 100 feet wide with 60 feet of quartzose material, but no ore. The predictions of an expert with a "divining-rod" caused the company to cross-cut westward into Mount Davidson for 400 feet, piercing strata of syenitic rock with intersections of quartzose material at intervals of 40 to 50 feet, varying from ½ to 2 inches in thickness, but naturally barren of ore. It is the intention of the company to sink a new shaft 900 feet east from their present one, which from its proposed locality would be 300 feet east of the west wall, at a depth of 1,500 feet, in order to prospect from it.

The Alpha, Exchequer, and Treglone have lain idle.

III. *Southern portion of the vein.*—In this portion, extending from the Imperial North to the Caledonia, we have to record nine separate ore-bodies; four of them have been exhausted of their ores, viz:

1. That which extended from Alpha to Imperial, south, 850 feet in length, to a depth of 300 feet.

2. The parallel body east of No. 1, commencing in the Empire North, near the surface, and extending into the North Yellow Jacket to a depth of 500 feet.

3. That western body which extended from the north portion of the Belcher into the Imperial ground to a depth of 460 feet, and which yielded so well in the Kentuck and South Jacket mines.

4. The largest body, which lay east of the above, was discovered at first in the 500-foot level of the Crown Point. It had its southern terminus 300 feet north of the Belcher Company's north line, near the 400-foot level, and its northern in the 100-foot level of the Yellow Jacket, 230 feet north of the Jacket shaft. The large quartz-mass in which this body was imbedded, did not close out in either of these mines, but, on the contrary, gaining strength southward and downward, can to day be traced from the Belcher to the Imperial, and in fact contains the new ore-body of Belcher and Crown Point. (See No. 9 below.)

The five other bodies have not been exhausted, viz:

5. That very irregular body which coursed through Segregated Belcher into Overmann and beyond, has yielded largely in ores for 1,400 feet north and south; most of its ores are extracted; but in all probability it

will continue to yield low-grade ore for some time to come. Estimates cannot well be made concerning it.

6. That west body which extended from Alpha into Crown Point, and which has yielded ores with interruptions for over 2,640 feet in length, is not yet fully exhausted. It was found to extend into Belcher also. Although not yielding ores at present, the day is not far off when its reserves will be attacked. It is impossible to estimate the quantity of ore left standing in this body.

7. A mass of ore, without definite course or dip, in which gold predominates largely over silver, lies to the east and southeast of those already enumerated. Commencing northwest from the Justis it extends southeast for over 1,500 feet into the Lucerne and Silver Hill, &c., and has yielded largely in ores worth from $5 to $9 per ton, of which a large amount is still standing. There is, in fact, an area of nearly 2,000 feet square which would well repay a thorough system of prospecting by the different companies owning it. (See remarks below.)

8. Commencing in the Empire ground a new body of ore has been found between the 1,600 and 1,700-foot levels of Empire, 220 feet south of the incline, on the same plane with the 1,300-foot level of the Yellow Jacket mine. It lies 90 feet west of that quartz-mass which carried the ore-body No. 4, above named. Its extent is as yet unknown, although its prolongation southward shows itself in the Yellow Jacket mine at this level, in small stringers in the connection-drift of Jacket and Imperial throughout. The ores are remarkably free from base metals and carry a high percentage in gold. So far 6 to 7 feet width and 40 feet depth of $45 to $50 mill-ore has been discovered. The predominant portion of the matrix is quartz, but carbonate and sulphate of lime are intermixed to a much larger extent than at the upper levels of the Imperial, and the 800-foot level of the Bullion, where the same kind of material showed itself, but barren of ores. It is impossible, from the present limited explorations, to calculate its importance. The ores are very similar to the rich ores found in the seams imbedded in the larger bodies, which have been exhausted in the Kentuck and Jacket; and they also resemble in their general nature those of the other new body (No. 9, below) of Belcher and Crown Point. The apparently undisturbed crystallization of the matrix leads to the belief that these ores must belong to good-sized masses, rather than to small deposits; but, on the other hand, all the large Comstock ore-bodies cross the vein-fissure transversely, originating at or near the foot-wall, and finding their terminus at or near the hanging-wall, so that from analogy we would have to look for the main bulk of this body, overhead rather than below. Nevertheless, considering that the two ore-bodies found in this portion of the Comstock overhead stood nearly vertical, whilst those north of them inclined southward, and all those south of them inclined northward, it seems possible that this new body may be an exception to the prevailing form. At all events this development is looked upon by nearly every one capable of an opinion as very promising for the finding of a large ore-deposit. The admixture of lime-rock with the quartz proves that it does not belong to any of the upper ore-bodies heretofore found.

9. The other new ore-body, first encountered in the 1,000-foot level of Crown Point, in November, 1871, 200 feet from the Belcher north line, and 440 feet eastward from the shaft, lying immediately east of the region where body No. 4, above enumerated, trailed itself out, has thus far been proved to be 775 feet in length, varying from 36 to 115 feet in width, and is known to exist for 450 feet in depth. It carries ores varying from $30 to $80 mill-yield per ton, which are, contrary to all expec-

tations, remarkably free from iron, copper, and zinc ores, carry a higher percentage in gold than the upper bodies did, and are readily beneficiated up to 70 per cent. of their value by amalgamation. The matrix, where the body nears the old western quartz-body, shows but a small percentage of lime-rock, which increases, however, eastward and downward. It has yielded thus far over $10,000,000 worth of ore, and what now stands in view will in all probability give as much more. The yield in March, 1873, was $1,500,000. To more fully describe the ground containing these nine bodies:

The Imperial Empire has reached through its shaft and incline a vertical depth of 1,785 feet, *i. e.*, 1,360 feet vertically and 610 feet further at 45°. At the 1,600-foot level the vein has been explored for 350 feet north and south, showing vein-matter over 100 feet wide, with 30 to 35 feet quartz-width, carrying spots of ore, but of no practical value. The first signs of compact ore were found 50 feet east of the incline in this level in May, 1871, and assayed as high as $80 per ton, carrying much free gold in a quartz-width of 20 feet. Since then the 1,700-foot level has been opened, and the 1,630-foot level connected with the 1,300-foot level of the Yellow Jacket mine. A winze sunk from the 1,600 to the 1,700-foot level has developed so far 7½ feet ore-width; its actual width is not known yet. Nothing of consequence has been developed in the upper levels, and the only reserves of ore are a few scattered pillars left of former workings, in the upper western body, in the so-called Mina Alta.

The intervening ground to the Yellow Jacket mine, viz, Bacon, Bowers, Gold Hill Quartz, Eclipse, French, and Confidence, making 339 feet, has not prospected any. Some of these companies have extracted low-grade ores left in the upper levels, which are now, however, practically exhausted.

The Yellow Jacket mine has attained a depth of 1,500 feet, viz, 1,125 feet vertically, and 450 feet further at 45° east. Within the past year the 1,300, 1,400, and 1,500 foot levels have been opened. In the 1,100-foot level, the western portion of the vein for 150 feet consists of the same material as constitutes the western (quartz and porphyry) quartz-body so called of the Comstock throughout. Beyond this, 150 feet, a little clay divided it from 20 feet of quartz-width, which, to all appearances, is the northern extension of the quartz-body in which lies the Belcher and Crown Point ore-body referred to above as extending from the Belcher into the Imperial This 1,100-foot level followed the quartz for 300 feet north, and it was found to carry gold to the amount of $3 to $10 per ton, and only traces of silver. It is perfectly white, showing no trace of metal of any description.* The 1,200-foot level left the west wall at the incline, and was extended 230 feet eastward without meeting the east wall. The same 150 feet width of west quartz and porphyry, as in the upper level, was encountered; the clay division was here one foot thick; the identical 20 feet of white quartz with the same assay-value was found. Down to this depth the foot-wall has always kept its regular dip of 45° east, but below this point it fell to 35° east. At the 1,300-foot level the vein was followed throughout the company's ground, and connection made with Imperial on the north, and Belcher on the south. Cross-drifts east for 500 feet developed the same characteristics as the two upper levels. The white quartz widened to 30 feet in places

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* Contrary to the fears expressed in my former reports, the influence of carbonate of lime has not proved hostile to the metalliferous and concentrated character of the ores. On the contrary, this body, for instance, seems to carry most metal in the portions in which this mineral abounds most largely.—R. W. R.

and ran out into stringers in the Eclipse ground; the assays of it remained the same as above. A trial was made of several tons, yielding $7 per ton. This level, although tolerably well explored eastward, and not successful in finding pay-ore, and though it shows at 500 feet east from the incline what is called the east wall, has, nevertheless, probably not been driven far enough east.

The next or 1,400-foot level, shows the west wall still 35° east, but the western quartz-porphyry stratum is only 50 feet wide. The white quartz east of it is 20 to 30 feet wide, and keeps its character, but does not contain as much gold as above. Explorations have gone, so far, 300 feet east and 225 feet north and south, but nothing of note has as yet been encountered. The lowest or 1,500-foot level still shows the west wall 35° east, the western quartz and porphyry only 14 feet thick, whilst the white gold-bearing quartz has always kept its distance from the incline the same as in the 1,100-foot level. This level just penetrated this quartz here and found considerable water, which retarded the work of prospecting for one month. No work north or south has been done here yet. This mine has been worked very vigorously during the past year; 3,736 feet of drifts and 659 feet of winzes have been excavated, and the main incline was lowered 636 feet. The ore produced during the year came from the body enumerated as No. 4 above, between the 900 and 1,000 foot levels, showing signs of weakness below, and pinched where the west wall changed its dip. The product was 20,000 tons of $26 mill-ore. There is very little ore left, and the mine produces none at present.

The Kentuck mine has overhauled its old works thoroughly during the year, and is not producing any more ore now. Prospecting is carried on in the 1,300-foot level eastward through the neighboring mines. There being only 96 feet of ground, the company awaits the results of the work done in the two adjoining mines. If successful in finding ore, it extracts through them, obviating the sinking of its own shaft.

The ore body of No. 9 was at first discovered in Crown Point 1,000-foot level, east and south of where the upper body trailed itself out in that large quartz-mass. The Crown Point has explored it to a depth of 400 feet, showing it to extend north of the south line of that company, in all, 360 feet. Its dimensions have been, on the 900-foot level, 90 feet long, greatest width 14 feet; on the 1,000-foot level, 200 feet long, greatest width 60 feet; on the 1,100-foot level, 285 feet long, greatest width 84 feet; on the 1,200-foot level, 350 feet long, greatest width 124 feet. These are the figures given by the company. The average value of the ores in Crown Point has been below that of the ores from Belcher.

The Belcher has attained a total depth of 1,299 feet, viz, 844 feet vertical, and 455 feet at 40° and 38°. Work was at first commenced through Crown Point on the 1,100-foot level, at the company's north line, and followed southward for 310 feet. The south end showed 10 feet, and the north end, at the line, 65 feet ore-width. Afterward, the 1,000-foot level was opened, also through Crown Point, and the ore and quartz followed for 300 feet north and south, showing ore 210 feet long; the quartz is 80 feet wide, showing ore in an east and west seam; the west seam is the best, and is 20 feet wide; the center, between the two, is composed of low-grade ores; the eastern seam is 10 feet wide, of good ore. The 1,200-foot level has followed the ore so far 90 feet south of the company's north line, showing 84 feet of quartz-width, the east boundary not being reached as yet. Going south here, it becomes narrower, turns more to the east, and has not been followed to its southern terminus, but to all appearances it will not go as far south as on the upper level. The ore occurs here also in two seams, exposed 50 feet south of the company's line, where the west ore-seam is 28 feet wide, of excellent ore. Bounding it on the east are 30 feet of poor ore in spots; further east come 12 feet of good ore, and beyond this again 60 feet of quartzose material, followed on the east by another 14-inch ore-seam. Work is still advancing eastward, but no east wall has as yet been found.

On the 1,300-foot level a winze has been driven east from the 1,200 to the 1,300 foot level, 50 feet south of the Crown Point mine, landing in the 1,300-foot level, 70 feet south of the line. It shows 36 feet ore-width here, but 100 feet south of the line the ore is 28 feet wide, and not so good as farther north. The width and extent south has not yet been fully demonstrated. In fact, both companies, to all appearances, have stumbled into this ore-body, and are digging pell-mell to see which can produce the most in the shortest space of time. Belcher now produces nearly 500 tons of ore daily from it, and is making preparations to produce between 500 and 600. Former workings of this style on the Comstock have taught us what result to expect.

All these levels of Belcher show, so far, that the ore runs parallel with the west wall, and apparently the ore-strata incline southward; but the lower levels show a real widening of the ore and quartz northward. It shows itself in the upper levels in the shape of a ridge descending north and south at about the same angle, but its dimensions are so stupendous that the naturally occurring irregularities are apt to lead to an erroneous opinion as to its position and form; further explorations yet to be made southward will have to determine that. The matrix is quartz and limestone mixed. Porphyritic intrusions are not as frequent as they were in the other bodies, at least as far as the present stopes show; and where lime predominates, there occur the richest ores, carrying a high percentage of gold, the bullion ranging from .060 to .070 fine in this metal. From the explorations made up to date through the four levels described, there is certainly twice the amount of ore that has been already extracted yet standing in the mine, even allowing that the ore should incline northward, which is possibly or probably the case. South of the Belcher, several companies have been sinking shafts and exploring the upper grounds, but no new feature of note has been developed.

The Obermann Company has sunk a new shaft eastward from its old one, in order to prospect the eastern portion of the Comstock; the Caledonia Company has done the same. The Justis has again commenced operations in earnest.

Considering all, it must be said that to-day the Comstock looks more promising than one year ago. Beginning at the north and going south, there is hardly one important mine which has not developed within the last year quartz and ore-material in its lower levels. The vein has not that barren appearance which it had. It is true that only three new ore-bodies in depth have been developed; and these are not sufficiently explored to speculate upon their value. The other three new bodies can only be looked upon as the reward of a thorough system of prospecting, namely, the Crown Point and Belcher, Hale and Norcross second level, and Virginia Consolidated ore-bodies, which might have been met with a year ago. If thorough and judicious prospecting were more generally pursued, it would not fail to give positive results. There are mines in the Comstock which have deep shafts, (1,500 feet,) and yet have left the territory passed through very partially examined. The ores of the old bodies, which local circumstances have made valuable in the course of time, have kept many of the mining companies alive for years; but now, since these, with very few exceptions, are virtually exhausted, attention must be paid to a thorough system of overhauling of all the ground already penetrated. I do not doubt, for instance, that the ground lying east between South Jacket and Chollar Potosi, 1,800 feet long, for a depth of 1,000 feet below the surface, contains valuable ores which have been passed by. Illustrations and analogies are not lacking. The Belvidere ore-body in Chollar, which has yielded nearly $3,000,000, was passed by in 1869, the prospecting drift running within 10 feet of it. The finding of the Hale & Norcross second-level ore-body east was the result almost of accident. Work had been pushed past it, downward, and its existence was not suspected. The greatest body found on the Comstock (except those which cropped to the surface) was through exploring work south and east in Crown Point, when the 1,000-foot level had been pronounced a failure, and all hopes of finding ore abandoned. Even when the edge of the ore was encountered, it was not believed to be of any importance, and the main work was already in progress down along the vein. Without a doubt, this last-named body, being so large, will have, like the other bodies, many smaller parallel masses and tributaries, which it will take some time to thoroughly explore and extract, so that the mines through which this ore-mass courses may be expected to yield very handsomely for at least one to one and a half years to come.

The hypothesis that ore-bodies will occur and continue to occur in depth has been proven, so far, correct; but, contrary to all expectations, they have been found of much larger dimensions, and the ores more universally distributed than overhead. Above all, the admixture of limestone as matrix has not been detrimental, as it was supposed it might become.

The cost of the work of prospecting in depth is greatly diminished from what it was one year ago, through the use of compressed air as a motor. This was at first employed in the Yellow Jacket mine by leading the air from a Burleigh compressor 1,300 feet vertically downward, and through 800 feet of drifts and winzes, to drive a Burleigh drill in the sinking of a 200-foot winze, which fully demonstrated the practicability of this power.

The hoisting of ores through the inclines is now done by machinery separate from the other hoisting-gear; and much credit is due to Mr. H. Donelly, foreman of the Yellow Jacket, for a simple invention, in the construction of an incline car for dumping its load alone.

A thorough system of natural ventilation is gradually being adopted and becoming universally understood, and is much facilitated by the desire to connect the different mines, which formerly the controlling mania for speculation prohibited. Mr. Luckhardt found, for instance, the temperature at 1,897 feet depth below the croppings in Hale & Norcross, and 1,400 feet deep in Yellow Jacket, not at all oppressive, certainly not exceeding 85° F. in the face of the drifts; while at places where air was only artificially introduced from the surface by blowers the temperature at 1,500 feet rose to 125° F.

Wood for fuel in the last year has become scarcer than it was, and much coal is now being used as an admixture, and found to be more economical than either used alone.

Yield of the Comstock mines.—The following is the yield of the leading mines, as given by the Virginia Enterprise, from the assessor's returns. The average per ton is that of the last quarter only.

Yield of the Comstock Mines.

	Tons.	Value.	Average per ton.
Belcher	83,194	$4,794,669	$65 00
Crown Point	110,762	4,598,849	31 79
Chollar Potosi	44,350	752,012	15 07
Empire	11,248	177,377	15 10
Hale & Norcross	38,064	617,325	17 64
Savage	53,083	811,867	14 03
Sierra Nevada	18,380	122,577	7 39
Woodville	650	10,504	16 16
Kentuck	11,183	141,847	8 90
Challenge	380	1,125	4 88
Total	371,349	12,028,152	

To this amount should be added the product of the Yellow Jacket, estimated at $520,000, and the amount produced from tailings, estimated (on the basis of the assessor's returns for nine months) at $1,021,572, making a total of $13,569,724. The mines and works of outlying districts, shipping through Virginia and Gold Hill, undoubtedly swelled this sum still further. Unfortunately, I have not at hand for comparison the express shipments from these two points alone.

THE SUTRO TUNNEL.

The Sutro Tunnel has passed the first stage—always tedious—of such works; that is, the establishment of the line, collection of machinery, construction of roads, and other preliminary labor. The surveyor is Mr. Schussler, and the work was done with an excellent transit instrument originally made for the city of San Francisco. Mr. Schussler is an engineer of that city, and a most competent man. The plan of the work includes a tunnel entrance at the town of Sutro, on the Carson River, and four shafts, which divide the work as follows:

	Feet.
From entrance to shaft No. 1	4,915
From shaft No. 1 to No. 2	4,150
From shaft No. 2 to No. 3	4,480
From shaft No. 3 to No. 4	4,150
From shaft No. 4 to Comstock lode	2,450

In addition to these, there is an air-shaft completed 2,252 feet from the mouths and 500 feet deep. The total length of the tunnel will be 20,145 feet, and of the shafts, 4,910 feet. The latter, omitting the air-shaft, will have the following depths: No. 1, 523 feet; No. 2, 1,041 feet; No. 3, 1,361 feet; No. 4, 1,485 feet. The present condition of the work is as follows: In the tunnel the header had reached, November 30, 1872, a distance of 3,451 feet, and the enlargement is completed for 1,100 feet. Shaft No. 1 had been sunk 454 feet, with only 69 feet remaining unfinished. Shaft No. 2 was 623 feet deep, with 418 feet to go. Shaft No. 3 was sunk 377 feet, and had 984 feet left. Shaft No. 4 was 421 feet deep, and had still 1,064 feet to pass through. It will be seen that these shafts are in themselves no inconsiderable works. Shafts of 900 and 1,000 feet deep collect a pretty heavy amount of water, and the engines and pumps which were at first put in were intended merely for a commencement, and at length failed to keep down the water.

In expectation of this, sixteen pumps had been ordered of Messrs. Allison & Bannan, of Pottsville, Pennsylvania. Each has a steam-cylinder of 22 by 72 inches, 10-inch water-cylinder, weighs 20,000 pounds, and raises 300 feet. These are the first direct-acting pumps of this capacity which have been placed in the West. As the tunnel will, of course, be the drain of nearly five miles of mountain, it will be certain to collect a great amount of water, and in estimating the amount the engineers thought that the Comstock lode itself offered the best criterion in forming an opinion. The quantity provided for at the shafts is, therefore, equal to the largest amount pumped from any one mine on that lode, namely, 20,000 gallons per hour. This is the capacity of the pumps at very moderate speed, and it can be increased by 50 per cent. It is not, however, thought that the water will ever amount to 720,000 gallons per day.

The amount of water actually pumped from the shafts during the past year was as follows:

Month.	Shaft No. 1.	Shaft No. 2.	Shaft No. 3.	Shaft No. 4.
January	Not measured.	Not measured.	Not measured.	Not measured.
February	58,000	Not measured.	Not measured.	Not measured.
March	1,860,000	Not measured.	Not measured.	620,000
April	3,000,000	210,000	330,000	1,140,000
May	4,000,000	62,000	217,000	3,800,000
June	3,000,000	300,000	300,000	2,100,000
July	2,500,000	558,000	403,000	2,480,000
August	4,800,000	Not measured.	2,500,000	2,170,000
September	5,000,000	300,000	3,000,000	Not measured.
October	3,500,000	350,000	5,000,000	Not measured.
November	2,800,000	2,000,000	4,500,000	1,530,000
December	3,336,000	2,108,000	4,700,000	1,844,000
	33,854,000	5,888,000	20,950,000	15,684,000

Taking December as an average, we have 387,000 gallons a day. The putting through of shaft No. 1 will, of course, remove the necessity of pumps at that station.

The quantity, however, is certain to be vast, and provision has been made for utilizing it in the operations of the tunnel. The water pumped from shaft No. 3, and probably also that from No. 4, (which latter, however, will have to be pumped an additional height of about 150 feet,) will be conveyed by its natural flow to the divide between shafts Nos. 1 and 2, which has an elevation above the tunnel-level of 1,350 feet, whence it will be conveyed in pipes to the face of the tunnel; the pressure obtained will be 675 pounds to the square inch, which will give a large power. The quantity of water will be largely increased by the construction of dams and reservoirs in the ravines adjacent to the flume which conveys the water from shaft No. 3 to the divide, and in which will be stored up the rain-water accumulating during the winter-months and that from melting snow, which falls to considerable depths in some of the deep gorges, and does not altogether disappear until the month of June. The completion of the tunnel will, of course, remove the supply from the pumps, while that obtained from the reservoirs will be permanent. To this will, at a future day, be added the water flowing from some remarkable springs situated at an elevation of about 1,000 feet above the tunnel-level, at a distance of about five miles to the northward, which are estimated to supply from nine to twelve miners' inches. One of the dams spoken of above has been completed, and a pipe carried to and down the air-shaft a distance altogether of about a mile, with a fall of 500 feet.

The whole work in the tunnel has, so far, been carried on by hand. One holder and two strikers are employed at each drill. Two holes are drilled from two to five feet deep, according to the nature of the rock, into each of which a cartridge of dynamite, or "giant powder," is inserted. The cartridges are then exploded simultaneously by means of fuses and caps. This explosion makes an opening of considerable size at the bottom of the drill-hole, which is then filled with ordinary black powder. This is fired off with a water-proof fuse, the men in each case retreating from 200 to 300 feet distant from the header until the explosion takes place. Mules have lately been used to run the cars out, and mining-locomotives will soon be put on.

The alternations of rock encountered were as follows: From the mouth of the tunnel a belt of conglomerate, consisting of bowlders of trachyte cemented together with volcanic tufa, extends for a distance of 650 feet; this is succeeded by a formation of coarse trachyte about 530 feet wide; then follows a seam of red clay 35 feet in width; following this is a belt of blue clay 150 feet, succeeded by porphyry or greenstone, of varying hardness, 175 feet wide. A narrow seam of trachyte was then met, which was succeeded by propylite, extending to a distance of 3,000 feet from the mouth of the tunnel; here trachyte was struck again, in which rock the work was, November 30, 1872, 3,455 feet from the entrance. Shafts Nos. 1 and 2 are sunk in trachyte; Nos. 3 and 4 in propylite. The full size of the tunnel, as far as completed, is 12 by 16 outside of the timbers, which are 10 by 12 inches, except the inside posts, which are 10 inches square. This is divided into two compartments, each 5½ feet wide at the bottom, 4½ at the top, and 10 feet high, with a passage-way between and a drain underneath. The top and sides are covered with "lagging," or sheathing, of 2-inch plank. This timbering is to be permanent, but it is proposed to adopt a different style for the remainder of the tunnel, where the arch-form will be used. In the clay ground a brick arch will be necessary.

The four shafts are of the same size, viz, 5 by 10 feet, divided into two compartments, one 5 by 5 feet, the other 4 feet 2 inches by 5 feet. One division is used for hoisting rock, which is raised by means of a large wrought-iron tub attached to a flat wire cable, operated by a large steam-engine at the surface. The workmen also use this shaft. The other compartment is for pumps and air-pipes. It also contains ladders, each 15 feet long, and resting on a platform 5 feet by 20 inches. It is proposed to replace the hoisting-tubs by cages, on which cars can be run and hoisted to the surface. The shafts are timbered with sets of timbers placed 5 feet from centers, the outside pieces 10 by 12 inches; the posts 10 by 10 inches; the inside girths 10 by 14 inches. The "lagging" or sheathing around the outside of timbers is of 2-inch plank; the lining is 1-inch boards.

The tunnel-water is to be used as a source of power, and the plan of the town of Sutro contains some noticeable features; but these and other points not immediately connected with the work of the tunnel we must pass over.

The great question in regard to this, as to every engineering work of the kind, is, How soon will it be finished? The projector of the enterprise is happily able to give a favorable answer to this. Lying as it does under ranges of comparatively low hills, the work can be reached by shafts, and its completion hastened with ninefold rapidity. From the day the last shaft has reached the tunnel-level there will remain the time necessary to penetrate 2,450 feet of rock, and then the work will be finished. The coming of that day is to be hastened by the use of diamond or Burleigh drills, whichever shall be found best suited to the hard rock in which the Comstock is imbedded.

The shafts are to be sunk by the system of continuous drilling, which General Pleasants has introduced with such success in Pennsylvania. It is a question whether this method will succeed in a homogeneous, tough rock, like propylite, as well as it does in the stratified deposits of the coal-regions. It does not seem to us that the chance of failure is very great, and in any event the use of the diamond drill, in one way or another, will certainly hasten the work. In the shafts, diamond drills alone are to be used, but in the tunnel, trial will be made of the Burleigh drills, as before stated. The motive-power of the drills will be the water brought, as above mentioned, from the auxiliary shafts. This will be conveyed to the heading, where hurdy-gurdy wheels will be placed. This system is preferred to the transmission of force by compressed air, on account of the loss of power by the latter.

It is expected that these improvements will permit a progress of three feet in twenty-four hours in the shafts, so that the deepest of them will be completed by midsummer of 1874. Mr. Sutro calculates that if the diamond or percussion drills do as good work in propylite as the latter did on the less favorable rocks of Mount Cenis, the lode will be reached within thirty months from January 1, 1873.

The progress thus far made appears to be decidedly creditable to the projector and engineers of the work. The organization of the office seems efficient, and the work has progressed so far with few delays. In fact the progress made is very flattering, and if the coming work answers the expectations formed of it, we shall have had in this country one example, at least, of a well-conducted great mining enterprise on the largest scale.

Report of the Gould & Curry for the year ending November 30, 1872.

The superintendent reports no ore extracted during the year. Prospecting has been vigorously prosecuted, 298 feet of shaft and incline having been sunk, and an aggregate of 4,100 feet of drift made, as follows:

	Feet.		*Feet.*
Fourth station	684	Eighth station	1,453
Fifth station	390	Tenth station	1,002
Seventh station	477	Eleventh station	97

In addition thereto, 360 feet of old drifts have been re-opened and re-timbered.

So far all this work has not succeeded in discovering a new ore-body. A new and powerful engine has been added to the six already at the works. All the machinery is in good order, with the exception of the boilers, which are insufficient and need replacing.

The secretary's report furnishes the following data:

RECEIPTS.

Cash on hand December 1, 1871	$43,267 38
Assessments Nos. 12 to 15, inclusive	321,966 00
Mine account	11,368 95
Real estate	25 00
Mill account	2,017 20
Total	378,644 53

DISBURSEMENTS.

Mine account	$311,140 67
Interest	315 71
Mill account	75 20
Adverse claims and legal expenses	5,564 95
Exchange	1,641 00
Taxes	2,471 15
General expenses	21,587 02
Cash on hand November 30, 1872	35,848 83
Total	378,644 53

Total assets	$150,947 37
Total liabilities	705 50

Report of the Savage for the year ending July 10, 1872.

[Extract from superintendent's report.]

The mine has yielded during the twelve months ending June 30, 1872, 47,505$\frac{1668}{2000}$ tons* of ore, taken from the following sections of the new and old mines:

NEW MINE.

	Tons.	lbs.
First level south	500	550
Second level north	10,334	1,400
Second level south	2,591	1,630
Third level north	4,579	280
Third level south	1,695	1,220
Fourth level north	848	310
Fourth level south	3,745	960
Ninth level south	1,768	560
Tenth level south	3,029	1,050
Eleventh level south	5,502	950
Twelfth level south	336	500
Total	34,931	1,410

*During the rest of the year, 1872, the Savage mine has produced ore as follows:

	Tons.	lbs.
July	5,128	600
August	5,200	1,000
September	5,231	1,250
October	3,917	.....
November	3,912	400
December	4,103	1,400
Total	27,493	650

This ore is from the north second and third, the south eleventh and twelfth, and the old third and sixth levels. The ore ran from $21 to $38 per ton.

OLD MINE.

	Tons.	lbs.
Second level	959	770
Fourth level	569	1,150
Fifth level	1,711	1,250
Sixth level	9,333	1,080
Total	12,574	4,250

A fair quantity of ore has been extracted, amounting to nearly 4,000 tons per month on the average, but it has been of so low a grade as to be far from remunerative. It has yielded $18.70 per ton, which falls short of the cost of production and of reduction by the sum of $3.25 per ton. The cost of production, in which care has been taken to include with labor and materials every item of incidental expense, has been $10.15 per ton, and the cost of reduction has been $11.80 per ton, making the whole expense incurred, until the ore has become beneficiated, $21.95 per ton, which is 29 cents less to the ton than the average cost for the five preceding years. This loss, then, from the last year's operations, is due to the diminished yield of the ore and not to any increase in the aggregate of the cost of production and reduction.

On the eleventh level, connection has been made with the Hale & Norcross mine, which establishes a free circulation of air. Ore has been found here in places. On the twelfth, or lowest level, a drift has been run southerly, about half way to the south line, and from this a cross-cut to the east, reaching vein-matter. Progress here has so far been slow on account of the hot air.

At the present time the resources of the mine for ore are limited to the second level north, third level north, eleventh and twelfth levels south, and the third and sixth levels of the old mine. Work on all the other levels has been suspended, as they are exhausted of all ore considered worth taking out. The levels above named are now yielding in the aggregate about 170 tons daily, and the assay value of the ore taken from them in the month of June will fairly represent the value of the ore now in sight. These values, per ton, are respectively as follows: Second level north, $19; third level north, $18; eleventh level south, $24; twelfth level south, $31; and the third and sixth levels, old mine, $36. From present appearances, the second and third levels north, and the sixth level, old mine, will continue to yield, for many months, ore of the quality above indicated.

The total quantity of ore reduced in the past year was 48,392 $\frac{1790}{2000}$ tons, all at custom mills, excepting about 1,100 tons, which was reduced at the company's mill (Savage mill) at Washoe, in the months of July and August.

Condensed statement of the production and expenses of the Savage Mining Company for the year ending June 30, 1872.

	Tons.	lbs.	Tons.	lbs.
Ore on hand July 1, 1871, at mills	968	130		
Ore on hand July 1, 1871, at mine	214	...		
			1,182	130
Ore produced			47,505	1,660
Total			48,687	1,790
	Tons.	lbs.	Tons.	lbs.
Ore reduced at Savage mill	1,095	1,080		
Ore reduced at custom mills	47,297	710		
			48,392	1,790
Ore on hand July 1, 1872, at mine			295	
Total			48,687	1,790

PRODUCT.

Bullion	$883,192 72
Deduct bullion from 109 $\frac{1230}{2000}$ tons Belcher ore reduced, intermixed with Savage ore	6,095 32
Total bullion from 48,392 $\frac{1790}{2000}$ tons ore reduced (Savage ore)	877,097 40
Add reclamations received from mills—cash	28,197 69
Total product of 48,392 $\frac{1790}{2000}$ tons ore	905,295 09

Cash, from materials sold	$116 76	
Sundries	456 50	
		$573 26
Total product		905,868 35

EXPENSE.

Cost of production of ore, 47,505 $\frac{1660}{2000}$ tons—				
Mine cost, labor	$307,232 46			
Materials	150,598 31			
		$457,830 77		
Assaying bullion		1,785 67		
Assaying ore		3,741 12		
Other incidental expenses		18,827 73		
			$482,185 29	
Cost of reduction of ore, 48,392-$\frac{1790}{2000}$ tons			571,252 05	
				$1,053,437 34
Total loss				147,568 99

Average yield of the ore reduced, including reclamations, per ton			$18 70
Cost of production, per ton—			
Mine cost—labor, $6 47; materials, $3 17		$9 64	
Assaying bullion		0 03$\frac{8}{10}$	
Assaying ore		0 07$\frac{9}{10}$	
Other incidental expenses		0 39$\frac{3}{10}$	
Total cost per ton		$10 15	
Cost of reduction at Savage mill, net cost	$9 94		
Cost of reduction at custom mills	11 85		
Average cost of reduction		11 80	
			21 95
Average loss from the ore produced, per ton			3 25

Average assay value of the ore reduced, per wagon-samples, per ton, $30 16.
Average yield of the ore reduced, in bullion, per cent. of assay value, 60.1.
Average yield of the ore reduced, in bullion, including reclamations, per cent. of assay value, 62.

	Gold.	Silver.
Proportions of gold and silver in the ore	28.3	71.7
Proportions of gold and silver in the bullion	32.2	67.8
Percentage returned of the gold and silver contained in the ore	68.3	56.9

Average value of the bullion, per ounce, after melting, $1,85$\frac{8}{10}$.
Average loss of weight in melting, 3 per cent.

Comparative statement.

For year ending June 30.	Ore produced (not including ore extracted from old mine on con'ct s'ld.)		Ore reduced.		Cost of production.	Cost of reduction.	Total cost.	Yield of ore reduced.	Profit.	Loss.	Proportions of gold and silver in the ore. Third class.			
											Per wagon-samples.		Per mill-samples.	
	Tons.	Pounds.	Tons.	Pounds.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Gold.	Silver.	Gold.	Silver.
1867	70,721	620	69,376	1,340	$7 91	$14 04	$21 95	$41 94	$19 99	......	......	......	26.9	73.1
1868.	83,444	1,250	84,626	1,670	7 21	13 74	20 95	40 84	19 89	......	27.9	72.1	28.8	71.2
1869.	53,953	1,350	55,479	760	8 90	12 22	21 12	34 87	13 75	......	25.1	74.9	26.4	73.6
1870	14,051	530	13,272	600	26 87	10 01	36 88	20 67	......	$16 21	27	73	27.1	72.9
1871.	39,715	150	38,147	290	11 06	9 95	21 01	21 43	42	......	27.8	72.2	......	......
1872	47,505	1,660	48,392	1,790	10 15	11 80	21 95	18 70	......	3 25	28.3	71.7	......	......

The secretary's report gives the following receipts and bursements:

RECEIPTS.

Cash	Balance on hand July 10, 1871	$18,299 81
allion	Bars received from mine . $883,192 72	
	Reclamations from mills . 28,197 69	
	911,390 41	
	Less amount returned to Belcher Company 6,095 32	
		905,295 09
Virginia & Truckee R. R. Co.	Return-freights on account	12,367 69
Rent	House-rent	35 00
Cash	Balance overdrawn	133,708 50
Total		1,069,706 12

DISBURSEMENTS.

rveying	In mine	$9 00
Fuel	Wood and charcoal	44,970 92
eight	On mining-materials to Virginia	3,568 29
eight on bullion	Per Wells, Fargo & Co.'s Express	2,173 36
y-office	Net cost of company's office	4,917 87
terest	On overdrafts at bank	3,080 90
al expense	Attorney's fees, &c	2,440 00
l-material and labor	Cost of reduction of ores at company's mill	8,225 50
duction of ores	Paid custom mills	560,361 60
idental	Sundry extraordinary expenses	1,486 28
se-keeping	Feed, vehicles, and repairs	1,831 17
saying	Paid for outside work	9 00
Water	Virginia and Gold Hill Company	9,600 00
pense	Office-rent, porter, &c	2,899 48
oks and stationery	For Virginia and San Francisco offices	1,133 96
change	On superintendent's drafts	2,684 69
abor	Miners, engineers, &c., and company offices	313,232 46
imber and lumber		46,557 04
Taxes and stamps	Federal, State, county, and city taxes	9,344 92
aterials	Mining-supplies, hardware, candles, oil, &c., and insurance on hoisting-works	48,179 10
iscount	On bullion	2,005 58
Real estate	City lot at Virginia, recording, &c	104 00
Total		1,069,706 12

Report of the Hale & Norcross mine for the year ending March 1, 1873.

e superintendent reports that during the past year 39,272½ tons of ore have been cted from the various levels of the mine; and 40,417$\frac{680}{2000}$ tons been reduced. Bullion to the amount of $657,950.37 has been produced from this quantity of ore, and there are now remaining on hand in the ore-houses 2,010$\frac{180}{2000}$ tons, valued by assay at $63,418.40. Within this period the sinking of the main incline was energetically con-inued until it had attained a length of 773 feet below the eighth level, or bottom of perpendicular shaft. The ninth and tenth levels were also opened, and have been ially explored; the yield from the several stopes in this section already aggregating 59½ tons.

t the next station below (the eleventh) no excavation has yet been made; but at a point 100 feet below it, the twelfth-level station has been opened out. From this in-cline station a drift has been run in the west wall of the vein northward, to within 70 feet of the northern boundary.

On the 800-foot level a new ore-body has been discovered, lying 70 feet east of the old ore-body, formerly worked in this level. It was first encountered 130 feet distant from the southern boundary-line, and explored up to the latter, where it is very large and richer than before. The average width of the ore exposed is 45 feet.

From the secretary's report I take the following:

RECEIPTS.

Amount forward from February, 1872	$10,484 32
From sundry sources	12,420 51
Assessments Nos. 37–39, inclusively	240,000 00
From ores worked	657,950 37
From bullion received on account of February (1873) workings	53,114 24
Total	973,969 44

DISBURSEMENTS.

Amount of bullion received on account of February (1872) workings, charged cash in last annual statement, and credited on account as portion of this year's receipts	$37,359 74
Tax account	4,321 58
Machinery account	13,706 77
Team account	2,956 56
Assay-office account	6,481 01
Mine account	358,111 44
General-expense account	47,081 54
Ore account (working $40,417\frac{680}{2000}$ tons)	462,650 73
J. G. Fair, superintendent, amount of his book-account	2,896 91
	935,566 28
Cash on hand per cash-book to balance	38,403 16
Total	973,969 44

PRODUCT.

			Tons.	Pounds.
1872—February 1st—On hand			3,154	1,860
Extracted.	Tons.	Pounds.		
From 175-foot level	491	1,000		
From 500-foot level	2,263	....		
From 535-foot level	791	....		
First-station level	9,161	500		
Second-station level	11,672	1,500		
Third-station level	33	1,500		
Ninth-station level	14,859	500	39,272	1,000
Reduced.			42,427	860
First quarter	10,894	560		
Second quarter	9,663	1,910		
Third quarter	8,702	230		
Fourth quarter	11,156	1,980	40,417	680
On hand, February 1, 1873			2,010	180

The following table of the proportion of the precious metals in the ore, assay values, actual yield, and loss, is interesting:

Period.	Proportion of metals in the ore.	Assay values. Quantities. Tons.	Lbs.	Assay values. Per ton.	Assay values. Amount.	Yield. Per ton.	Yield. Per cent. of assay value.	Yield. Amount of bullion.	Loss. Per ton.	Loss. Per cent.	Loss. Amount.
Quarter ending April 30, 1872		10, 894	560								
Gold	.30			$7 52	$81, 989 64	$4 91	.65	$53, 549 79	$2 61	.35	$28, 439 85
Silver	.70			17 72	193, 046 58	11 68	.66	127, 259 67	6 04	.34	65, 786 91
Ore				25 24	275, 036 22	16 59	.65	180, 809 46	8 65	.35	94, 226 76
Quarter ending July 31, 1872		9, 663	1, 910								
Gold	.30			5 46	52, 814 53	4 08	.74	39, 448 00	1 38	.26	13, 366 53
Silver	.70			12 84	124, 132 29	8 27	.64	79, 960 25	4 57	.36	44, 172 04
Ore				18 30	176, 946 82	12 35	.67	119, 408 25	5 95	.33	57, 538 57
Quarter ending October 31, 1872		8, 702	230								
Gold	.32			9 17	79, 853 04	6 56	.71	57, 072 32	2 61	.29	22, 780 72
Silver	.68			19 25	167, 545 94	12 07	.62	105, 067 56	7 18	.38	62, 478 38
Ore				28 42	247, 398 98	18 63	.65	162, 139 88	9 79	.35	85, 259 10
Quarter ending January 31, 1873		11, 156	1, 980								
Gold	.31			8 32	92, 858 51	6 15	.74	68, 682 79	2 17	.26	24. 175 72
Silver	.69			17 98	200, 659 25	11 38	.63	126, 909 99	6 60	.37	73, 749 26
Ore				26 30	293, 517 76	17 53	.66	195, 592 78	8 77	.34	97, 924 98
Year ending January 31, 1873		40, 417	680								
Gold	.31			7 61	307, 515 72	5 41	.71	218, 752 90	2 20	.29	88, 762 82
Silver	.69			16 95	685, 384 06	10 87	.64	439. 197 47	6 08	.36	246, 186 59
Ore				24 56	992, 899 78	16 28	.66	657, 950 37	8 28	.34	334, 949 41
Seven years ending January 31, 1873		270, 962	1, 500								
Gold	.31			12 44	3, 370, 440 18	9 54	.76	2, 585, 214 01	2 90	.24	785, 226 17
Silver	.69			26 99	7, 314, 631 66	16 30	.60	4, 416, 575 98	10 69	.40	2, 898, 055 68
Ore				39 43	10, 685, 071 84	25 84	.65½	7, 001, 789 99	13 59	.34½	3, 683, 281 85

The quantity of ore reduced during the year compares as follows with previous years:

	Reduced.	Average.	Bullion.
1867, tons	28,636	$47 32	$1,355,220
1868, tons	25,333	34 14	864,998
1869, tons	16,536	23 89	395,146
1870, tons	45,441	27 13	1,232 929
1871, tons	64,974	25 13	1,632 844
1872, tons	49,625	17 38	862,701
1873, tons	40,417	16 28	657,950

During the past seven years this mine has turned out and reduced 270,962 tons of ore, varying in value from $47.32 to $16.28 per ton. The total out-turn of bullion during this period has been $7,001,789, of which $4,416,575 was in silver and the remainder in gold. From this large sum of $7,000,000, stockholders ought to have realized something handsome. Only $1,598,000 has, however, been paid in dividends, while of this amount the company have compelled stockholders to contribute $1,050,000 in assessments. The case may be stated thus:

RECEIPTS.

Bullion-product for seven years	$7,001,789
Assessments seven years	1,050,000
Total	8,051,789

DISBURSEMENTS.

Dividends seven years	$1,598,000
Expenses seven years	6,400,675
Cash, February 28, 1873	53,114
Total	8,051,789

Deducting the assessments paid from the dividends received, we find the net profits to stockholders to have been $548,000, or a trifle over $78,000 per annum, on an annual bullion-product of $1,000,000. Allowing the average capital employed to be $1,000,000, the returns to stockholders show a small rate of interest. On the 40,417 tons ore mined and reduced last year, yielding $657,950, the sum of $358,111 was paid for getting the ore to the mills and $462,651 for reducing the ore to bullion; in other words, $850,762 was paid to mine and mill a product of $657,950. It is evident, therefore, that the mine has been managed not so much in the interest of the stockholders as in that of the mills which have crushed the ore.

Report of the Chollar Potosi for the year ending May 31, 1872.

[Extract from superintendent's report.]

Ore extracted	37,789½ tons.
Ore milled	35,930 tons.
Average yield per ton	$26 17
Gross yield of bullion	$940,119 60

The ore mined was obtained from—

	Tons.
Blue Wing	10,789
Belvidere	20,000½
Piute Station	7,000
Total	37,789½

Condensed statement of cost, production, &c., from June 1, 1871, *to May* 31, 1872.

ORE-STATEMENT.

Period.	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.
Ore on hand June 1, 1871	906	1,110				
Ore extracted during year	37,789	1,020	38,696	130		
Ore worked during year			35,930			
Ore on hand June 1, 1872					2,766	130

COST PER TON.

Extracting ore	$2 38		
Repairs, prospecting, dead work, and incidentals	4 19		
		$6 57	
Reduction, including melting and assaying		12 16	
Total cost per ton			$18 73
Average yield of ore worked			26 17
Average net yield of ore worked			7 44

BULLION.

	Gold.	Silver.	Total.
Average value of bullion per ounce	$.092½	$1.22½	$2.15
Average fineness of bullion per ounce	.045	.950	.995
Average proportion of precious metals	.43	.57	1.00

WORK OF ASSAY-OFFICE.

Ounces of bullion assayed before melting	446,889.35
Ounces of bullion assayed after melting	436,602.85
Average loss in melting, per cent	2.3
Number of ore-assays made	9,541
Number of bars made	313

RECEIPTS AND EXPENSES.

Received from bullion	$940,119 60		
Received from other sources	4,304 52		
		$944,424 12	
Expenses by all sources		673,250 45	
Net receipts for year			$271,173 67

The secretary's report contains the following receipts and disbursements:

RECEIPTS.

Bullion-account:		
Proceeds of bullion sold	$940,119 60	
Reclamation on mills	2,200 00	
		$942,319 60
Sundries:		
Received from sale of wagon, harness, &c	415 60	
Received rent from Breed & Crosby	40 00	
Received from sale of machinery to Buckeye Company	1,238 75	
Received from sale of lot at Virginia	200 00	
Sundry materials during year	160 17	
		2,054 52
Book-accounts:		
Amount received for account of sundries		39 00
Cash-account:		
Cash on hand, as per last statement		200,721 32
Total		1,145,485 44

DISBURSEMENTS.

Dividend-account:		
Paid dividend No. 37	$56,000 00	
Paid dividend No. 38	28,000 00	
Paid dividend No. 39	28,000 00	
Paid dividend No. 40	28,000 00	
Paid dividend No. 41	28,000 00	
Paid dividend No. 42	28,000 00	
Paid dividend No. 43	28,000 00	
Paid dividend No. 44	28,000 00	
		$252,000 00
Working-ores account:		
Expenditure for the year		431,160 00
Labor-account:		
Expenditure for the year		164,793 03
Timber and lumber account:		
Expenditure for the year		44,479 68
Taxes:		
State and Federal taxes		17,997 53
Hardware-account:		
Expenditure for the year		7,693 98
Water-account:		
Expenditure for the year		6,600 00
Wood-account:		
Expenditure for the year		3,581 00
Charcoal-account:		
Expenditure for the year		1,325 78
Candle-account:		
Expenditure for the year		3,132 05
Powder-account:		
Expenditure for the year		1,970 88
Discount-account:		
Paid on superintendent's draft	$1,074 00	
Paid on bullion sold	777 58	
		1,851 58
Oil-account:		
Expenditure for the year		486 50
Assaying-account:		
Expenditure for the year		1,200 17
Stable-account:		
Expenditure for the year		2,690 22
Rent-account:		
Rent of San Francisco office		1,500 00

l-expense account:		
xpenditure for the year		$8,699 50
erials-account:		
undry purchases of materials		1,672 35
ionery-account:		
xpenditure for the year		846 10
graph-account:		
xpenditure for the year		222 01
ight-account:		
aid for carriage of bullion	$3,504 14	
Paid for miscellaneous freight	465 69	
		3,969 83
veying-account:		
xpenditure for the year		950 00
e-account:		
urchase of Milton stock to perfect title		500 00
al-estate account:		
urchase of lots at Virginia		650 00
eral-expense account:		
cidental expenses of Virginia office during the year	$4,676 68	
ncidental expenses of San Francisco office during the year	2,965 94	
Paid fire insurance on company's property at Virginia	1,181 35	
		8,823 97
Superintendent Requa:		
Due from him on superintendent's account	$4,128 74	
Less last year's balance received	2,313 28	
		1,815 46
ok-account:		
mount paid on this account		725 00
h-account:		
Cash on hand this day		174,148 82
Total		1,145,485 44

Report of the Crown Point for the year ending May 1, 1872.

[Extract from the secretary's report.]

The number of tons of ore extracted was 81,226, at an average cost of $7.09, and 80,567 tons of ore were milled, at an average cost of $11.43 er ton. The number of mills employed in crushing this ore was fifteen, cluding the Rhode Island mill belonging to the company. The average of this ore was $43.48, and the total product amounted to the sum of ,503,633.

 following are the receipts and expenditures for the fiscal year:

RECEIPTS.

From bullion	$3,503,633
cellaneous sources	2,328
Total receipts	3,505,961
Cash on hand May 1, 1871	94,602
Total	3,600,563

EXPENDITURES.

, labor, and supplies	$576,670
improvements	65,331
e Island mill, labor	109,331
Rhode Island mill, improvements	14,307
ushing 67,220 tons ore	807,309
eneral expenses Gold Hill office, &c	36,360
Legal expenses	8,400
San Francisco office-expenses, &c	9,171
iscount	2,803
nterest	1,385

Assaying		$18,462
Taxes		18,454
Treasure freight		13,547
Real estate		468
Total expenditures		1,682,048
Cash, May 1, 1872	$644,507	
Cash in hands of superintendent	14,008	
		658,515
Dividends to stockholders		1,260,000
Total		3,600,563

The difference between the total receipts and expenditures, during the year, leaves a surplus of $1,823,913, of which $1,260,000 has been disbursed as dividends and the remainder carried to the surplus fund, leaving $644,507.09 cash on hand on the 1st of May. The assets of the company, including said cash, amount to $895,903, and the liabilities are nominal. The mine has paid out as dividends a total of $105 per share, or $1,260,000. Of these dividends five were $10 per share, two $15, and one $25. Since the 1st of May the largest dividend has been disbursed, viz, $480,000, or $40 per share.

The average yield of the ore for the year being $43.48, the mining costing but $7.09, the crushing $11.43, and the general expenses on the number of tons crushed $1.53, leaves a profit of $23.05. The operations in the mine during the past month have been retarded by the water, and by an accident to the machinery. The capital stock of the company is now $10,000,000 in 100,000 shares.

By the kindness of Mr. E. S. Davis, United States surveyor-general, I am enabled to publish the following table, which, although furnishing only a few points of comparison with the company's statement for their fiscal year, is very valuable in itself, in showing the comparative yield during the different months:

Bullion, ore, and labor for year ending July 1, 1872.

Month.	Tons of ore.	Number of men.	Product.
1871.			
July	6,986	305	$199,376 30
August	4,949	308	161,290 62
September	5,306	279	165,898 14
October	4,366	288	141,695 59
November	6,788	278	234,797 84
December	6,674	339	223,129 56
1872.			
January	5,573	320	231,643 58
February	2,794	266	167,657 99
March	10,753	387	630,848 01
April	12,328	552	808,681 26
May	12,538	550	536,071 82
June	10,316	578	414,993 43
Total	69,371	....	3,916,083 14

Average yield per ton, $56.45.
Dividends during the above period, $2,100,000.

Report of the Belcher for the year ending January 1, 1873.

In the superintendent's report occurs the following paragraph in regard to the resources of the mine:

Of the ore-bodies already developed, only approximate estimates could be made of their quantity or value. The reserves still above the 1,100-foot level are large, and from that level to the 1,300-foot level (on which the Crown Point—adjoining mine—have made large developments) has scarcely been touched, except what ore has been taken from the prospect-drifts and winzes. This gives an ore-body of over 300 feet in depth on the incline, which has uniformly given high assays. These facts will enable you to make approximate estimates of the quantity of these reserves already developed, and it may not be overestimating their value to take the past year's results as the best criterion to judge by.

In regard to the quantity of ore raised and work done the superintendent says:

Of the amount of ore extracted during the year, 72,595 tons came from the 1,100-foot level, 10,000 tons came from the 1,000-foot level, and 600 tons came from the 1,200-foot level.

A summary of the labor performed in the mine, during the year, shows the extracting of 83,195 tons of ore; the running of 2,872 linear feet of drifts and winzes; the sinking of 559 feet of the incline; the retimbering of 257 feet of the main shaft; the laying of 400 feet of car-track, and other general repairs in and about the mines.

The secretary's report contains the following statements:

RECEIPTS.

Bullion	$4,794,659 10
Virginia and Truckee Railroad Company	5,230 38
Cash, January 1, 1872	712,945 08
	5,512,834 56

EXPENDITURES.

Labor-account	$660,609 16
Crushing ore	998,341 38
Hoisting ore	83,633 75
Mine expenses, south	124,184 14
Mine expenses, north	61,458 14
Wood and coal	33,141 06
Timber and lumber	113,352 80
Assay-ore	3,517 13
Assay-bullion	11,571 83
Taxes, proceeds of mine	33,785 12
Taxes, State, city, and county	3,476 58
Exchange	6,994 48
Discount on bullion	46,222 57
General expense	6,284 61
Legal expense	10,250 00
Office expense	8,775 00
Treasure freight	17,412 07
Construction	21,782 36
Freight account	38,124 98
Salaries "Gold Hill"	8,750 00
Dividends Nos. 1 to 9, $21 per share	2,184,000 00
Supplies	13,865 48
William H. Smith, cash on hand	12,177 81
Cash, January 1, 1873	1,011,124 11
	5,512,834 56

Cost of producing and reducing 85,195 *tons of ore.*

Labor	$460,609 00
Hoisting	83,633 00
Supplies, hardware, tools, iron, &c	85,642 00
Timber	64,352 00

Assays, ores, &c	$3,517 00
General expenses	6,284 00
Freight—wood, timbers, and supplies	19,124 00
Wood and coal	13,885 00
Salaries and office expenses	17,525 00
	754,571 00

Equal per ton, $9.07.

Cost of crushing	$12 00
Cost of mining	9 07
Total	21 07

ORE STATEMENT.

Monthly account of ores reduced in 1872.

Month.	Tons.		Average per ton.
January	8,473½	$426,127 51	$50 29
February	5,504	290,396 57	52 76
March	6,721	354,825 98	52 79
April	7,542½	365,915 15	48 52
May	7,411	429,349 35	57 93
June	6,979	407,772 37	58 43
July	5,000	321,421 93	64 28
August	5,886	251,790 83	42 77
September	6,545	442,201 16	67 56
October	4,690	366,326 54	78 10
November	7,656	534,394 63	69 80
December	10,787	604,137 08	56 00
	83,195	4,794,659 10	57 63

Number of tons worked	83,195
Total receipts of bullion	$4,794,659 10
Average yield per ton	57 63

BULLION STATEMENT.

Stamped value of bullion as per assay certificates.

Value in gold		$3,087,948 56
Value in silver		1,706,710 54
Total		4,794,659 10
Number of ounces refined bullion	1,483,753	
Average fineness in gold	101 thousandths.	
Average fineness in silver	890 thousandths.	
Value per ounce, gold		$2 08
Value per ounce, silver		1 15
Value of bullion per ounce		3 23
Average value per ton in gold		$37 12
Average value per ton in silver		20 51
Total value per ton		57 63

LANDER COUNTY.

Reese River district.—The Manhattan Silver-Mining Company has again been the principal producer of the district; but its operations have not been as profitable to the individual shareholders as in former years, as will appear from the following report of the board of trustees:

Report of the Manhattan Silver-Mining Company of Nevada for the year ending December 31, 1872.

STATEMENT OF EARNINGS.

Receipts:		
From Oregon and North Star mines, 1,136 $\frac{1593}{2000}$ tons ore, producing		$226,984 14
From Camargo and Whitlatch mines, 242 $\frac{495}{2000}$ tons ore, producing		28,969 51
From Isabella mine, 238 $\frac{1129}{2000}$ tons ore, producing		34,655 08
From Mohawk mine, 95 $\frac{1152}{2000}$ tons ore, producing		37,301 88
From Grove Tunnel, 28 $\frac{720}{2000}$ tons ore, producing		7,965 57
Profit on custom-ores, 3,284 $\frac{1022}{2000}$ tons ore		20,534 32
Sundry royalties		390 19
Sherman House sold		450 00
Roanoke reel and frame sold		500 00
Premium on bullion		10,905 44
Premium on drafts on New York		767 25
		369,423 38
Disbursements:		
Mining expenses	$188,843 80	
Milling expenses	49,193 05	
Mill repairs	12,335 57	
General repairs	1,251 03	
Freight of bullion to New York	20,836 67	
Reclamations on bullion	15,150 52	
Taxes	7,128 67	
Interest	6,776 28	
Fire-insurance	2,404 20	
Discount on drafts on San Francisco	3,454 56	
Expense-account	22,905 04	
Quicksilver lost	2,755 00	
Depreciation of stable stock	337 56	
Sundry losses	338 08	
		333,710 03
Earnings, coin		35,713 35

GENERAL ACCOUNT.

Dr.

Surplus January 1, 1872		$126,951 12
Earnings in 1872		35,713 35
Indebtedness to individuals		65,276 96
Coin		227,941 43

Cr.

Dividend paid January, 1872		$19,375 00
Re-invested in developments		52,364 75
Mill improvements		4,549 07
Hoisting-works improvements		1,602 10
Purchase of Dollarhide mine	$3,559 09	
Purchase of Grove Tunnel, one half interest	800 00	
Purchase of Nevada Hotel building	500 00	
Purchase of *South America shaft*	*1,500 00*	
Purchase of Homestake mine	237 54	
Purchase of Jones's shaft	150 00	
Purchase of Homestead water-right	250 00	
Purchase of High wood-ranch	100 00	
Purchase of Croft wood-ranch	75 00	
Lease of Diana mine	500 00	
		7,671 63
Supplies on hand		112,109 70
Bullion on hand		14,803 94
Cash on hand		15,465 24
Coin		227,941 43

Statement of surplus December 31, 1872.

Supplies on hand	$112,109 70
Bullion on hand	14,803 94
Cash on hand	15,465 24
	142,378 88
Less indebtedness to individuals	65,276 96
Surplus, coin value	77,101 92

New York, March 11, 1873.

H. AUGUSTUS TAYLOR, *President.*
JOSEPH LEE, *Treasurer.*

From a report on the property of the company, made by Mr. J. E. Clayton, early in January, 1873, I insert here the following extracts:

The mining-property on which the company commenced work in July, 1865, consisted of *four* claims only, viz, the Southern Light, 1,000 feet; North Star, 1,000 feet; Blue Ledge, 800 feet, and the Oregon, 1,000 feet, making in all 3,800 linear feet of mining-ground. During the progress of the work, since the above date, very extensive and valuable additions have been made to the property, in the discovery of numerous blind leads, made during the progress of under-ground explorations; by purchases of adjoining mines and lodes, made from the net earnings of the original claims; and by extensive improvements and enlargement of the reduction-works, the purchase of the exclusive right to use the Stetefeldt furnace for chloridizing ores in this district, the erection of hoisting and pumping machinery on a number of the most promising mines, and a thorough equipment of every department of the enterprise—all of which has been done and paid for out of the earnings, besides paying an original debt of $180,000.

The company now owns, in this district, sixty-eight mining-claims, aggregating about 70,000 linear feet in length; one thoroughly-equipped 20-stamp mill, Stetefeldt furnace, amalgamating-machinery, retort, smelting and assay furnaces; one large general-business office, fully furnished with desks, safes, &c.; one engineer's office, with all necessary instruments for making surveys and drawings; one coal-house with capacity of 35,000 bushels; one salt-house, with 450 tons capacity; two brick store-houses for supplies, lumber, &c.; one powder-house, two dwelling-houses, one wood-ranch, and a portable saw-mill, complete and in good order; one stable and hay barn, sufficient for ten horses; also a large stock of supplies for every department of the business. On the mines there are now erected and in good running order ten hoisting and two pumping engines, aggregating 220-horse power; three 6-inch column Cornish pumps, one portable saw-mill for preparing mine-timbers, &c.

Of the company's mining-property nearly or quite one-half is, according to Mr. Clayton, covered by double locations. This will leave about 35,000 linear feet on the various lodes located and owned by the company. Even so large a deduction leaves the Manhattan Company in possession of the largest mining-property in Nevada.

Mr. Clayton gives the following description of the property:

1. The North Star lode is situated on the southerly slope of Lander Hill. The extent of the Manhattan claim on this lode is 1,000 linear feet, and is bounded by the Buel North Star on the northwest, and the Timoke ground on the southeast. The course of the lode is nearly northwest and southeast, and it dips to the northeast at angles varying from 25° to 40°.

Both the course and dip vary greatly from straight lines, owing to numerous breaks and slips of the country-rock. The thickness of the lode also varies greatly in different portions of the ground. In some portions it is "pinched" down to a thin seam of a few inches only, and in other portions expands to 2 feet or more in width, making an average thickness or width of 12 to 15 inches.

This has been one of the most productive lodes in the district, and has been worked to greater extent than any other. The explorations have extended from the surface or outcrop of the lode to a depth of about 500 feet vertically, and about 800 feet on the slope or dip of the lode. The first shaft sunk by the Manhattan Company cut the lode at a depth of 180 feet. Levels were then run on the lode, west 360 feet and east 230 feet. In the mean time the shaft was continued vertically. At a depth of 220 feet a cross-cut was run for the lode, cutting it at a point 120 feet northeasterly from the shaft. Levels were extended from the cross-cut, on the lode, east 400 feet and west 265 feet. The shaft was then driven down to a total depth of 330 feet. At a point 300 feet from the surface a second cross-cut was run northeasterly for the lode, striking it at a point 320 feet from the shaft. Levels were run from this point as before, east 515 feet and west 520 feet, making the total length of this third level 1,035 feet. It may be inferred from this that the levels extend beyond the boundaries of the claim, but such is not the case. This is owing to the numerous crooks and faults on the line of the lode.

While the ground thus explored was being stoped out, a new shaft (called the Oregon shaft) was sunk on the Oregon lode 550 feet northeasterly from the North Star shaft. This new shaft cut the North Star lode at a vertical depth of 500 feet. Levels were then run, east 425 feet and west 310 feet. All these levels were connected by inclines on the dip of the lode, and a large amount of pay-ore has been stoped out east and west as far as the levels have been extended. The extent of the lode explored from the levels described is about 700 feet long from northwest to southeast by 600 feet on the dip of the lode, including the 500-foot level. There are some barren spots and low-grade vein-stuff that will not pay to stope out of this area, but there are several large blocks containing pay-ore between the third and fourth levels; but the best chutes of ore have been taken out so far as known.

The following statement will show the results obtained from the block of ground worked through the North Star shaft, as above described, from October, 1866, to December 31, 1871, and extending from the old surface-workings down to the 300-foot level, making a block of ground 400 feet deep by 700 feet long:

Whole number of tons worked, $5,130\frac{290}{2000}$.

Bullion produced	\$828,504 62
Total cost mining and milling	501,736 71
Net profit from North Star mine, above 300-foot level	326,767 91

The vein continues below the 500-foot level as strong and rich as at any point above, and, as it shows every essential character of a true fissure-lode, there can be no doubt of its continuity and value. The vein is further proved on the east by the Timoke mine, and on the west by the Buel North Star, both of which have been very productive mines, so far as they have been worked. The Timoke has been worked down on the incline of the vein 350 feet deep, and the Buel North Star has been worked by the Pacific Company down on a line with the 500-foot level in the Manhattan Company's shaft.

2. The Oregon lode (1,000 feet) is nearly parallel in course and dip with the North Star, and is situated about 225 feet above it, (or northeast,) measured at right angles to the dip of the lode.

The surface portion of the lode has been worked by an incline, and levels from it, to a depth of 360 feet on the incline of the lode. The Oregon vertical shaft cut the vein at a depth of 240 feet below the surface, and at a depth of 290 feet a cross-cut was run northeasterly, which cut the lode again. At 340 feet deep a second cross-cut was run northeasterly cutting the vein again. From all these points levels have been run each way on the lode. Small portions of the lode have been stoped out from the lower levels. The remaining portions are virgin ground, and contain large quantities of rich ore. The average length of the lode, proven by these levels, is about 620 feet, and from the surface out-crop down the incline of the lode to the 340-foot level is about 700 feet.

The amount of ore taken out of the Oregon lode from the three levels run from the shaft and the small stopes made is 1,517 tons 1,118 pounds. The bullion-yield was \$473,560.11, giving an average value per ton of \$312.

3. The Blue lode lies under the Oregon, and about midway between it and the North Star. It is a small vein carrying some rich ore, but has not been explored sufficiently to prove its value. Next above the Oregon are three other veins that have been cut by the northeasterly cross-cut from the Oregon shaft on the 290-foot level, the Fortuna, the Black, and the Joe Lane. These lodes have not been followed far enough each way from the cross-cut to determine their extent and value, except the Black lode, which has been driven up on a short distance, and 187½ tons of rich ore taken out, which gave a yield of \$51,785.12 in bullion, or an average of \$270 per ton. A number of other small veins were cut by the cross-cut, all showing some ore.

The Southern Light, Savage, and Seymour mines are all on a large, strong vein that lies a short distance south of the North Star lode. This is generally called the Savage lode, and it belongs to the second system of veins, or those having a more westerly and easterly course and steeper dip. Its course is N. 54° W., and its dip 56° northeasterly. This is a strong and true fissure-vein, having an average width or thickness of 18 inches. The principal work has been done in the Savage mine.

The Seymour mine, lying west of it, had some good chloride-ore on the surface, but it has not been followed in depth.

4. The Southern Light, lying east of the Savage, has been worked down but a short distance, where a cross-course broke the lode, and it has not been recovered. This slip or fault has a course north and south, and dip of 40° W. Every vein on the south slope of Lander Hill has been faulted or slipped by this cross-break. An incline

was sunk on the Savage ground to a depth of 360 feet. This incline is 450 feet west of the Southern Light boundary, and all the ore taken out lay east of the incline and west of the slip. This block of ground was of triangular shape, and continued rich down to the slip above described. About 2,113 tons of good ore were taken out of this portion of the ground before it came into the possession of the Manhattan Company, the aggregate yield of which was $270,000. There have been some attempts made to recover the lode east of the break, but so far without satisfactory results.

5. The Alida lode is an under-ground discovery made in a cross-cut south of the Southern Light. It is a large, strong lode, 1 to 4 feet thick, carrying streaks and chimneys of fair average ore; 103 tons worked gave, in bullion, $20,714.63, or an average yield of $200 per ton. This vein belongs to the same class as the Savage and Southern Light, and appears to be conformable to it in course and dip. Explorations are now in progress to get the lode east of the great line of fault.

The foregoing described lodes comprise only those that have been explored to a greater or less extent in the section across the rich belt from the Alida to the Black lode, above the Oregon mine. The whole distance has been cross-cut at points below the surface, varying in depth from 170 feet to 500 feet. All veins cut by these levels, and not known to crop to the surface, have been located by the Manhattan as "new discoveries."

6. Those cut in the cross-levels run from the Oregon shaft are as follows: 1st. On the 170-foot level, the Blind lode, 65 feet north of the shaft; 2d, the Miantonomah, 186 feet from the shaft; 3d, the Stetefeldt, 256 feet from the shaft; 4th, the Frost, 314 feet from the shaft; 5th, the Huber, 384 feet from the shaft; 6th, the Alliance, 411 feet; 7th, the Lee, 453 feet; 8th, the Farrell, 516 feet from the shaft. This 170-foot cross-cut northeasterly has been extended 560 feet. Of the eight lodes cut by this cross-level there are three that have been followed by levels each way, viz, the Blind, Frost, and Alliance lodes, and the work on them is still progressing with satisfactory results.

7. South of the Oregon shaft the Curtis, Antarctic, Pacific, Hiko, Research, Alsop and R[illegible]y lodes have been cut, making a total of fifteen blind lodes discovered by underground cross-cutting.

The Manhattan Company owns another set of claims northwest of those above mentioned, and in the same rich silver zone of country. The most prominent of these are the Isabella, Dollarhide, Mohawk, Graham and Ashley, and O'Connell lodes. Of this northwesterly group the explorations are now in progress, and very rich ores are being extracted.

1. The Isabella is a well-defined and promising vein, carrying high-grade ore. An incline 200 feet deep, and levels run each way, have proved the character and value of the mine; 704½ tons of ore have been extracted and reduced in the Manhattan mill that gave a product, in bullion, of $147,357.96, or about $209 per ton of 2,000 pounds.

2. The Dollarhide is a westerly extension of the Revenue. This is a small vein of very rich ore; it will probably average about 8 inches in thickness. An incline is now down 280 feet on the lode, and levels are being driven on the vein. Seventy and a half tons of ore worked from this mine gave a yield, in bullion, of $22,412.44, or an average of about $315 per ton.

3. The Ogden incline is on the O'Connell lode, and is now down 400 feet. It strikes the dip of the lode at 240 feet from the surface, and then follows the vein. This is a well-defined vein of 12 to 18 inches, and, from its general appearance, is supposed to be a westerly portion of the Black lode. The ore is high grade, but has not yet been milled.

4. The Graham and Ashley has an incline down 300 feet on a good vein 8 to 10 inches thick, of high-grade ore. One hundred and sixty-six and a half tons of ore from this mine gave, in bullion, $37,482.18, or $224 per ton.

5. The Mohawk lode has an incline down on the dip of the lode 460 feet. The vein is from 4 to 16 inches thick, and carries exceedingly rich ores. Three hundred and fifty tons of ore extracted from the incline and levels from it have been milled, giving a yield per ton of $435, or a total yield of $152,282.89. The net profits from this small lot were $62,861.06. The ore in the westerly stopes and in the bottom of the incline holds equally good as that already stoped out.

In addition to the mines described, the company owns a group of mines near the head of Marshal Cañon, about one mile south of the Lander-Hill group, and on the south slope of Union Hill. The principal mines of this group are the Congress Independent, Whitlatch Union and Camargo. The explorations on this group are not extensive. Most of the work has been done on the Whitlatch Union and Camargo. The vein is one of the largest and most promising in the district. It is from 1 to 5 feet thick, and has produced a large amount of good ore near the surface, but, as most of it was taken out before it came into the possession of the Manhattan Company, I have no authentic data of the earlier workings. There have been extensive faults and slips in this great lode, and the original owners lost it entirely. Since the Manhattan Company has owned the property a systematic exploration of the ground has been commenced. During the progress of the present work several blocks or detached portions of the lode have been found, and 261 tons of ore taken out, giving a yield of $32,670.23, or about $125 per ton. There can be no question about finding this lode below the surface breaks; it is only a question of time and labor. It will probably be found within a short distance east of the present workings. The character of the ground and the form of the hill would seem to indicate that most of the broken country has been passed. The unexplored claims belonging to the Manhattan Company are too numerous to describe. A majority of them are situated in the rich zone of silver-bearing country that passes through the district. Most of them are known to contain good ore in the surface outcrop, and are identical in character with those lodes that have been extensively worked, and as there is not a single lode in the rich belt that is known to be barren of ore, it is reasonable to suppose that many of them will prove as good as those now being worked.

The reduction-works consist of a 20-stamp battery; 1 rock-breaker; 1 Stetefeldt chloridizing furnace; 8 amalgamating-pans; 8 settling-pans; retort-room with smelting and assay furnaces; one refining-furnace, and all the appliances needed for the proper handling of the ores. The driving-power consists of four tubular boilers, 48 inches diameter, by 16 feet long, (only two used at one time;) one engine, 18 inches diameter of cylinder, by 42 inches length of stroke; one machine-shop, with lathes, (driven by donkey-engine,) and complete set of blacksmith's and carpenter's tools. The works are complete in every part, and capable of reducing 20 tons of ore per day of twenty-four hours. There is no mill in the State that does better work or is kept in more constant use.

The reduction-works as they now stand, including furnaces, shops, storehouses, offices, &c., have cost the Manhattan Company about $180,000.

The hoisting-works and pumps on the different mines have cost as follows:

Oregon hoisting-works	$22,800 12
North Star hoisting-works	18,876 75
Mohawk hoisting-works, (donkey)	791 05
South America hoisting-works	1,204 58
Whitlatch hoisting-works, (donkey,)	758 26
Isabella hoisting-works	7,000 00
Dollarhide hoisting-works	1,500 00
Grover Tunnel hoisting-works	1,200 00
Two extra donkey-engines, ready for use	1,800 00
Two extra horizontal engines, 10 by 20 inches each	1,600 00
Approximate total cost of machinery and improvements	237,530 76
Add to this the cost of mines and properties purchased within the last five years	92,712 83
Explorations and dead work for opening the mines, estimated	200,000 00
Cash investment, exclusive of original purchase	530,243 59

The present stock of supplies on hand is as follows:

Salt in store-house	$13,848 35
Quicksilver	9,760 18
Fuel, (wood and charcoal)	34,292 72
Tools and extra machinery	16,658 29
General supplies—steel, powder, candles, oil, &c	24,622 79
Mine and mill timbers	1,800 66
Stable supplies	2,673 49
Live stock and wagons	3,028 50
Total supplies on hand January 1, 1873	106,624 98

This large stock of supplies is necessary for the winter months, but is allowed to run down in the spring and summer to about one-half the above amount. This will make the average stock of supplies necessary for the efficient management of the business about $75,000.

During the years 1868–'69 the company had much difficulty in procuring efficient labor. This was owing to two causes: 1st. The discovery of the White Pine and Pioche mines drew off a large portion of the best miners, leaving a very indifferent class of workmen in this district; and 2d. The veins being small and the underground work much spread out and scattered, it was found to be impossible to get faithful, honest work done. These difficulties appeared at one time to be almost fatal to the success of the enterprise, but they were overcome by a radical change in the labor management. This was effected by the adoption of the contract and tribute system for all underground work. This change could not be made suddenly without a large falling off in the product of the mines, but the company contented itself with doing custom-work in their mill, and allowing the work on its own mines to lie comparatively idle. The miners, however, gradually became reconciled to the change, and the work of development and consequent yield of the mines has steadily increased during the last two years. The present tribute system has become established, and a good supply of Cornish miners are now settled in the district.

Manhattan tunnel, (6,000 feet long.) It is proposed to run an adit level or drain-tunnel from the southwest base of Lander Hill, commencing at the mouth of Pony Cañon below the town of Austin, and drive it on a line N. 83° E., magnetic, to the Oregon shaft, a horizontal distance of 5,560 feet, and thence until the North Star lode is cut, making a total length of 6,000 feet. At the Oregon shaft the vertical depth will be 760 feet below the surface, and at the intersection of the North Star lode the vertical depth from the surface will be 810 feet.

The advantages claimed for the proposed level are, 1st, the drainage of the rich belt of ground to the lowest possible point; 2d, furnishing a cheap line of conveyance for all ores extracted within reach of the adit; 3d, giving better ventilation to the mines than can be procured from the surface alone; and 4th, the chances of making valuable discoveries of lodes that do not crop to the surface, or that are not known to be rich at the surface, and have not been explored in depth.

The operations of the Pacific Mining Company (limited) have not been very encouraging. The report of the directors states that the value of the bullion sold during the past year is £22,692, of which £13,430 was for ore milled with the Manhattan Company, and £9,261 for bullion produced from the Mettacom Mill, and from the sale of ores in Liverpool. Up to October the directors had the fullest hope of continued remittances, but a letter then received from Captain Prideaux gave the first intimation of a break in the vein at the 400-foot level having occurred, and the consequent serious falling off in quantity and quality of the ore. From this date the mine has been worked at a heavy loss. The operations at Lander Hill have been brought within the narrowest limits, and the superintendent will endeavor to meet the monthly cost from the proceeds of the mine—working it upon the tribute system. The company was indebted at the end of December, at Austin, £2,344 14*s.* 2*d.* To enable the company to continue working, the directors propose to increase the capital by 15,000 shares of £1 each, to bear a preferential divivend of 20 per cent.

The Citizens' Mill and Mettacom Mill have both worked only a very short time during the year, and were stopped entirely during the latter part.

Eureka district.—This district has continued to hold the position of the foremost smelting-district in the West. Extraordinarily large developments of lead-ore have been made in the older mines, and quite a number of other mines have sprung into notice, which were hardly known by name last year.

The Eureka Consolidated Company still takes the lead, as far as magnitude of operations and product of "base bullion" are concerned; but several other companies have sent large quantities of argentiferous lead to market, and among these the Richmond Consolidated (limited) is the principal one.

The mines of the Eureka Consolidated Company on Ruby Hill have been repeatedly described in former reports, to which I refer for general description of the work heretofore done on them. In August, 1872, when I visited the mines, the company had erected and put in operation small hoisting-works on the Windsail shaft, which connects with the Lawton tunnel. From the floor of the latter a shaft 60 feet deep had been sunk, near the east line of the Sentinel claim, which stood in an excellent body of ore. From the bottom of this shaft a drift was being driven west, which had reached over 100 feet in length and was all the way in good ore, the latter getting richer in silver as the level progressed westward. During the latter part of the previous year and the first half of the year 1872 the ore mined by the company and sent to the smelting-works had nearly all come from the east end of Ruby Hill, partly from the Sentinel and partly from K K ground. This ore was of very low grade, containing only about 12 to 15 per cent. of lead, and rarely over $30 in silver and gold. The consequence was that it took these 9 tons of ore to produce 1 ton of bullion worth $260 in gold and silver. But since the drift running west from the winze in the tunnel-floor had advanced 50 or 60 feet the ore became much richer in lead and also in gold and silver. It is remarkable that the contents of gold and silver in the bullion remain always about the same, whether it take 4 tons or 9 tons of ore to produce 1 ton of lead. This shows that there is a certain and constant proportion between the contents of lead and those of gold and silver in the ore; in other words, gold and silver must both be contained in the lead-ores. At the same time it is certain that an increased proportion of arseniate of iron in the ore brings an increase of gold, over and above the usual proportion, into the lead-bullion and speiss.

The smelting-works of the Eureka Consolidated Company have undergone considerable alteration since my last report, their capacity having been much enlarged. The shape of the newer furnaces, each of which has a capacity of 50 tons in twenty-four hours, is also different from that of the older ones, being now rectangular. A more detailed description of the furnaces and their working will be found under "Metallurgy," in another part of this report. The official report of the Eureka Consolidated Company below gives the details of the company's business during the last year.

The hoisting-works on the Windsail shaft were finished on August 19; those on the Lawton shaft on September 4. Sinking has been steadily carried on in both shafts, and the ore-body has been reached in both. At the time of the superintendent's report, October 4, 1872, there were 30,000 tons of ore in sight, equal to a supply for the smelting-works for a period of six months. At the same time furnace No. 5, the last of the large class of shaft-furnaces, was completed at the company's reduction-works, which had then a capacity of 200 tons of ore per twenty-four hours. New shafting had been put into the furnace-building, to transfer the power from the engine to the breaker and the five large Sturtevant blowers. A Knowles steam-pump had also been put up, which commands the coal-pile and the smelter building.

The secretary of the company makes the following financial statement for the year ending September 30, 1872:

RECEIPTS.

For sales material, horses, &c	$1,062 55
For rebate for overcharges on freight	1,273 42
For exchange on coin-drafts	3,525 87
For proceeds 3,019 tons base bullion refined, (including 1,430 tons of last year's product)	1,159,508 78
Approximate value 1,981 tons at refining-works and *en route*	641,160 00
	1,806,530 52

DISBURSEMENTS.

For construction and improvements	$54,958 54
For mine-account	251,802 46
For smelting account	680,330 26
For general expense Eureka	41,298 96

For expense San Francisco	$11,001 43
For interest, &c	23,125 82
For freight, refining, &c., on bullion	259,101 47
For office-fixtures	75 00
For dividend No. 6, paid stockholders	50,000 00
For real estate Eureka	1,500 00
For house for use of assayer	1,200 00
For wood-ranch	718 98
For mining-property	2,023 50
For bills payable	25,000 00
For book-accounts	682 88
	1,402,819 30
Balance bullion-receipts over disbursements September 30, 1872	403,711 22
	1,806,530 52

RESOURCES AND LIABILITIES.

Resources:		
A. M. Ellsworth, superintendent	$1,713 98	
Supplies at Eureka, as per inventory	5,116 50	
Charcoal on hand	150,665 92	
Base bullion, 1,981 tons	641,160 00	
		$798,656 40
Liabilities:		
Overdrafts	$169,327 94	
Drafts against bullion-shipments	328,588 85	
Superintendent's drafts, not presented	9,569 10	
Book-accounts not due	8,374 72	
Bills payable	75,000 00	
		590,860 61
Net resources September 30, 1872		207,795 79
		798,656 40

ANNUAL PRODUCT AND EXPENDITURES.

Product:		
Base bullion, 3,570 tons, of which 1,589 tons have been refined, yielding	$608,339 60	
Base bullion at refining-works and *en route*, 6,981 tons	641,160 00	
		$1,249,499 60
Expenditures:		
Construction and improvements	$54,958 58	
Mine-account, including supplies on hand	251,802 46	
Smelting-account, including supplies on hand	680,330 26	
General expense Eureka	41,298 96	
Expense San Francisco	11,001 43	
Freight and refining on bullion	259,101 47	
Interest, &c	23,125 82	
Office-fixtures	75 00	
Real estate Eureka	1,500 00	
House for assayer	1,200 00	
Wood-ranch	718 98	
Mining-property	2,023 50	
Dividend to stockholders	50,000 00	
Bills payable	25,000 00	
Book-accounts	682 88	
		1,402,819 34
Disbursed over annual product		153,319 74

COST OF EXTRACTING ORES.

Expense of extracting and hauling to furnaces 32,170 tons of ore is	$251,802 46
Supplies on hand September 30, 1871	3,100 00
	254,902 46
Less supplies on hand, per inventory	2,627 50
	252,274 96

Or $7.84 per ton delivered at furnaces.

COST OF SMELTING ORES.

Expense of smelting 3,109 tons of ore is	$680,330 26	
Coal and supplies on hand September 30, 1871	42,425 79	
		$722,756 05
Less supplies on hand, per inventory	2,489 00	
Less coal on hand, per inventory	150,665 92	
		153,154 92
		569,601 13

Or $18.33⅓ per ton.

Thirty-one thousand and sixty-nine tons of ore reduced produce 3,570 tons of bullion, or 8.42 tons of ore produce 1 ton of bullion, at a cost of $220.43.

Transportation, refining charges, &c., aggregate, per ton, about $78.

W. W. TRAYLOR, *Secretary.*

The Richmond Consolidated Mining Company (limited) has had much trouble during the year on account of the title to the mine, as will be seen in the following report of the directors, which also gives a limited review of the company's business:

The first year of the company's operations expired on the 31st of August last, but, as the accounts were only received on the 22d of October, it has not been possible to prepare the balance-sheet and statement of accounts earlier. The directors have on several occasions sent to the shareholders statements relating to the affairs of the company; but as these may not have been seen by many of the present proprietors, it is deemed advisable to advert to them shortly. In order to satisfy themselves as to the value of the mine, the directors, before concluding its purchase, engaged the services of Professors Clayton and Fisher to examine and report to them thereon. Copies of these reports, which were most favorable, were sent to the shareholders. To insure the proper legal transfer of the property from the vendor, then in Eureka, the board deputed one of the directors, Mr. Streeton, a barrister, to go out to attend to the completion of the purchase, examine the property, and inquire into the best mode of conducting the business in future. Copies of Mr. Streeton's report were also forwarded to the shareholders. Within about three weeks from the date of the first general meeting, which was held on 1st December, 1871, the board received intimation from the manager, by cable, that the title of the company to its property was disputed, and an attempt had been made to obtain possession of the mine by force, which had been successfully resisted. It was extremely difficult, at such a distance from the scene of operations, to obtain full information of this attempt or of the nature of the case set up against the company; the directors therefore cabled to the manager to hold the mine at all hazards until they could send out a representative of the company. Mr. Corrigan, a member of the board, undertook to go out to attend to this matter, and he was accompanied by the vendor, Mr. English, who had a short time previously returned from the mine. The fearful snow-storm in January last kept both those gentlemen prisoners on the railway for a month, a most unfortunate delay, which greatly increased the cost of defending the property, as it had to be retained by force during the whole of this time. The adjustment of these claims occupied a long time; and although the local legal advisers were of opinion that there was a good ground of defense, they advised that it would be better, if possible, to compromise the matter, as some of the questions raised had never been decided by the American courts, and the company might be involved in litigation for two or three years, during which time the working of the mine would be stopped. In the end these claims were all settled by purchasing the Tip Top mine, (a property adjoining the Richmond mine,) and certain other assumed rights, which purchase the directors have no reason to regret. The directors desire to express their thanks to their manager for the energetic steps he took in defending the mine, often at the risk of his own life, and also to those who acted under him. During this period of anxiety and suspense no profitable work was done at the mine, but Mr. Corrigan and the manager availed themselves of this opportunity of putting up new and more efficient machinery and buildings, and of adding to the efficiency of the working plant generally. On the 24th May smelting operations were recommenced; these continued very satisfactory for some time, the first new 60-ton furnace yielding as much as $23,000 in bullion the first week in August; the second furnace of the same dimensions did not, from some unexplained cause, succeed so well.

The directors, however, have the pleasure of informing the shareholders that the smelting is again satisfactory, as the following results will show:

	Tons smelted.	Bullion product in dolls.		Tons smelted.	Bullion product in dolls.
Week ending September 4, 1872	220	12,000	Week ending October 16, 1872	159	7,100
Week ending September 11, 1872			Week ending October 23, 1872	140	8,100
Week ending September 18, 1872	108	5,200	Week ending October 29, 1872	190	10,800
Week ending September 25, 1872	176	9,900	Week ending November 6, 1872	300	15,000
Week ending October 2, 1872	200	9,800	Week ending November 14, 1872	340	18,000
Week ending October 9, 1872	160	8,000	Week ending November 20, 1872	336	20,700

As regards the grade of the ores, both in the Richmond and Tip Top mine, the directors have every reason to be satisfied; the quality continues to improve, and by the last return it will be seen that we are now smelting ore of the value of $60 per ton. The first ore reached in the Tip Top mine was not much above $40 ore, but the deeper the shafts go the richer the ore becomes. This fact is of great promise for the future, and tends to prove the value of this acquisition to the company's property. The fear of the supply of charcoal being monopolized before the winter, induced the manager to make large contracts during the summer, and on the 3d day of September he reports having in stock 215,000 bushels; this, with the wood in store, and the 3,000 tons of ore then on the dumps ready for smelting, absorbed £21,750; but, as a consequence, the manager expects to be able to work the mine advantageously through the winter months. After payment of the purchase-money of the mine and the preliminary expenses, a sum of £18,000 only was left for working capital, erecting two new furnaces, and all other purposes. It will be seen by the statement of accounts that the cost of erecting the new furnaces, buildings, engines, and machinery of the Tip Top mine, of defending the Richmond mine, amounts to £39,921; and that the expenses of accumulating ore and charcoal for future use amounts to £21,750; together, £61,761. Of this sum a portion has been provided out of profits, and the sum of £42,440 has been transmitted from London; and in order to send this sum the directors have had to exercise their borrowing powers to the full extent, namely, £25,000. The company having been called upon unexpectedly, as before mentioned, to incur heavy and unforeseen expenses in defending the mine, the board represented these circumstances to the vendor, and urged upon him that the case was one calling for some consideration on his part, and the directors have much pleasure in stating that the vendor has placed at the disposal of the board 2,000 fully paid-up shares, which have been transferred to and are now in the possession of the directors for the benefit of the shareholders. On the 24th October last the manager wrote that a suit had been entered by the Eureka Consolidated Company, as owners of the Lookout mine, against himself and the company, asking for a survey to be made of our workings, and alleging that we were not entitled to any ore which might be under their surface-claim, (technically known as a square location.) As Mr. Corrigan at this date was about to visit America upon business of his own, the board gave him full power to attend to this matter, and at his request sent out a shareholder intimately acquainted with the process of smelting at the same time to confer and advise with him. These gentlemen left Liverpool on 2d November. From a letter since received from Eureka, the directors feel confident that the claim on the part of the Eureka Company is unjust, and one that cannot be substantiated. The accounts show a profit of £16,002 19*s.* 9*d.* as the result of working the mine during the year. Six thousand four hundred pounds of this amount was divided among the shareholders in April last, when the directors declared a dividend of 4*s.* per share. The remainder, £9,602 19*s.* 9*d.*, will be available for dividend if the shareholders so desire. As the directors expect to be able henceforth to pay dividends quarterly, it is proposed at the meeting to ask the shareholders to authorize the directors, from time to time, to declare dividends of such amounts as they may think fit.

The case alluded to in the latter part of the report has not yet been decided by the courts.

Furnace No. 2, which is mentioned in the report as not giving satisfaction, was in the course of construction when I visited the works in the summer. It had the form of an inverted pyramid, all the sides inclining equally toward the hearth. With this exception the works of the Richmond Company are constructed in the very best and most efficient manner, though a good deal of money has evidently been expended for the sake of appearances. The company's smelting operations are further described in another part of this report under "Metallurgy."

During the calendar year 1872, the company's works have produced, according to data furnished from the account-books by Mr. Howell to Mr. O. H. Hahn, who kindly transmitted the same to me:

	Tons lead.	*Gross yield gold, silver, and lead.*
First quarter	215.5	$75,895 74
Second quarter	391.0	114,491 55
Third quarter	441.0	142,684 49
Fourth quarter	391.0	120,607 21
	1,438.5	453,678 99

The Ruby Consolidated Company (limited) is a new English company, which owns fifteen mining claims in the vicinity of Eureka. The most important of these are the Dunderberg, situated in one of the side cañons at the head of New York Cañon, about two miles south of the town of Eureka. The country rock here is shale and limestone, running north and south, and dipping west. The Dunderberg crosses these rocks nearly at right angles, running easterly and westerly, and dipping north. There are several inclines sunk, two of which follow the vein, the latter having a dip of about 8° near the surface, and down to a depth of 60 to 70 feet. Here the dip suddenly changes to 45° N. The third incline, which is intended for the main working shaft, is started below the outcrop of the vein, in the shales, which here form the foot-wall. It will strike the vein below the point where the dip becomes steeper than near the surface; but if it is to be kept straight, as it ought to be as a working shaft, it must cross the vein at inconsiderable depth, leaving the latter after that under the floor of the incline; and the deeper the incline becomes, the more will the vein recede from it, thus necessitating longer and longer levels at every station which is gained in depth. The correct way, it seems, would have been to start the working incline above the outcrop at a point which could have been easily determined by survey, and from which an incline of 45° would have struck the vein where it assumes that dip. This incline, after once striking the vein, could have been kept in it, and a shaft straight for its whole depth and for the larger part in ore would have been the result. Where exposed, the vein is from 3 to 5 feet thick, and filled in some parts with very solid oxidized ores, carrying here and there pockets and nodules of galena, while in others it contains soft pulverulent ferruginous carbonates. The claim is 1,600 feet long, about 800 of which lie in the limestone, while the rest is in the shale. The Dunderberg ore contains 12 to 16 per cent. of lead, and from $40 to $60 in gold and silver. About one-quarter of the latter values is gold. The ore contains a considerable proportion of lime and iron oxide. The so-called "black carbonate" occurs occasionally.

The Lord Byron, Valentine, Ida, Dudley, and Valentine Day are five claims belonging to the Ruby Consolidated Company, and situated on the south side of a lateral ridge running easterly from Prospect Mountain. Most of these are so-called "pipes," *i. e.*, round shaft-like and nearly vertical cavities in the limestone, which are partly filled with carbonate of lead, iron ore, spar, bunches of quartz, &c. Galena occurs very subordinately. These "pipes" have a diameter of from 4 to 10 feet, and have no connection between each other, at least not so far as present developments show. They are, however, nearly all situated on the contact between the limestone and a stratum of shale. Some of these pipes are excavated so as to form shafts of considerable depth, the Byron, for instance, being 210 feet deep. In the bottom is gray carbonate of lead, and above all the ore is taken out clean. There is *none in any direction outside of the shaft. These pipes are evidently cavities formed in the limestone by water.* This appears from the fact that they all occur immediately at or near the contact with the shales, which are impervious to water, and which would therefore arrest the water running towards them in the limestone above.

The ore from the Lord Byron and the Valentine assays from $40 to $50 in gold and silver, and contains little lead. In some of these pipes occurs a mineral very much resembling stetefeldtite, which is rich in silver.

The Eldorado, also belonging to the Ruby Consolidated Company, is situated on the western slope of Prospect Mountain. A number of shallow shafts have been sunk here immediately below the summit of the mountain. These disclose a thin layer of very rich ocherous ore lying between the solid rock and the surface detritus and soil. The streak follows the slope of the mountain, and is evidently the dislocated croppings of a vein above. This seems to have been found at last on the very top of the mountain, where a narrow crevice, filled with the same kind of ore, has been sunk upon with a shaft, which was some 40 feet deep in August. The vein runs east and west, crossing the ridge, and dips steeply south. It is not over 8 or 9 inches thick, but the ore assays from $80 to $400 in gold and silver, and 15 to 20 per cent. of lead. This ore is the richest so far discovered in the district.

The Bullwhacker, another of the Ruby Consolidated Company's mines, lies a considerable distance away from those described heretofore in the northernmost spur of the foot-hills of Prospect Mountain, close to the plain below. It occurs in a stratum of shale running across the ridge from west to east, and which is itself crossed lower down towards the plain by a dike of rhyolite. The Bullwhacker is not a vein, but a series of pockets in a zone running east and west; all the ore-bodies dipping at varying angles easterly and southerly. The shale around and between the pockets is considerably altered, being replaced, in many cases, by a yellowish-white clay with many "slicken-sides." The ore of the Bullwhacker is carbonate of lead in a talcose and calcareous gangue; in the carbonates occur very large bodies of galena, probably larger than in any other mine in Eureka. The contents of the ore in lead vary from 35 to 62 per cent., and in silver from $13 to $50 per ton. The deepest shaft is 240 feet down. Several drifts run from this shaft at different depths, which all show more or less ore. The ore exposed in the upper works is mostly carbonate, while in the lowest drift, 185 feet in length, considerable galena is standing.

The Ruby Consolidated Company has erected smelting-works in the southern part of the town of Eureka, opposite the Richmond works. It was the intention of the superintendent, Mr. L. N. Dougherty, to build two furnaces, but the lateness of the season permitted only the completion of one. It is a 40-ton furnace, similar in shape to the new ones of the Eureka Consolidated, but smaller. Mr. O. H. Hahn, a metallurgist frequently mentioned in my former reports, has been engaged by the company to superintend the smelting-works. I am indebted to him for the following facts: The furnace was blown in on November 15, and, from that time to December 31, 1872, the following ore was smelted:

354.7 tons from Bullwhacker mine; gangue calcareous and talcose; contents from $13 to $50 silver, and from 35 to 62 per cent. of lead.

438.3 tons from Dunderberg; gangue calcareous; contents from $40 to $60 gold and silver, and 14 per cent. lead.

228.3 tons from Eldorado; gangue quartzose; contents, $200 silver, and 17 per cent. lead.

130.3 tons mixed ore from the crusher; gangue quartz, clay, and lime; contents, $40 silver, and about 12 per cent. lead.

58.2 tons from Valentine; gangue calcareous; contents, $40 silver, and 5 per cent. lead.

1,209.8 tons of ore. This ore was fluxed with—

1. Ferruginous poor ores (bought) from the Marcellina and K K, containing from $13 to $24 in silver and gold; quantity not given.

2. Slags from the Richmond and the Phenix Works, on account of their contents of iron and silica, respectively; quantity $418\frac{1045}{2000}$ tons.

The amount of charcoal used during the above time was, including waste, 71,564 bushels, averaging 59 bushels to the ton of ore, (not counting Marcellina and K K ore.) This is much more than is generally used at Eureka smelting-works, but it is seen, from the above description of the ores, that they require a great quantity of fluxing materials, their contents of lead and iron being very small. The pressure of the blast was kept at $1\frac{1}{8}$ inches mercury.

The product was 5,006 bars of lead, containing, on an average, 140.39 ounces, worth $181.52 silver; 3.45 ounces, worth $71.37 gold; total, $252.89 silver and gold, per ton of 2,000 pounds. Total weight of the bars, 449,637 lbs., equal to $224\frac{1637}{2000}$ tons; total silver and gold value, $56,856.31.

The highest production per twenty-four hours during the campaign up to the last of December was $9\frac{1829}{2000}$ pounds. There have been no stoppages whatever since the 15th of November, and the furnace promises to run a campaign of three months at least. The average amount of ore smelted in twenty-four hours may be set down as 35 tons.

From a letter of Mr. Hahn, dated as late as January 20, 1873, I extract the following additional information:

A normal charge of the furnace is composed of—

Ore from the Bullwhacker	42.00	
Ore from the Dunderberg	36.70	
Ore from the Eldorado	6.00	
Ore from the Valentine	15.30	
		100.00
Ore from the K K and Marcellina	63.02	
Slag, rich in iron	26.06	
		89.08
		189.08

The charge varies, of course, according to the quantities of ore on hand from the different mines, and according to the changes in the gangue; the quantity added of K K ore depends more or less on its moisture and its contents of lime. The Dunderberg ore, for instance, is sometimes rich in oxide of iron, and then again very calcareous; the Bullwhacker ore is sometimes talcose and argillaceous, sometimes calcareous, and often contains an extraordinarily large amount of galena, in which latter case a larger percentage of ferruginous K K ore must of course be added. The K K ore contains from 10 to 16 per cent. of moisture, while the company's own ores do not contain over 7 per cent. on an average. Sometimes it happens that none of the ore used for fluxing purposes is on hand, and in that case up to 75 per cent. of slag must be added to the charge. But, in spite of this, the resulting slag is in that case stiff and evidently too highly saturated with lime, so that it runs badly, and accretions are formed on the tuyeres. In this latter case, about 50 bushels of charcoal are consumed per ton of ore, while the average consumption of coal up to the 18th of January, 1873, had been 44.2 bushels per ton of ore, 2,261.1 tons having been smelted with 99,958 bushels of coal. This figure includes the waste.

It is seen from these figures that the consumption of charcoal, per ton of ore, stood much more favorably on the 18th of January than it had stood on the last of December, the cause being, probably, that the furnace had reached between those dates its maximum of effectiveness.

The greatest quantity of ore smelted in twenty-four hours was 44.1 tons; the highest production (January 6) was 21,350 pounds of lead, which contained $171 in gold and silver. The matte, or rather speiss, contained, in the first part of the campaign, when $400 bullion was produced, $49, the dust, $87; later the matte contained $23, and the dust $33 in gold and silver, and 18.5 per cent. of lead. There is a higher value of gold in the speiss than of silver, the reason being the greater affinity of the former for arsenic. The slag contains no gold and silver, except when particles of speiss are mechanically mixed with it. The percentage of gold and silver saved directly in the lead has been 85.2 per cent. of that contained in the ore, (moisture not deducted,) and of the lead 96 per cent. The latter figure is, however, in reality, too high, as before January 1 the lead contained in the fluxes, especially the ferruguious K K ore, was not determined and counted in. The total cost of smelting one ton of ore was, up to the date above mentioned, $20.66.

The Silver West Consolidated is a new company, which has built a furnace, opposite the Richmond Company's works, to smelt the ores from the Silver West mine and the Excelsior.

The Silver West mine is located a short distance below and west of the Bullwhacker heretofore mentioned. It is a contact deposit between rhyolite and limestone, which is opened by two shafts about 60 feet apart. The deposit was, in the summer of 1872, explored for a distance of 80 feet along the strike and 45 feet in depth. Here the mine pinched suddenly, and although the shaft was sunk, following a clay seam, which had been on the foot-wall above, for a further depth of 165 feet, there was no more ore discovered. There are no drifts below 45 feet from the surface. About 1,000 tons of ore had been taken from the mine at the time above mentioned, and not over 400 tons were in sight.

The Excelsior is situated at the head of New York Cañon, in limestone. In sinking a shaft of 100 feet in depth, 500 tons of ore had been taken out, and at the bottom of the shaft the deposit was 22 feet thick. It dips into the hill at an angle of about 40°. The ore taken out was very quartzose, containing only 3 per cent. of lead, but $60 per ton of gold and silver, the value of the gold in the ton being about $10. In the bottom of the shaft the ore assayed 22 per cent. of lead and $46 in precious metals. The deposit has been followed in the direction of its length for 56 feet, the drift being entirely in ore.

The furnace of the company is a rectangular one, somewhat similar to No. 1 of the Eureka Consolidated, but having much higher and steeper boshes. The inside dimensions in the level of the tuyeres are, depth, 50 inches; width, 28 inches; boshes, 4 feet high, bringing about an enlargement of the furnace in its upper part of 2 feet in depth and 3 feet 6 inches in width. The total height above the tuyeres, of which there are ten of $2\frac{3}{4}$ inches diameter, is 10 feet.

When I visited the furnace it had only been running three days, but already on the second day $47\frac{1}{2}$ tons of ore were smelted. The charge was then:

Charcoal, 10 scoops, equal to 3 bushels; Silver West ore, 14 shovels, at 15 pounds, equal to 210 pounds; ferruginous ore from Sentinel, 6 shovels, at 15 pounds, equal to 90 pounds; total, 300 pounds; slags 2 to 3 shovels. Six tons of ore made one ton of base bullion.

The Phenix Company's Adams & Farron mine has been provided with very good hoisting-works, which are put up over the new shaft. There is a 40-horse power engine and two reels independent of each other, the power being imparted by friction. The Adams & Farron lies east of the Eureka Consolidated Company's mines, the K K and Marcellina being intermediate claims. The new shaft was started 80 feet northeast of the quartzite in the limestone, and being perpendicular it struck the former at a depth of 300 feet. At this depth a drift of 320 feet in length was run to the north, which struck the ore first 210 feet from the point of starting. The ore is here of very poor quality. There was also some ore found in the 200-foot level. The deposit is very irregular. There appears to be a main channel running north, from which wings start sideways, continuing ore-bearing for 50 to 80 feet in length, and then cutting off abruptly. In the main channel there is, on the contrary, always some connection between successive ore-bodies, though it be only a seam of ferruginous material. The shaft was, at the time of my visit, 400 feet deep, and stood in its lower part in quartzite. In this rock small nests of ore were occasionally found, which assayed from $4 to $30 in silver and gold, but no large bodies have been met with. In the levels above about 1,500 tons of ore, containing from $30 to $35 in gold and silver, were in sight, but by far the larger quantity of the ore exposed was very poor, containing only 7 per cent. of lead and $10 to $18 in gold and silver.

The smelting-works of this company have been moved from their former site higher up the hill and back from the road, in order to gain a better and larger slag-dump. They have been running very irregularly both before and since the rebuilding.

A new company, the Eureka Mining and Smelting Company, has been formed in San Francisco, which is based on what was formerly the property of the Buttercup Company of New York. There are several valuable mines among those belonging to this company, but the smelting-works are almost without value, as far as the furnaces proper are concerned.

The K K, Marcellina, and several other claims adjoining these mines have also been acquired by a San Francisco corporation. The first named of these mines is well opened from the underground workings of the Sentinel, and shows an enormous body of ore, which is, however, not rich. It has so far been found that the large ore-body in Ruby Hill, on which this claim, those of the Eureka Consolidated and the Richmond Consolidated Companies are located, carries rich ores toward the west and much poorer ones toward the east.

A number of other companies, the principal ones of which are the Star Consolidated and the Lemon, have worked mines, yielding amalgamating-ores during the year, but no great results have been attained. The Lemon Company's mill has run very irregularly and not successfully; principally, I think, on account of the ineffectiveness of the White roasting-furnace attached to the mill. This is a badly-planned imitation of the Brückner cylinder, long, and of small diameter, which has not given satisfaction as a roasting-apparatus. Especially the gold contained in the ores had, up to August, defied all attempts at successful extraction, and of the silver only a part had been obtained.

The production of the Eureka works, during 1872, was as follows:

Company.	Tons lead.	Gross value Ag, Au, Pb.*
Eureka Consolidated Company	4,312.5	$1,617,187 50
Richmond Consolidated Company	1,438.5	453,678 99
Phenix Smelting and Mining Company	443†	166,133 55
Silver West Consolidated Mining Company	241.192	92,032 10
Ruby Consolidated Mining Company	224.8	81,584 31
K K Consolidated Mining Company	120.05	39,616 50
Pinto Silver Mining Company	Silver bars	19,800 00
Lemon Mill and Mining Company	Silver bars, (estimated.)	25,000 00
	6,780.042	2,495,032 95

Mineral Hill district.—The unfortunate collapse of the English company during the summer has practically ruined this district, at least for the present. The mineral-deposits, upon which the mines of this company are located, are shown by developments to be of very small extent in depth, and are nearly all worked out. The country-rock is a stratified limestone, about 160 feet thick, which overlies clay-slates, and the deposits occurring in the top-rock do not continue in the shales. Besides this the value of the ore has always been very fluctuating. This is especially shown in the following report on the ores, taken out weekly, from July 6 to November 23, 1872:

	Tons.	Grade of ore.
July 6	20	$50
July 13	20	60
July 20	20	61
July 27	17	64
August 3	22	64
August 10	21	73
August 17	22	74
August 24	24	70
August 31	30	70
September 7	31	70
September 14	34	$71
October 5	64	65
October 12	83	69
October 19	84	76
October 26	70	77
November 2	62	76
November 9	63	79
November 16	63	70
November 23	64	60

It has been rumored that the company would try to find the means of carrying on explorations in new ground, in order to possibly save in this way the very large amount of money invested; but I am unable to learn whether these plans will be carried out.

The nature of the mineral-deposits and of the work done on them is well shown in the following report of Captain Hoskins, made to the company in July, 1872:

In handing you my report on these mines, I am sorry that it does not fall to my lot to notice any decided improvement in them, although we have maintained our weekly results, and increased them to 40 tons per week, still, in the main tunnels and other points where a discovery would be of immense value, our efforts, so far, have been unavailing to meet with a continuation of the rich surface-deposits. Queen Tunnel: This tunnel is extended south, a distance of 480 feet parallel with the ridge of the hill, and right under the main ore-deposits, and is now communicated to the shaft sunk from the center of the giant ore-chamber; in all this distance (after the first 120 feet) no trace of ore has been seen, the rock being hard, compact limestone, crossed in many points by fissures, which show plainly the action of the water by the carbonate of lime crystal-

*Value of lead assumed at $110 per ton.

†Number of tons estimated. Only the actual proceeds in coin were furnished by the company.

lized on the walls, without trace of mineral. We shall extend this tunnel south as far as the 120-foot level from the deep shaft, and thus be able to work here to a good advantage, which we have been unable to do this summer on account of the bad air. This tunnel is also communicated to the Troy incline shaft, and thus we have everything in good working order for bringing all the ore and waste to one ore-sorting house, which will be of great advantage during the stormy months. There is a chute put in the prospecting-shaft, and thus throws down all the ore from the Rim Rock and Giant, and passes it by car through the tunnel. Taylor Tunnel: This tunnel is being extended east by six men, and is now in over 229 feet; the ground has been generally hard, but in the last 20 feet we have struck several "vughs," or small cavities, and the rock is much mixed with spar, and altogether any change is hopeful, and further extension in the hill may prove something good. Vallejo: Our workings in this mine are confined to taking out the ore on the sides and roof of the chamber, which give about 2 tons of $75 ore per week. Giant: The prospecting-shaft is sunk 72 feet below ore-chamber, and communicated to the Queen Tunnel, but without the discovery of mineral; this shaft being made into a chute for ore, we shall not be able to sink it again for a short time. There is very little ore standing anywhere in this mine. Rim Rock: So soon as the large accumulation of ore was hoisted from the Giant ore-chamber, we recommenced working this mine, and the quartz proved much better than we anticipated, and the six men are now breaking 30 tons of $70 ore per week, and with a chance of its continuance for some time. The 120-foot level is extended under it without ore, but the only way in these limestone deposits is to sink on the ore until it gives out. Mary Ann: The air was so bad in 60-foot shaft that we could not possibly work it, and the men were put to strip down the west side of the ore-chamber, which pays well to do. So soon as the winter sets in we shall drive the level east from the bottom of the shaft. Great Republic: We have sunk about 8 feet for another stope, and shall carry it over the bottom of the ore-chamber; at present it shows but little ore, but hope it may improve as we progress forward. The Troy and Star mines with the Champion show nothing worthy of remark, all the ore having been nearly taken out of them. The location belonging to the Manhattan company close by the Queen Tunnel is at present worthless; there is a deposit of carbonate of lead with a little silver, and I see no reason why this deposit (even if it contained silver) should continue deeper than the many other richer deposits on the hill. The shaft is sunk about 20 feet, and has gone through the deposit and is now in limestone; but as soon as we can lease it, two men will be put there and prospect it thoroughly. We have sixty men employed in the mines, at $4 per day, and have raised during the five months to the end of August 589 tons of ore of an estimated grade of $71 per ton at a mine's cost, including stores, and prospecting of $35,129. The cost of prospecting in dead-ground during the same period was $13,084, a large amount to come out of our very much reduced ore-returns. On the question of what is best to be done in the future, my only recommendation is to keep on the Taylor tunnel as fast as possible, with the hope of meeting in depth with a channel of ground more favorable for mineral than that nearer the surface. Nothing having been done in the district deep, we have no guide to give us an idea as to what the probabilities may be of striking ore, but I am sorry to say that, after a careful examination of the hill for many months, I cannot see that there is much chance of meeting ore in depth. The deposit on surface was evidently formed by water from the top, and has no connection whatever with the interior of the hill.

HUMBOLDT COUNTY.

I am indebted for the principal report on this county to D. Van Lennep, M. E., of Unionville, an eminent authority.

Mining-operations in the county, during the year, have been prosperous in some districts, while in others they have been on the decline.

Buena Vista district.—The leading mine, the Arizona, has been steadily worked throughout the year, under the direction of the superintendent, J. C. Fall, of Unionville. From 60 to 90 men have been employed in the mine, summer and winter. The western portion, called sometimes the Fall ledge, has been mostly stoped out above the main tunnel and along the slide traversing the tunnel at about 1,100 feet from the intersection of the two ledges, (at the turn-table,) except from 300 to 400 feet front, next to the surface. That is, the slide running in a southeast course and the ledge a little west of south, it traverses the ledge in the main tunnel at about 1,100 feet from the turn-table, while it is over that distance from the tunnel, at the turn-table; so that the tunnel, the outcrop, and the slide form a triangle. Of this triangle one corner-portion, bounded by the outcrop, the slide, and a front of 300 to 400 feet parallel to the tunnel, has not been worked out. Several efforts have been made to reach the ledge beyond the slide. At a point about 500 feet from the turn-table a drift on the ledge with a winze had been left in the working of excavations. The slide is reached here at about 160 feet from the main tunnel and at about 47 feet elevation above it. An incline was sunk on the slide, and at about 52 feet of incline the ledge was found undulating for about 50 feet nearly horizontally, and then rising at an angle of about 30°. The work was stopped here on account of water and the expense of extraction. At about 260 feet farther in the tunnel another drift, run level with the tunnel westward, has reached the slide at about 75 feet from the tunnel. This drift has been run forward for about 300 feet, sometimes having the ledge broken up and undulating above the floor and sometimes below it. It is intended to be a discharge for water and material from the ledge beyond the slide. About 300 feet west of the old Arizona and original location, a location had been made on a ledge called the Argenta. This was secured by the Arizona Association, and a tunnel has been run, following a very strong ledge, with little mineral, for about 200 feet. From what is known of the slide on the Arizona ledge, the probability is that this ledge is the Arizona, west of the slide, taking its regular dip. It has the same direction, and dips about 25° E. A tunnel on a level with the main tunnel has also been run about 460 feet west of it and for nearly 200 feet in the bed-rock. It has little bearing on the development of the mine, but may be in time useful for discharging material.

The Fall ledge, below and east of the main tunnel, has been mostly extracted as far down as the ore appeared rich enough for extraction from the turn-table to an incline sunk on the ledge 1,060 feet inside. It usually decreased in size or was cut off. The incline at 1,060 feet from the turn-table was run, about 150 feet on the ledge and stopped on account of water. Drifts at different levels have been run southward, connecting with another incline sunk about 70 feet away, and, from this, additional drifts still farther south—100 to 200 feet south of the main tunnel. The ore extracted has kept up the good reputation of the mine for richness and uniformity of yield.

On the eastern side of the mine what has been called alternately the eastern branch and the continuation of the Arizona ledge has been developed into a mine with independent outlet. Following the ledge from the inside, a tunnel was run, mostly on the ledge to the outside. The mouth of this tunnel is nearly on a level with the main tunnel and about 220 feet east of it. About 100 feet from the mouth an incline was sunk on the ledge, showing a heavy vein. About 100 feet south of this another incline was sunk about 160 feet on the ledge. The ledge is smaller here, and about 70 feet down it is nearly level; then it becomes broken and rises, becoming smaller. The work was left off at a point where it is made probable, by the indications of a change of direction in the bed-rock, that a few feet more work would again discover the ledge taking its regular dip. Much valuable ore has been taken out of this part of the mine during the year.

The old stopes of the Silver-Mining Company (a part of the present Arizona) have also yielded much ore, and a large proportion of shipping-ore. These works have been united with the old Manitowac mine by drifts. The Manitowac ledge splices with the Stewart ledge, one rising above while the other curves down.

The ore furnished by the mine has been crushed and worked by the two stamp-mills of the Arizona Association, the twenty stamps of which it has kept at work for nearly two-thirds of the time. The mine has yielded 6,478 tons of milling ore and about 122 tons of shipping-ore, the latter yielding about $63,000 in the San Francisco market. The mills of the company, the Arizona mill, the Silver-Mining Company's mill, and the tailings-mill, have run with but little interruption during the year. The two former have stamps, and have run on ore and tailings; the latter on tailings only. The milling-ores run from $50 to $70 per ton, of which 35 to 50 per cent. is extracted by the pan process; the tailings run from $25 to $35 per ton, of which about 35 to 40 per cent. is extracted. The Aikin furnace, built in connection with the tailings-mill, was never regularly run. A trial was made, but the unsatisfactory result, and the trouble of drying the tailings, led to its abandonment.

During the summer months the Pioneer and Inskip Mining and Milling Company had a grade constructed about three miles long, from the Pioneer mill to the Henning mine; and in October a few men were put to work on the mine. The mine is hardly fairly open, and it will take several months of labor to open it and ascertain more certainly its value. The Pioneer mill has run most of the year on old tailings, with the exception of about 100 tons of Henning ore worked on trial. The Pioneer and Inskip Mining and Milling Company through their manager, D. H. Temple, have taken possession of the Pioneer mill, and made several repairs for the better working of ores in future. The bullion shipped during the year from Unionville is $327,291.40. The Governor Bradley and the Adams mines were discovered during the year. An incline 150 feet deep was sunk on the first, and a tunnel about 200 feet run on the second. Both mines have very rich ores in places, but need more work to ascertain their real value.

A considerable amount of surface prospecting was done during the summer.

Star district.—The Sheba mine has been worked during the year by a small force, prospecting and taking out shipping-ore for the San Francisco market. The first three months of the year the eastern part of the mine was worked on tribute by four Cornish miners. They got good wages out of the share of shipping-ore coming to them. The 5-stamp mill with concentrating apparatus has been idle, the concentration proving a failure.

The De Soto has also been worked at intervals by a few hands, taking out good shipping-ore and prospecting the mine. Some fine bodies of mineral were found in it during the year.

The dumps of the Sheba and De Soto mines containing several hundred tons of second-class ore, of a character apparently favorable to concentration, preparations have been made to erect a fine concentrating-mill. The building will be ready to receive the machinery in the first months of the coming year. It is to be propelled by a hurdy-gurdy water-wheel, with a fall of 170 feet of water. The ore will go through a breaker and two pairs of rollers, and then be concentrated by 8 Krom concentrators. Mr. T. G. Nequs has charge of the erection of the mill for the Star City Mill and Mining Company. Mr. Krom is expected to give the finishing touches by his own presence. Considerable prospecting has been going on during the year, testing the value of old claims; but thus far these efforts have not resulted in permanent working.

Sierra district.—During the year the mill for reducing the precious metals by the Paul process received several alterations. The ore was first crushed by Dodge's crushers, and pulverized in a revolving cylinder, with balls of iron or pieces of quartz. The amount of rock put through this machinery, in a fit state for amalgamation, was very small, and a change was made, trip-hammers replacing Dodge's crushers. The trip-hammers could not be kept in order on account of their velocity, and finally a 5-stamp California battery was erected. This was run for a few months. The heavy expenses incurred ran the company in debt, and it had to stop operations. The rock worked by the mill yielded at different times $28 per ton and $15 per ton, mostly gold.

The Gem and the Empire mines have been prospected during three to four months of the year. Some shipping-ore was taken out of both mines, and they were again abandoned. The Tallulah mine was also worked by a small force for several months, prospecting the ground.

Central district.—The Marietta mine was worked during most of the year by a small force of men, the present owners. An incline about 200 feet deep has been sunk on the ledge, and drifts at two different depths run on the ledge to prospect the mine. Some rock from this mine was reduced by the Winnemucca Mill, and gave satisfaction to the owners, yielding net above transportation and milling $172 per ton. The bullion bears a considerable percentage of gold.

The Teamsters' ledge has been also worked by a small force, and a few tons of ore were tried at a mill erected in the district during the year. The yield of the ore has thus far met the expenses of the mine. This ledge also yields a good per cent. of gold. Some tons of ore worked at Winnemucca Mill yielded $225 per ton for first-class and $72 for second-class ore. The mill put up in Unionville in 1869 for reducing the ore of the National ledge between the lower and upper towns, was bought by some of the owners of the Teamsters' ledge and erected in Central district, with some additional machinery. It has four stamps and one pan.

Relief district.—The Batavia and Pacific mine is the only one in a state of development in the district. About three miles below the mine is Batavia Mill, used for reducing the ore of the mine. The mine is in limestone. After working out a large and rich outcrop, the ledge was lost by a slip. By want of knowledge the work was pursued on a barren ledge close to the main ledge and intersecting it. A shaft was sunk on the same in hopes of finding again some rich deposit. Also, a tunnel was run below on the hill-side, calculated to reach the ledge at a good depth, with the hopes of finding it richer at that spot. These means failed to discover any ore-deposit. During the year, however, an experienced miner followed the slip, and, after running a few feet, reached again a rich deposit of ore and the continuation of the main ledge. Since the discovery, the mill, which was idle, has again started. The superintendent, Mr. Bailey, seems satisfied with the yield of the rock. The richer part is shipped to the San Francisco market through Oreana, the nearest railroad-station.

Echo district.—The mill that had been burned down in 1871 was rebuilt with a Stetefeldt furnace, and began to run in the fore part of this year, with satisfactory results to the owners. The mine belonging to the company owning the mill is the Butte mine, and the only one in active operation in the district. It has yielded enough ore for the wants of the 10-stamp mill. In the fall of 1872 Mr. Charles Hoffman made the sale of the property to San Francisco parties and has since been in charge. The sum paid for the property was about $80,000. The new company was incorporated under the name of the Rye-Patch Silver-Mining Company. Mr. Hoffman, finding that the ores of the Butte mines were readily worked at about 70 per cent. of assay value by the Meadow Valley process,* has ceased to roast the ores in the Stetefeldt furnace. The cost of roasting is saved; the ore is worked more quickly; and the royalty for the use of the Stetefeldt is also saved. It is now claimed that the Meadow Valley process gives better gross results than the former way of working. The Alpha Mine was worked during the year to some extent, and the ores shipped to the Reno works. The mine is now mortgaged to English parties and lying idle.

Winnemucca district.—The Pride of the Mountain has been worked during the year, and the ores worked at the Humboldt Canal reduction-works at Winnemucca. During the year a roasting-furnace and quartz-mill has been erected on the old site of the Humboldt Mill at Winnemucca, and run by the waters of the Humboldt Canal, built by a French company in the mining excitement of the early settlement of the county. The furnace was designed and built by Ginaca, of Mill City, an Italian by birth, and an old resident of Humboldt County. It is on the same principle as the Stetefeldt and Akin furnaces, but built more like a reverberatory furnace. It has a hopper above the fire-places to let the pulp drop. On dropping, the pulp is blown in and under the general arch of the furnace by a blower, which gives it a rotary motion; the heaviest part drops on the hearth directly between the fire-places, while the lighter is carried into the several compartments in which the rest of the hearth of the reverberatory is divided. This hearth is deep, and presents, instead of a plane surface, two sharp walls traversing the width, and presenting inclined surfaces to the pulp settling on them. The pulp, reaching the hearth, finds inclined planes conveying it by gravity toward three discharge-doors at the bottom and opening under the hearth. These doors are opened only when the pulp has lain in the furnace several hours. This is done to give to the pulp a chance to perfect by time any chemical change commenced by its ignition in falling. The heavy stuff dropped on the hearth between the fires is discharged in like manner. The furnace is claimed to work to 80 and 90 per cent. of assay value. The following are the rates allowed in buying ores for reduction at the Humboldt Canal reduction-works:

Ores assaying $60 per ton, 35 per cent.; ores assaying $70 per ton, 40 per cent.; ores assaying $80 per ton, 43 per cent.; ores assaying $90 per ton, 47 per cent.; ores assaying $105 per ton, 52 per cent.; ores assaying $130 per ton, 57 per cent.; ores assaying $150 per ton, 60 per cent.; ores assaying $175 per ton, 63 per cent.; ores assaying $200 per ton, 65 per cent.; ores assaying $225 per ton, 67 per cent.; ores assaying $250 per ton, 68 per cent.; ores assaying $275 per ton, 69 per cent.; ores assaying $300 per ton, 73 per cent.; ores assaying $350 per ton, 74 per cent.; ores assaying $400 per ton, 75 per cent.; ores assaying $450 per ton, 76 per cent.; ores assaying $500 per ton, 78 per cent.; ores assaying $600 and upwards per ton, 80 per cent. The ores of the mines of the district are reduced at this mill, and ores from all the surrounding country and along the line of the railroad are also bought by the works.

Golconda district.—The mill in this district being on a section of land owned by the railroad, and the owners having neglected to buy the land during the time allowed by law for its purchase, some sharp lawyer and his accomplices bought it from the railroad company and sold the mill principally for old iron. The Gregg mine has worked its way out

*Pan-amalgamation, with adequate amounts of salt and sulphate of copper.—R. W. R.

of debt by shipping Galena ores in small quantities to San Francisco and to the Winnemucca Mill.

Battle Mountain district.—In Galena the White mine has been run during the year, shipping ore to San Francisco. The Butte mine and the mill connected with it were attached for debt and sold. The new owners sold the mill again, and it has been transferred to Belmont, Nye County. In Copper Cañon the copper-mine has been worked and the ore shipped as heretofore.

Salt-mines.—A description of the Eagle salt-works in this county is given on a preceding page.

ELKO COUNTY.

The principal mining and metallurgical work in this county during 1872 has been done in Railroad and Spruce Mountain districts. Both of these lie south of the Central Pacific Railroad. The northern districts of the county, Cope, Bull Run, and Lone Mountain, have been very quiet.

For notes in regard to Railroad district I am indebted to Mr. O. H. Hahn, M. E., who lately constructed a smelting-furnace in the district, and Mr. C. Weberling, M. E., who is now in charge of those works.

Railroad district.—This district, almost forced into oblivion for reasons already stated in my report for the year 1870, page 152, has received a new impetus by the commencement of smelting-operations under the auspices of New York parties, forming the Empire City Mining Company. Although the principal industry of the district has been mining for copper-ores, which found a ready market, there are also deposits of argentiferous lead-ores of considerable magnitude. The majority of the mines are located on the northeast slope of Bunker Hill, a high peak of the Inskip Mountains, which are a branch of the Diamond range. The ore-bearing belt is a limestone, probably belonging to the Carboniferous age. This is frequently crossed by quartz and granite dikes, at the contact of which the larger deposits of argentiferous lead-ore, consisting in part of galena and cerussite, are found.

The copper-ores form net-works of pockets in a dolomitic rock and ore frequently intermixed with a white talcose matter and a brown-colored ore, which is probably serpentine. These copper-ore deposits have not been followed yet to a great depth. The leading mine, the Ella, belonging to a San Francisco company, has been explored to a greater extent, but chiefly by surface-work, than any of the other copper-mines in the district. It has furnished considerable quantities of chrysocolla and azurite, occasionally intermixed with tenorite and native copper, but no sulphurets to speak of, to various smelting-works in the East and at San Francisco. The copper-ores do not contain any notable quantities of precious metals, as erroneously stated in my report for the year 1869, page 186. A peculiarity of the lead-mines is the preponderance of copper-minerals near the surface. In some of the mines these disappear almost entirely, (Hussey Tunnel, Shoo-Fly,) in others they remain associated with the lead-ores (Last Chance) as depth is attained.

For the beneficiation of these lead-ores a cupola-furnace was erected by Mr. O. H. Hahn in the month of August, 1872, for the Empire City Company, near the town of Bullion, which forms a happy contrast to the worthless mud-furnaces built by former operators. It is a blast-furnace, with three wrought-iron water-tuyeres of the Keyes patent, and has a capacity of approximately 18 tons of ore per day. Its height from the base to the top of the chimney is 37 feet 10 inches; the height of the stack or shaft proper, from the center of the tuyeres to the level of the feed-door, is 10 feet; the hearth is 2 feet wide by 3 feet deep;

the throat 3 feet 1 inch wide by 4 feet deep. The hearth is inclosed on three sides by solid sandstone walls 2 feet wide, and at the front by a cast-iron plate 1½ inches thick. The side-walls and the back are again incased on the outside by three wrought-iron plates three-eighths of an inch thick, which are fastened to one another and to the cast-iron front plate by bolts, thus forming a rectangular box, inside of which the furnace stands. The plates do not touch the walls immediately, but stand about 2 inches off, the intervening space being filled up with sand at the sides, and with a composition of fire-clay and quartz-sand at the front. The tuyeres lie 11 inches above the plates, and are inclosed in fire-bricks. One foot above the tuyeres the masonry, consisting of fire-brick on the inside and granite outside, commences to taper down to 18 inches for a height of 2 feet. From that point the furnace is carried up of common brick entirely, the feed-door only being inclosed by fire-brick. The walls from the feed-floor 9 feet 5 inches up, are 13 inches, and thence clear up to the top 9 inches thick. The blast is derived from a Sturtevant No. 6 fan, which is propelled by a 20 horse power engine, and makes about 1,600 revolutions per minute. As auxiliary machinery, a Blake's 8 by 10 crusher, and a Hooker's 1-inch steam-pump are employed. In the former all the ore which does not pass through a 1-inch grate is broken up to a size desirable for smelting The steam-pump raises the water from a reservoir 35 feet vertically below the works into the supply-tank for boiler and tuyeres.

On the 24th of October Mr. Hahn started the furnace, but had to shut it down again on the 30th of the same month for the want of coal and iron-ore.

The ores to be here treated present the following characters:

Hussey Tunnel, assorted galena, 68 per cent. Pb, and $134 Ag; vein-matter, lime-rock.

Hussey Tunnel, mixed ore; galena and cerussite, with 37 per cent. Pb, and $104 Ag; vein-matter, same as before.

Last Chance, 22 per cent. Pb, and $50 silver, mixed with silicate of copper and the silicates of magnesia and alumina; vein-matter, lime-rock, sometimes granite.

Shoo-Fly, 34 per cent. Pb, and $64 silver; vein-matter, calcareous and brown spar, with occasional lumps of ferruginous clay.

As there were neither chemicals nor balances on hand at the time of starting, to ascertain the quantities of the slag-forming ingredients, Mr. Hahn had to make up a smelting-mixture at random, relying on ocular inspection of the vein-matter in the different ores, upon which a fictitious stoichiometrical computation of the necessary flux to be added was based.

The result was a mixture of 8. 6 tons of Shoo-Fly ore, 3. 0 tons of Hussey Tunnel mixed ore, and 1. 4 tons of Last Chance, equal to 13. 0 tons ore, with 2.0 tons of a splendid hematite, occurring in apparently large masses near the town of Highland, immediately below the mine. To every charge two shovels of slag (20 per cent.) were added. The slag ran very well, but after blowing out the furnace it was ascertained that the boshes had been corroded very much, and an iron sow of considerable size had been forming in the hearth, thus indicating a deficiency of sulphur and also of silica in the charge.

In the next mixture Mr. Hahn tried an addition of quartz in varying quantities, and found at last 6 per cent. to be sufficient for the prevention of iron sows, and for forming a slag siliceous enough to protect the furnace-walls from corrosion. As the Last Chance ore contains considerable copper-minerals, while at the same time there is not a sufficiency of sulphur in the ores, a great portion of lead-skimmings were a necessary but unwelcome by-product of the bullion; 13 tons of ore yielded from $2\frac{1}{2}$ to 3 tons of metal, which afforded, by assay, in the neighborhood of $200 silver, and traces of gold.

Later, Mr. Weberling was smelting only Last Chance, with one-third galeniferous Hussey Tunnel ore, and an addition of 8.6 per cent. hematite, there being silica enough in the Last Chance ore to saturate all the earths. Besides a large quantity of lead-skimmings, (nearly as much as the lead by weight,) considerable copper-matte, carrying from 25 to 46 per cent. of copper and $40 in silver, was produced. The consumption of charcoal was from 40 to 42 bushels per ton of ore during the earlier smelting-operations.

There were smelted in 1872:

Hussey Tunnel ore	166.8 tons
Last Chance ore	162.3 tons
Shoo-Fly ore	38.8 tons
Total	367.9 tons=100

As fluxes were added:

Iron-ore	41.4 tons	= 11.2 per cent.
Slag	66.7 tons	= 18.1 per cent.
Total	108.1 tons.	

Amount of charcoal used, 16,609 bushels = 45.1 bushels per ton of ore for the average of the total amount smelted.

Product in argentiferous lead 133,617 pounds, which contained silver worth $14,539.54.

The average contents of one ton of lead in silver were, therefore, $217.65.

Fifty-five tons of ore made one ton of base bullion. The ore yielded 18.1 per cent. of lead, and $39.52 silver, per ton.

As the lead-skimmings now resulting in the process are rather troublesome in the siphon-tap, the latter will probably be discarded and an ordinary tap on each side of the furnace will be substituted.

Spruce Mountain district was formed in 1871, by the consolidation of the Latham and Johnson and the Steptoe districts. It comprises an assemblage of peaks and foot-hills known as Spruce Mountain, situated forty miles south of the Central Pacific Railroad, and is connected with Humboldt Wells Station by a line of stages. Nothing but prospecting had been done up to the fall of 1871, at which time the Ingot Mining Company of Philadelphia commenced operations on the Latham mine, and in the summer following built smelting-works. I am indebted to Mr. E. F. Eurich, the metallurgist of the Ingot Mining Company, for the particulars in regard to this district.

The ore in this district occurs in deposits in a gray limestone, and consists almost entirely of carbonate of lead, containing more or less carbonate and silicate of copper, according to the locality. Galena and ores containing sulphur are not found in any considerable quantities. The silver in the ore varies from a few ounces to $150 per ton, but no workable body of high-grade ore has been found.

The Latham mine shows a splendid deposit of carbonate ore. It crops out on the brow of a hill so near the surface that all the ore yet taken out has been mined in open cuts. The shaft is 108 feet deep, and a drift run off from the bottom cuts ore at several points. The limestone in which this ore occurs dips at a flat angle to the northeast, and as nearly as can be judged from the surface-workings, and the various bodies of ore cut in the shaft and tunnel, the ore-deposits lie between layers of limestone and dip conformably with these. From the open cut, which can furnish from 40 to 60 tons daily, the ore is run through a short tunnel to the western slope of the hill down an inclined tram-way, and is then dumped into chutes.

The Fourth of July mine, owned by the Ingot Mining Company, has a tunnel in 250 feet, the end of which runs over what seems to be the upper part of a considerable body of ore. This ore is much cleaner than that from the Latham and also much richer in silver. A little more work would show the true value of this mine.

The other prominent mines are the Monarch, Badger, Carrie, and Grecian Bend. This last is situated on the eastern slope of the mountain, and is owned by the Starr King Company, of San Francisco. It has several hundred tons of ore on the dump, and the company intend putting up a furnace as soon as possible. The other mines are at present little more than prospects of very various degrees of merit.

The smelting-works of the Ingot Mining Company, situated on the western slope of Spruce Mountains, about two and three-fourth miles from the Latham mine, are built in the most substantial manner. They are connected with the mine by a good road, down-grade all the way to the furnace. The arrangement of the works is such that there is the least possible handling of material. The ore passes through a Blake's crusher, set to $1\frac{1}{2}$ inches, and drops to the charging-floor. The furnace is of the Pily type, circular in cross-section, and is supplied with a cup and hopper-feeding apparatus. The diameter at the tuyeres is $4\frac{1}{2}$ feet, and at the top 7 feet. Height from the tuyeres to the top 14 feet 6 inches. It has eight wrought-iron tuyeres cooled with water, and $1\frac{3}{4}$-inch blast-nozzles. The blast is supplied by a vertical direct-acting blast-engine, with a blast-cylinder 4 feet in diameter and 3 feet stroke. The engine is worked at a speed of from 18 to 20 revolutions per minute.

Although the ore occurs in limestone, it contains so much silica that an addition of from 20 to 25 per cent. of iron-ore is necessary to form a good slag and enable the furnace to work well. With the exception of a small portion present as silicate of copper, the silica cannot be detected by simple inspection, and only becomes apparent on analysis. The quantity of material, proportioned as above, and smelted in twenty four hours, is 35 tons, and the quantity of lead-bullion produced very nearly 5 tons. The ore used is almost exclusively from the Latham mine, and contains considerable copper, mostly in the shape of malachite, but sometimes as silicate of copper. Owing to the absence of sulphur from the ore, no matte is formed, and the reduced copper consequently enters the lead. Besides making the lead impure, it also makes the work about the furnace harder for the men. As the metal flows out of the automatic tap, an alloy of copper and lead separates itself from the rest of the metal and invariably closes up the siphon-pipe, so that it has to be opened before each ladling by driving in a bar, and toward the end of the run the automatic tap has to be abandoned altogether, and the metal is tapped in the ordinary manner into basins. Unfortunately, there is no means of helping this state of affairs, since sulphur-ore cannot be obtained. With enough of this last kind of ore in the charge, not only would a clean bullion be obtained but the furnace would work more rapidly and not require such close attention to keep it in good working-trim. Another point which will greatly improve the working is the construction of an air-receiver, so that the air may be forced into the furnace more regularly, instead of intermittingly, as is now the case. The bullion produced contained 40 ounces of silver; and the slag, assayed daily about 4½ per cent. Pb., and 37 to 50 cents Ag. per ton, rarely running above these figures. The consumption of charcoal (not pine) was 25 bushels per ton of material smelted.

WHITE PINE COUNTY.

For most of the information in regard to this county, I am indebted to Mr. A. J. Brown, of Treasure City. I visited, however, White Pine district late in August, 1872.

The unmistakable signs of dull times were upon the district. Hamilton, the chief city, was painfully quiet. No crowds congregated in its streets; the merchants were selling out at great sacrifice, preparatory to removal to Pioche or Robinson or Schell Creek, whither many of the inhabitants had gone already. The houses, even, were disappearing; for in this region of scarce building-materials, a house is frequently the companion of its occupant in his pilgrimages. It was said that seventy-five edifices, at least, had started on their travels from Hamilton during the fore part of the year; and many of those that were left stood empty, with placards vainly calling for tenants upon their locked doors.

Yet, White Pine is not utterly played out, though the reaction from the sanguine hopes and reckless swindles of an earlier time is a staggering blow, and the fresh excitements of the year have drawn off the surplus population. Between four and five hundred men were, at the time of my visit, still actively employed in the mines, and three large mills, the International, of the Eberhardt Company, the Manhattan, of the Ward Beecher Company, and the Big Smoky, of the Hidden Treasure Company, were constantly running.

The developments of the past year have tended to demonstrate that the principal mines on Treasure Hill—both Auroras, the Ward Beecher, the Silver Wave, the Hidden Treasure, the Sheboygan, and the Mammoth—are situated upon a continuous belt or channel of ore, bounded on the west by a vein or dike of calcite. The question of depth is, however, the vital one. Explorations with the diamond drill had not yet resulted in anything favorable up to end of August. The Wheeler tunnel, of the Hidden Treasure Company, was advancing toward the point where the downward continuation of the ore was expected to be found—500 feet below the surface. Indications were said to be encouraging. So far as I could learn, they consisted in the cutting of a spar-vein, supposed to be the eastern boundary of the ore-belt, and the finding of rock beyond it similar in appearance to that in which the ore occurs.

Meanwhile, the Eberhardt Company was doing much better than heretofore. The old Eberhardt mine was not being worked productively, but the Ward Beecher ground, subsequently acquired by the company, contains a large body of high-grade ore, (reported at $100,) and kept the large International mill running. The wire tram-way, which has cost so much, was working satisfactorily, except in the matter of wire-rope, which it used up at a frightful rate. The shipments of the company were, at the above time, at the rate of $90,000 per month.

Other mines on the hill had a good deal of low-grade ore. The South Aurora was idle, and a director of the company was on the spot to decide whether work was to be continued, in the way of exploration, or stopped altogether. The splendid Stanford mill of the company was likewise idle.

In the absence of new discoveries of milling-ore in depth, another year would probably put an end to active production in White Pine, unless the "base-metal" mines, some of which possess undoubted value, should be again revived. The attempt to smelt in this district has everywhere failed; but the causes of the failure are not irreparabe. The metallurgical difficulties, which arise from the abundance of lime and lack of silica, may be overcome by the use of ores from some of the new districts, or the cheapening of transportation may permit the sale of ores direct to buyers, in the present favorable state of the market. The failure of Mr. Mattison's ambitious and extravagant enterprise was a great injury to the district, in discouraging all attempts to handle the base ores. His works, foolishly located high above the town, now stand in the desolate glory of whitewash and gold-knobbed flag-staff, as solemnly silent as the old cemetery which adjoins them.

On August 30, the International Mill of the Eberhardt Company was destroyed by fire. Every man in town felt it as a personal loss; for all realized that this English company was the mainstay of White Pine. It was fortunate that the disaster occurred at a time when the mines of the company were looking better than at any time since their purchase, and that some time before the fire the mill was insured for $250,000.

At the end of the year, it may be safely said that in this district the surface-deposits have been gradually exhausted of their workable ores, and, no new ones having been discovered in depth, the prospect for the future prosperity of its mining-industry is rather discouraging.

Active operations have been carried on by most of the leading companies with a view to testing their ground in depth, but thus far without making any very promising discoveries. That the ore-body is continuous from the Edgar mine to the O'Neil grade, South Aurora mine, a linear distance of 2,360 feet, has been proved beyond a doubt. In places this ore-body has been worked out at the comparatively trifling depth of 130 feet from the surface, while in others no bottom has been found at a depth of 180 feet from the surface. On the contrary, better ore has been found at the last-named depth in the North Aurora and Edgar than nearer the surface.

There has been a marked decrease in the bullion-product of the district for the year, as compared with that of 1871. This is partly owing to the decrease in the number of productive mines, and partly to the destruction of the International Mill in August last. The whole bullion product for the year will not exceed $750,000.

Only four mills have been run during the year, and those only during the summer-months. Their running-time, with the number of stamps, may be summed up about as follows:

International, 60 stamps, 7 months' running-time.

Big Smoky, 20 stamps, 7 months' running-time.

Manhattan, 24 stamps, 5 months' running-time.

Swansea, 10 stamps, 2 months' running-time.

The Dayton, 20 stamps, and the Monte Christo, 20 stamps, have been idle.

The Trinity was erected, during the summer, near Shermantown, for the purpose of working the large lot of tailings that had accumulated in that locality during the flush times of 1869 from Eberhardt ore, worked by the mills in the vicinity. This mill differs from others in having no stamps or other ore-crushing machinery, and in its large amalgamating capacity, concentrated in one pan adapted to grinding the pulp, and one agitator. Its capacity is estimated at 40 tons per twenty-four hours. The labor necessary to run it twenty-four hours consists of—

2 engineers, at $5 per day	$10 00
2 amalgamators, at $5 per day	10 00
2 pulp-carriers, at $4 per day	8 00
For labor per day	28 00
Other expenses consist of wood, 3 cords, at $7 per cord	21 00
Chemicals per day, (estimated)	12 00
Oil, lights, wear of machinery, &c	10 00
Superintendence	8 00
Total	79 00

Expenses per ton, in round numbers, $2.

The amalgamation differs from that of the raw ore only in the use of sulphate of copper and salt. This mill, after having made a short run, has been compelled to shut down for the winter, owing to the severe weather having frozen the tailings.

The mines in which active operations have been carried on during the year are limited to about a dozen, most of which have produced some bullion.

South Aurora.—Operations in this mine have been confined to prospecting with the diamond drill. Six holes have been sunk to perpendicular depths, varying from 400 to 800 feet from the surface. No ore has been found. The formation passed through varies but little from the ore-bearing zone near the surface. From 500 to 700 feet from the surface the drill passed through a zone of limestone rich in well-preserved fossils, (mollusks and radiates.) Below this was found a narrow zone of limestone containing some graphite.

The actual cost of prospecting with the diamond drill may be summed up as follows:

First cost of drill-machinery, &c., including 700 feet of tubular rods, 4 sets of annular bits, and other fixtures	$4,773 80
Freight on machinery	821 27
Cost of machinery delivered at mine	5,595 07

Cost of boring 2,315 feet of holes, viz:

	Feet.
Hole No. 1, depth	101
Hole No. 2, depth	576
Hole No. 3, depth	340
Hole No. 4, depth	510
Hole No. 5, depth	417
Hole No. 6, depth	371
Total	2,315

The actual expenses of boring are about as follows:

For labor	$3,694 00
For water*	2,652 53
For wood	568 25
Actual cost of boring 2,315 feet	6,914 78

Cost per foot, $2.98½.

* Water may be considered an extra expense, as it was procured under circumstances and at a cost that is not likely to occur in other localities.

This, as compared with the cost of exploring the same ground by means of shafts and drifts run by manual labor, effects a saving of about $40,000, and has in this case apparently done the work quite as effectually, as there is no large block of ground that has not been penetrated by the drill. So far as the annular diamond bit is concerned, there can be no doubt that it is admirably adapted for testing in some measure the value of mines where it is desirable to know what the ground contains in advance of the usual explorations.

But there is yet much room for improvement in the machinery used to work the rods. Mr. Brown writes in regard to this:

It would be a great improvement, and one very much needed, if the machinery could be made to draw the rods from the hole. As at present used, almost as much time is consumed in drawing the rods as in boring. The machinery used at the South Aurora mine is altogether too weak for the strain put upon it in boring even the comparatively shallow holes so far bored in that mine. This is particularly the case with the rods and the couplings. In several instances the couplings have broken, and in one instance the rod itself has been twisted off. In all cases it has been found difficult to recover the piece left in the hole, so much so, that at the last break it was found necessary to sink a shaft 30 feet to reach the end of the broken rod. In another case they have altogether failed to recover over 100 feet of rod with the bit attached. The strain on rods working in a hole from 500 to 700 feet deep must be enormous. The rods should be made, it seems to me, as nearly solid as possible, (with the exception of the first 20 feet, which should be full size for the core.) A tube ½ inch in diameter would be ample to admit all the water necessary. A deep square thread for the couplings would probably answer better than the present ordinary thread. Finally, the machinery costs too much by half to be generally adopted in mining, but this is a fault that will eventually right itself. The average distance sunk per twenty-four hours running-time has been about 36 feet. In many cases this would be a sufficient recommendation, as, in mining, time is often an important item.

O. H. Treasure.—Some ore was extracted from the old surface-deposits in this mine during the early summer, but it has been about exhausted, that remaining being of too low grade to admit of its being worked at a profit. The principal feature of this mine has been the Wheeler tunnel, which was started about eighteen months ago for the purpose of prospecting the mine to a depth of 500 feet from the surface. The ground has been hard and the progress necessarily slow, so that its present length is only about 425 feet. The last 100 feet has been run through what is usually termed ledge-matter in this district, viz, quartz and calcite, in this case showing traces of silver, from $5 to $10 per ton. If the main ore-channel maintains the same strike and dip here which it has in the leading mines of the hill above, the company need not expect to strike it before the tunnel is in 600 feet from the mouth.

North Aurora and Ward Beecher South.—These two mines are adjoining and on the same ore-body, and both belong to the same company, so that both can be described under one head. The entire length of this mine is 1,360 feet, and it contains throughout this extent a body of ore varying in thickness from 20 to 150 feet. In the central portion of the mine the bottom of the deposit has not been found at a depth of 180 feet from the surface, but this is accounted for by the fact, so far as observed, that the end lines of the ore mass dip toward the center from both north and south extremities of the mine. This immense ore-body has also extended through the South Aurora and Edgar mines, altogether a total distance of 2,360 feet, and has produced, as nearly as can be stated, 81,576 tons of ore, giving a gross yield of $3,257,419 up to the present time. A considerable amount of ore has probably been worked of which no account can be got at present, so that $3,500,000 would not be too high an estimate.

The Ward Beecher Company's ground consists of the mine of this name and the Edgar. The ore-body described in the last paragraph is continuous through this company's ground. About eighty men were employed by the company during the summer, but as the ore is too poor to pay the extra cost of transportation to the mill during the stormy weather of the winter, it is considered more profitable to allow the mine to lie idle during that season. Since it has been shut down a little prospecting has been carried on and good ore has been found at a greater depth in the Edgar shaft.

Eberhardt.—Considerable prospecting has been done on this mine, but without finding anything of great value.

East Sheboygan and Copper Glance.—A small prospecting force has been employed on these mines during the year. Large bodies of ore have been opened, but of too low a grade to pay a profit in a custom-mill.

Caroline.—This mine is situated at Mount Ophir, on the west side of White Pine Mountain, in what is usually considered the "base-range." The vein lies in limestone, and is very small, rarely exceeding 8 inches in thickness, and probably averaging not over 3; yet, owing to the high grade of the ore it contains, work has been carried on profitably on a small scale. It would not be worth the notice of, nor would it pay under the loose management of, an incorporated company. During the first nine months of the present year only 42 tons of ore of all classes were extracted and worked, which gave a gross yield of $7,795, or $195 per ton. The ore is quite refractory.

French.—This mine, situated in the same locality as the last named, has been in active operation during the year. The ore has been shipped for reduction, and I have been unable to get the full returns.

Imperial.—This mine is situated on one of the outlying spurs on the west slope of Treasure Hill, in the "base-range" proper. In early times it was considered one of the best mines in the district, but since the failure of the Mattison smelting-works it has been idle, with the exception of a short time in August last, when 20 tons of ore were extracted and shipped to San Francisco as an experiment. The returns gave a yield of $78 of silver per ton of ore; lead, 5 per cent.; copper, 12½ per cent. This mine may be cited as a fair representative of a large class of deposits which, considering their size and the character and value of their ores, are worthy of more attention than they have hitherto received.

On the west slope of Treasure Hill, in strata 300 feet below the geological horizon of the free-metal belt, we encounter a series of veins or deposits extending north and south through the whole length of the district, in which ores of copper, malachite, azurite, and arseniate form the predominating minerals. Most of these cupriferous veins are rich in silver. The most careful tests made of all the ores show quantities varying from 50 to 150 ounces per ton of ore, with only a small percentage of lead or antimony. The formation consists of a dark arenaceous limestone, which is much broken.

The veins or deposits found in this belt may be divided into three classes, as follows: (*a.*) Veins striking east and west generally vertical or dipping at a high angle. Their croppings are generally continuous for a long distance, sometimes several thousand feet, and, so far as explored—175 feet from the surface—they have been found persistent in depth. In thickness they vary from a thin seam to 20 feet. (*b.*) Veins striking north and south and dipping east at a low angle. The veins of this class correspond in strike and dip with the stratification of the country-rock. (*c.*) Irregular deposits, apparently impregnations, filling seams and cavities in the country-rock. In the first two classes named, the country on one side, sometimes on both sides of the veins, is impregnated with minerals characteristic of the vein, often to a distance of 10 feet from the vein itself.

In a few of the mines in this belt lead predominates on the surface, but in one instance, that of the C. T. Fay, it has been gradually replaced with ores of copper at a depth of 150 feet from the surface.

Mobile.—This mine is situated at the head of Swansea Cañon. It has been worked steadily for the past two years. The ore is cerussite. This mine has afforded some specimens of very pure white carbonate, almost as pure as could be made in the laboratory. The vein is about 2 feet thick, strikes east and west, and dips north from 75° to 80°. A tunnel follows the vein into the hill, a distance of 250 feet from the cañon. There are about 500 tons of lead-ore on the dump, that will yield from 40 to 80 ounces of silver per ton.

Chester.—This mine is situated on the west side of White Pine Mountain, in the copper-range. The vein is situated between a siliceous limestone, the hanging, and a quartzose schist, the foot-wall. It maintains the same relations to the formation for a distance of two miles. The vein, so far as developed, is about 12 feet thick. The ore is compact and of an even grade the whole thickness of the vein, and consists wholly of chalcopyrite.

Silver Plate.—This mine has been worked constantly with a small force. During the first nine months of the year 231 tons of ore have been extracted and reduced, giving a gross yield of $13,488, or nearly $58 per ton.

Noonday.—A large body of good ore has recently been struck in this mine at a depth of 96 feet from the surface.

Assessor's returns of ore worked in White Pine County for the quarter ending March 31, 1872.

Name of mine.	Quantity.		Gross yield.	Remarks.
	Tons.	*Lbs.*		
Caroline	1	733	$1,620 37	Refractory, shipped.
Eberhardt and Aurora	5,256	......	169,346 20	
Do	1,030	......	5,061 89	Tailings.
Edgar	14	1,000	249 84	
Empire	1	1,400	223 00	
O. H. Treasure	639	1,500	16,582 68	
Piermont Silver-Mining Company	550	......	11,133 03	Piermont district.
Pinto Silver-Mining Company	393	......	12,167 28	Pinto district.
Silver Plate	65	......	3,579 60	
Smith	9	1,000	972 00	
South Aurora	17	1,380	1,881 28	
Do	3,240	......	9,334 50	Tailings.
French	3	600	1,988 91	Refractory, shipped to Reno.
Truckee	12	1,600	253 75	
Total ore	6,964	1,213	234,394 33	
Total tons tailings	4,270	......		

Assessor's returns of ore worked in White Pine County for the quarter ending June 30, 1872.

Name of mine.	Quantity.		Gross yield.	Remarks.
	Tons.	*Lbs.*		
Caroline	11	500	$3,330 00	Refractory, shipped.
Eberhardt and Aurora	2,928	625	109,987 22	
Mammoth	52	......	1,058 20	
Noonday	35	1,000	741 50	
O. H. Treasure	393	......	7,187 50	
Oliver and Sullivan	15	......	2,115 75	Pinto district.
Selfrising	......	1,120	77 46	
Silver Plate	145	......	8,788 99	
South Aurora	8	500	168 30	
Total	3,588	1,745	133,464 92	

Assessor's returns of ore worked in White Pine County for the quarter ending September 30, 1872.

Name of mine.	Quantity.		Gross yield.	Remarks.
	Tons.	*Lbs.*		
Alceon	6	820	$411 00	
Banner State	15	940	676 00	
Caroline	29	1,000	2,845 00	
Eberhardt and Aurora	4,317	1,300	166,472 00	
Elk	1	1,480	132 00	
Iceberg	66	1,000	5,600 00	
O. H. Treasure	837	1,100	14,045 00	
Page	4	370	574 00	
Piermont	230		5,683 00	Piermont district.
Saint John del Rey	....	1,430	223 00	
Silver Plate	21	470	1,120 00	
Truckee	6	1,520	511 00	
Ward Beecher	2,324	1,450	63,814 00	
Total	7,862	880	262,196 00	

Assessor's returns of bullion produced in White Pine County for the quarter ending December 31, 1872.

Name of mine.	Quantity.		Gross yield.	Remarks.
	Tons.	*Lbs.*		
Antelope	1	1,076	$119 06	
Banner	1	1,831	148 14	
Columbus	6	1,137	990 62	
Eberhardt and Aurora	1,156	722	46,240 00	
Caroline	5	......	1,700 00	
Genesee	7	1,858	152 59	
Iceberg	41	1,818	2,270 13	
Iceberg, (English company)	1	1,541	81 00	
Iceberg South	52	938	1,601 87	
Mammoth	18	1,328	522 59	
Noonday	4	481	232 87	
O. H. Treasure	254	875	10,194 37	
South Aurora	29	1,096	1,447 85	
Silver Plate	60	344	1,335 02	
French	16	......	6,848 00	
Chloriders	24	254	2,240 81	
Total	1,782	1,299	76,124 92	

Schell Creek district.—This district has apparently not met with the success that its appearance a year ago warranted us to expect. The mines are extensive, and apparently contain ore of a fair average grade, but they have proved more spotted than was expected. Several purchases were made, during the winter and spring, of prominent mines, by capitalists in San Francisco and elsewhere.

The Woodburn was purchased by parties from the East, the McMahon and Great Western by parties in San Francisco. Considerable work has been done on all these mines, but, it seems, without satisfactory results, as the business development languishes. The Ruby Hill property was purchased by an English company, but little has been done on these mines, principally owing to legal squabbles in which the members of the company have seen fit to indulge among themselves. Early in the summer the Tehama Company of San Francisco purchased several mines, with other property, located about six miles south of Schellburn, and immediately commenced the erection of a 20-stamp mill, and the development of their property. But for some cause or other the affair was entirely closed about one month ago. Two small mills, the Henderson, at Ruby Hill, and the Livingstone, at Centreville, each containing five stamps, were erected during the winter and spring. The former has never dropped a stamp. The latter ran for a short time on Ruby Hill ore, rather unsatisfactorily, however, as the ore contains entirely too much antimony for raw amalgamation. In short, unfortunately there has been only one enterprise carried to a successful issue in the whole district, to wit: they have succeeded in building a good-sized town at Shellburn. But at present it has evidently no visible means of support.

Robinson district.—During the past summer this district has attracted considerable attention from mining men. This is fairly accounted for partly by the great size of many of the lodes or deposits and partly by the fact that recent explorations have proved that individual mines have improved in the quality of the ore with increasing depth of the works. Several new and quite important discoveries have been made during the last summer, both in the silver and copper bearing zones of the district, and, upon the whole, we may consider the prospects for its future prosperity as rather encouraging. There is, however, one serious drawback for a western district, though scientific skill would certainly succeed in overcoming it. The majority of the ores in the district belong to the class known among the miners as base or refractory. They contain both gold and silver in sufficient quantity to be of commercial importance, but some of them represent the most complicated associations of minerals known to the metallurgist. A large class of veins, of which the Hays is a fair type, contains gold, silver, copper, iron, lead, antimony, zinc, arsenic, and sulphur in combination. Great difficulty has hitherto been experienced in working these gold and silver ores by mill-process, so as to save a fair percentage of both the precious metals; hence it appeared to the miners that reduction by smelting was really the only process adapted to the ores, but that, too, has so far been, if not a complete, at least a partial failure. Several attempts have been made at reducing them in the ordinary shaft-furnace, but in every instance a few days' run has proved sufficient to destroy the lining. The last run was made with sandstone lining, hauled from Pancake Mountain, fifty miles distant, but with no better results than had attended the previous trials. The same sandstone is used with great success in the Eureka furnaces. It is therefore to be inferred that the correct ore-mixture has not been made for the charges. Western miners are too apt to forget, or possibly they do not know, that a siliceous lining will not do for a furnace which is to smelt basic ores, and that a basic lining will, *vice versa*, not be in place for smelting very siliceous ores.

Considerable exploratory work is being done in this district, principally by two companies, the Canton and the Hays, each of which employs about fifteen men. The first-named company owns some thirty-five locations, and one shaft-furnace of moderate dimensions. They have made two or three runs with the furnace, and have produced 33 tons of argentiferous lead, worth by assay from $250 to $800 per ton. The ores formed in the district can naturally be arranged in two classes, corresponding to their mineralogical character and their geological occurrence.

1. Argentiferous and auriferous lead ores, occurring only in metamorphic, stratified limestone, with mainly a quartzose and ferruginous gangue. Fluorspar is found associated with the ores of this formation exclusively.

2. True copper-ores, sometimes occurring in the limestones, but mainly inclosed in comparatively recent igneous rocks.

A marked peculiarity in this district is the occurrence of immense masses of iron outcrops. They are found all along the mineral-belt, but more abundantly in the vicinity of the igneous rocks, where they frequently attain a breadth of 500, or even more, and a length of several thousand feet. Some of them show on the surface only brown hematite, but the majority are associated with ores of lead and copper in variable quantities, and probably all will eventually prove to be the outcrops of plumbiferous and cupriferous lodes. The mineral-belt of the district is about eight miles in length by one and a half in width. Its longitudinal axis is about east and west, or nearly at right angles to the trend of the mountain-range. The eastern half is situated on both sides of a deep cañon, near the head of Murray Creek. The country in this vicinity is quite rugged and precipitous. Bold limestone bluffs, sometimes 100 feet in height, wall both sides of the cañon. Murray Creek is one of the largest streams found in Eastern Nevada, and, with abundant fall, is capable of furnishing motive-power for several stamp-mills or other metallurgical works. The western half of the belt occupies a valley, and is characterized by a succession of low rounded hills easy of access.

The mineral-deposits occur, as I mentioned before, in two distinct formations, a central one of granite and igneous rocks, and a surrounding one of fossiliferous, stratified limestone. The upheaval of the central granite rocks has tilted the stratified rocks outward in all directions; from the central mass, slightly on the north and west, and more steeply to the east and south. Subsequently, these granites themselves have been fractured along north and south lines, and rhyolite has here intruded, sometimes covering extensive areas, and in nearly every instance forming the smooth rounded hills of this portion of the mineral belt. The forming and filling of the cupriferous lodes in this formation was probably contemporaneous with or subsequent to the rhyolitic outflows, for we find extensive areas of the rhyolite thoroughly impregnated with minerals of copper. The surface-ores are principally malachite, the stain of which is found not in the seams only but through the whole mass of the rock, and as this is the product of decomposition of other cupriferous ores, we may reasonably infer that the deposit originally contained either sulphides or, what is perhaps more likely, grains of metallic copper. The latter opinion is strengthened by the occurrence of considerable metallic copper in the lodes found in this formation.

These copper-deposits contain too small a percentage of mineral to be of commercial importance under present circumstances. The largest of these copper-fields contains an area of not less than 160 acres, while the smaller ones contain from 1 to 10 acres. Very little work has been done on them. The Miami appears to be the most prominent at present. It was discovered early in November last. A perpendicular shaft has been sunk to a depth of 30 feet from the surface, disclosing a vertical fissure of small but gradually-increasing proportions. The thickness of the lode where discovered was only about 4 inches, but it has increased to 3 feet at the bottom of the shaft. The characteristic ore is red oxide, associated with considerable black oxide and some metallic copper. Malachite and arseniate of copper are also found. The Osborn is situated about one mile west of the Miami, and yields the same kind of ore. A shaft has been sunk to a depth of 70 feet.

In some of these lodes the copper appears to run out a few feet from the surface, a soft ash-like substance taking its place.

The Western, Kentucky, Ontario, Burnside, Gem, and Dirago are promising locations, but not prospected.

The principal portion of the lead-bearing zone is situated east of the copper-veins, although several valuable deposits have been found in the stratified rocks.

The Altman mine is situated on the south side of the cañon, three-quarters of a mile east of Mineral City, and near the extreme east end of the belt. This mine has been worked occasionally for the past three years, for the purpose of obtaining iron-ore for flux in the attempted smelting-operations. No value was attached to the property until it was discovered during the last summer that a large portion of the vein or deposit consisted of lead-ore, containing sufficient gold and silver to make mining for it remunerative. The gold is mostly free, and has been frequently panned out from the soft, friable mass in which it is found, sometimes yielding as high as 10 cents to the pan. This probably occurs only in the shape of nests or pockets. Several shafts have been sunk on the mine to depths varying from 60 to 100 feet from the surface. A tunnel has also been driven into the mountain 450 feet, tapping the ore 150 feet from the surface. These explorations have developed a deposit or vein of iron-stone over 100 feet in thickness from east to west, and 800 feet in length. The valuable argentiferous and auriferous lead-ore is found traversing the iron-stone gangue in irregular seams and deposits, varying from 1 to 30 feet in thickness. Probably one-tenth of the whole mass of the ledge will average $45 per ton.

The Hays is situated about one and a half miles west of Mineral City, and near the eastern limit of the copper-belt. It is inclosed in stratified siliceous limestone, which it crosses at nearly right angles to the plane of stratification. The vein is very irregular, its thickness ranging from 1 to 9 feet. An inclined shaft has been sunk on it to a depth of 100 feet; also, a perpendicular one 60 feet in depth. In the incline the vein is continuous. The ore is quite rich in gold and silver, the latter slightly predominating. Its average value, estimated from a number of so-called average assays, is over $150 per ton. But this is probably too high for a real average. The predominating mineral is a brown hematite, especially rich in gold, with a fair percentage of silver. But the richest portion of the ledge consists of a dark mineral, approaching very nearly to gray copper in appearance. It is the intention of this company to erect a 20-stamp mill the coming summer, for the purpose of reducing their ore by the ordinary Washoe-pan process, saving what percentage they can in the first place, but relying principally on reworking the tailings, after they have had sufficient time to oxidize, for saving a fair percentage of the gold and silver.

New district.—West of the copper-belt, and seven miles west of Mineral City, is situated the so-called New district. A considerable excitement was created here during the past summer by the discovery of a small pocket of horn-silver. But subsequent developments proved that the ledges differ in no respect, so far as the ore is concerned, from the lead-lodes in the eastern portion of the district.

Iron-stone, containing argentiferous and auriferous galena and other lead-ores, is also characteristic of this part of the district. The formation is stratified limestone.

The principal mine is the Emma. An incline has been sunk on it to a depth of 50 feet from the surface. The vein is large and fairly defined, and the ore of good grade. There are a great number of locations in all parts of the district that promise well, but I have thought it necessary to describe only representative mines of each class.

Ward district is situated about twenty miles south of Robinson, and at the eastern base of the same range. The first discovery of mineral was made in August, 1872, consequently but little work has been done. The formation is limestone, uplifted by diorite. The veins are large and well defined, and the ore is said to be rich. The gangue is gener ally quartzose, containing iron, copper, and manganese, the last in great abundance. The most noteworthy mines are the Paymaster, Atlantic Cable, Caroline, and Grampus. The first named has a shaft 40 feet deep. Samples of the ore have assayed from $50 to $300 per ton.

Pinto district.—An English company erected a splendid mill in this district, with Stetefeldt furnace, before they opened their mines, so as to assure them of a supply of ore. Subsequent explorations revealed the disagreeable fact that no mineral-deposits of any extent existed on the company's ground. Only a few thousand dollars' worth of ore was raised and worked when the company shut down their works.

Eureka district.—At the time of my visit to the neighboring Eureka district, early in September, 1872, the mines and works were idle, and there was no immediate prospect of a resumption of work.

NYE COUNTY.

Philadelphia district.—I am indebted to Mr. W. F. Leon for particulars in regard to this district, which has lately attracted the attention of San Francisco capitalists to such an extent as to induce them to make large investments in the purchase of the three principal mining-properties at Belmont.

The greater portion of the ores milled in the district during 1872 were beneficiated during the first quarter of the year ending March 31, 1872, at which time the principal mines were sold and incorporated in San Francisco, California.

1. The El Dorado South yielded, to the old owners, W. F. Leon & Co., $93,227 in bullion. Since March this mine has been developed by sinking incline shafts, running levels, and extracting some 1,500 tons of ore, valued at about $200 per ton. This has been stored in the ore-houses of the new company, and on the dumps, awaiting the completion of the new 20-stamp mill, which will be running the 1st of February, 1873. The mill has twenty 800-pound stamps, a Stetefeldt furnace, eight Stevenson pans, and four settlers, all costing about $100,000.

The vein in the mine has been continuous from the surface to a depth of 425 feet, averaging 6 feet in width. The ores are chloride and sulphurets of silver and stetefeldtite. There are slight traces of oxidized copper-ores and carbonate of lead in the ore.

At the main shaft are steam hoisting-works and pumps. The company are working eighty men, and the stock is now selling in San Francisco at the rate of $1,000,000.

The Arizona mine was consolidated, and is now a portion of the El Dorado South Consolidated Mining Company's ground. It has been developed by 2,000 feet of levels and tunnels, exposing a lode averaging 3 feet, which contains some of the richest horn-silver ever found in the district. About 600 tons out in the dump are awaiting the completion of the company's mill. The yield of this mine, for the first quarter of 1872, was $43,860.

2. The Monitor mine, now also the property of a San Francisco company, has been developing by running levels and sinking shafts. It contains a fine vein 4 feet wide. The new 20-stamp mill of the company is now running on ore yielding about $150 per ton. The yield of the first quarter was $74,300.

3. The Belmont Mining Company owns the High Bridge South and the Transylvania Nos. 1 and 2, and is also incorporated in San Francisco. They have been making some very extensive developments during the

year, and have large quantities of ore in their dump awaiting an opportunity to get it reduced.

4. The Combination Company's mines have been partially worked, having been under lease. They produced several hundred tons of ore. The first quarter's yield was $55,000.

5. Washington Heights Mining Company, incorporated in San Francisco, is considered the best undeveloped mine in the district. It is now being vigorously worked.

The town of Belmont has increased largely in population and enterprise, and the district is generally conceded to be only second to Virginia City and Pioche.

A large number of claims that have been lying idle for years are now being prospected.

Morey district.—This district, located sixty-five miles south of Eureka, and upon the eastern slope of the same range of mountains, has been mentioned in former reports. The silver-bearing veins, eighteen in number, are within a belt of 3,000 feet in width. They all stand perpendicularly, cropping out at intervals from the ravine up to and over the summit of the mountain, a distance of two miles. The veins vary from 4 to 5 feet in width, and show remarkably regular and well-defined walls. The country-rock is granite. As there has been no mill nearer than Austin, by present road one hundred and five miles distant, the developments have been confined mostly to two mines.

In the Cedar there are three tunnels, the lowest starting from the ravine, the others 80 feet in perpendicular height apart. The lowest one is in 410 feet, the next 225 feet, the third 400 feet. The pay-streak varies from 6 to 18 inches. The entire ore averaged the last year $353.53 per ton.

Upon the Magnolia lode there is a tunnel of 600 feet, one shaft of 75 feet and one of 125 feet, with a level from the last starting 70 feet from surface, and now in 175 feet. The pay-streak varies from 18 inches to 3 feet, and will average $200 per ton; but in places the ore will work from $600 to $1,000 per ton. It resembles the Lander Hill ores, except that there is less quartz and more antimony.

The American Eagle has one incline of 90 feet and another of 60 feet; also three levels, each 60 feet in length. The pay-streak varies from 6 to 20 inches, and works, including second class, $168.50 per ton.

The Mount Airy has a shaft of 75 feet upon a vein of three feet, the pay-ore occupying the entire span between the walls. The ore worked but $62 per ton.

Upon the Little Giant a shaft has been sunk 20 feet, and an open cut of the same depth and length has been made. The ore and vein are similar to that of the Cedar.

Upon the Monetary a shaft has been sunk 20 feet, the vein containing for the entire distance two feet of pay-ore, which will work $125 per ton. There is a 10-stamp mill in process of erection, which will be ready for operations in May, 1873. There will be a White's furnace in connection with it. About 375 tons of ore are out on the dumps, and a large amount of ground is open and ready for stoping. There are but few men mining at present, but the force will soon be increased sufficiently to keep the mill supplied with ore.

The foregoing data have been kindly furnished by Mr. David S. Ogden, superintendent of the Morey Mining Company.

Twin River district.[1]—This district acquired at one time considerable reputation on account of the great richness of the ore-chimney found in the Murphy mine. Since, however, the New York company, owning this mine, went foolishly into bankruptcy, the whole district has bee lying idle. During the last year, however, a new company has bee organized in San Francisco to take up the explorations in the Murph and the McDonald, a contiguous claim. The Murphy and McDonal claims are together 4,000 feet in length, and were located in 1866, an developed in 1867 and 1868. The former owners sank a shaft 240 fee and opened three levels, which were driven 300 to 400 feet. The min produced during 1867 and 1868 $750,000 in bullion, the average work ing of the ore being $117.30 per ton. The company had a fine 20-stam mill, which has been completely renovated, new pans being provided with roasting-furnaces. Its capacity is 600 to 700 tons per month. In cluded in the present purchase was a fine assortment of cord-wood charcoal, and other milling supplies, valed at $40,000. There are als fine hoisting and pumping works, the former company disbursing for al of the above improvements $250,000. The present prospecting of th mine, under Mr. P. S. Buckminster, the efficient superintendent, ha been successful to a degree to amply repay the owners for money ex pended. The second level south, and the fourth level both north an south, have been extended, cutting ore in each case of considerable ex tent and high in quality, and the sinking of the shaft has been resumed showing already indications of ore. The vein is large and well defined varying in width from 8 or 10 to over 20 or even 30 feet; the ore is rich occurring in seams from 6 inches to 8 feet wide, and assaying from $10 to $300 per ton, picked specimens being of much greater value. Th present company is incorporated under the name of the Murphy Minin Company; capital stock $3,000,000, divided into 60,000 shares of th par value of $50 each.

Troy district.—Mr. H. Newton has done some work here during th year for an English company on the Eagle and Troy locations. He ha also built a fine 20-stamp mill containing a Stetefeldt furnace. Towar the end of the year it was, however, reported that all operations ha been suspended. I am not informed as to the reasons for the abandon ment of the enterprise. The district is represented as being well situ ated in regard to grass, water, and timber.

ESMERALDA COUNTY.

Very little productive work in the way of gold and silver mining ha been done in this county during the year. Only in Columbus, Monte zuma, Lida Valley, and Gold Mountain districts some little activity ha been maintained, as far as I can ascertain. In Columbus district ar situated probably the most important borax fields now known. Mr. H R. Whitehill, State mineralogist of Nevada, says in his report for 187 and 1872 in regard to them:

Columbus, Fish Lake, and Teal's Marshes alone contain 20,000 acres of borax land which will yield an unlimited supply for an indefinite period. Besides the richer por tions of the borax fields, there are many thousand acres on which it is found, but no sufficiently concentrated to be profitable, except in the very driest and warmest sea sons. Columbus Valley, in which is located the richest deposit, is surrounded on al sides by semicircular ranges of mountains, having openings to the north and south It is about ten miles in diameter and entirely destitute of vegetation, being covere for the most part with a light incrustation of salt, though near the borders of th valley along the slopes of the surrounding hills there are wide stretches of driftin sands, which in many places form large mounds. Water is usually found at a dept of about 12 feet. At the north end of the valley, which is the lowest, it comes t within 2 or 3 feet of the surface. Near the foot-hills to the west side of the valley it i found free enough from the salts to be good for drinking purposes.

The borate of lime (ulexite) is found in small quantities in all parts of the valley But the principal deposit is near its northern extremity, where the wash of the whol valley and surrounding hills is collected. It forms here a large bed, which is covere with a coating of salt. This accumulation varies in thickness with the moisture of the ground, growing in warm, dry weather, and shrinking again in wet, cold weather. The whole surface is elevated several inches in the early part of the summer, and keeps on increasing until the first rains. It rises and falls somewhat in the manner of a great pan of dough. Every time, however, that this increase and diminution takes place, there is left an additional quantity of the solid material. Four years ago, where now the bed is nearly 2 feet in thickness, out of holes dug in the marsh were taken small balls of this substance no larger than birds' eggs. These have grown until they vary in size from the bulk of a potato to that of the solid bed 2 feet thick. There is a stratum of salt underlying the borate bed a few inches in thickness, and beneath this a bed of sulphate of soda, (glauber salts.) Beneath this beds of clay and sand alternate to an unknown depth. A well has been sunk 28 feet through this sedimentary formation without finding anything harder. The borate of soda is also found on this marsh. Messrs. Eaton & Smith, of Columbus, have probably the best location. Several other companies also have borax lands on the same marsh, only two of which, however, are engaged in its manufacture.

The process of refining here is very similar to that of the American Company in Churchill County; but, as the material is much purer, a greater quantity is produced at much less expense. Mr. Hearne, with six tanks, each holding two thousand gallons, crystallizes one ton of borax daily. The Pacific Company have thirty tanks in use refining. This company has been engaged heretofore in concentrating the crude material and shipping it to San Francisco. The companies at work here use only the borate of soda, as it contains the chief elements in the composition of borax. When the borate of lime can be found pure, or nearly so, it is more profitable to ship and manufacture it near market, a large proportion of the carbonate of soda and water being used in the process of crystallization, and these materials can be obtained nearer the railroad. Materials obtained here contain about 31 per cent. of borax. The cost of manufacturing is about $40 per ton; the price of freight to the railroad is $80 per ton.

Rhode's borax field lies fourteen miles northwest of Columbus. There are several hundred acres of borax lands here. Native borax, in large white monoclinic crystals, is found in the mud near the surface, from six inches to a foot in depth. Other borates are also found here. The marsh is very soft and muddy, the waters coming close to the surface, and in wet weather covering it. There are also here about 1,000 acres of salt lands, from which the mills at Belmont and Columbus are supplied. The following analysis of the borate of lime was made by Professor Price, of San Francisco, from samples taken from fourteen tons of the material obtained at Columbus:

Sesquioxide of iron and alumina	2.25
Chloride of sodium and potassium	6.25
Sulphate of soda	2.70
Lime	11.10
Boracic acid	36.24
Water	29.35
Insoluble residue	12.15
Total	100.04

Lida Valley and *Gold Mountain districts* have, probably owing to their isolated location, not made as much progress during the year as was expected. From some of the mines in the former district small lots of ore have been worked in the Deep Springs mill, the pulp-assays of which are herewith given:

Names of lodes.	Value per ton.
Simon Pure	$1,303 00
Sewana	1,171 00
Mountain View	1,016 00
Bennett	1,012 00
Oro Fino	896 00
Lida Bella	724 00
Frenchman	425 00
Martin & Henry	386 00
Monitor	330 00
Rappahannock	265 00

Brown's Hope, owned by the Deep Springs Mill Company, is reported to have produced ore that worked much higher than any of the ledges named.

In Gold Mountain district, twenty miles north of Lida Valley, there are many fine ledges, about one hundred locations being on record. The developments made on some thirty-five ledges are from 10 to 75 feet in depth. In many of the lodes gold predominates. Though this district is much the senior of Lida Valley, very little has been done in it, save on the State Line ledge, until since the organization of Lida Valley. Bordering on the undisputed domain of the "noble red man," its attractions have not hitherto been appreciated. There are at present about twenty miners in the district, all buoyant with confidence in soon realizing handsome compensation for their labor.

LINCOLN COUNTY.

Ely district.—This district, popularly known as the Pioche, but legally denominated the Ely district, is at present, next to the Comstock, the most important on the Pacific slope. This statement is justified by the figures of the bullion-production, from which it appears that during the twelve months ending August 1, 1872, the district shipped in fine silver bullion, $5,151,234; in base bullion, (100 fine in silver,) $127,173; and in gold $42,600; total, $5,321,007. I visited this district late in August, 1872.

The large production had been obtained almost entirely from two veins (or one vein with a spur that joins it) and by two companies, the Meadow Valley and the Raymond and Ely. At that time it was a single enormous and extraordinarily rich body of ore, in one of the mines of the latter company, which maintained the reputation of the district. Outside of the veins upon which these two companies are located, the numerous incorporated and unincorporated enterprises of Pioche were of various degrees of merit and probable success. Many of them were encouraged by the circumstance that the country-rock outside of the main ore-veins already known, abounds in seams, pockets, and small bodies of ore, which yield rich mineral, and, in some cases, repay the cost of exploration.

Wildcat claims were, of course, innumerable, as they always are in the neighborhood of really good mines. The miners of this coast should know by stern experience that "extensions" seldom prove profitable, when they adjoin claims containing rich bodies of ore. Of course, while the limits of a bonanza are uncertain, it is always worth while to explore adjacent ground; but the owner of the ground just beyond the bonanza is frequently all the worse off by reason of the good fortune of his next neighbor. The reason is simple enough; the concentration of rich ore in large bodies is likely to leave barren spaces and zones in the ore-bearing channel or vein of equal or greater dimensions. Moreover, every vein has two ends, and the location of extensions without discoveries is a method of "going it blind," with decidedly unfavorable chances, for one is doubly ignorant, first, as to where the vein goes, and secondly, as to whether it goes anywhere at all. I believe "practical" miners know these facts quite as well as "scientific" ones; but there is this notable difference between them, that the former always regard the enterprises in which they are for the time being engaged as exceptions to all the rules of experience, while the latter are less subject to believe in "anomalies." But it is only when such undertakings are bolstered up by misrepresentation, exaggeration, wild "practical" theorizings, and the like; when they are made the media of stock-jobbing, or the leaky receptacles of "foreign capital," that they pass from the realm of legitimate adventure into that of deceit and folly.

Combined with them in many cases were the blackmailing and piratical claims. The recent Federal mining law, providing that claimants shall not hold possessory titles without working, has produced, for the present, a medicinal aggravation of the disease it is calculated ultimately to cure. Thousands of ancient "claims," which were slumbering peacefully, have been revived suddenly, because, if they do not speak this year, they must forever after hold their peace. Pioche, like so many districts in Utah, is cursed with old locations to a dreadful extent; for it was unlucky enough to lie in the track of Connor's California volunteers of 1864, who spent their leisure time, when they were not killing Indians, in locating mines. Development they effected little or none; but there are few good mines in the region over which they campaigned which they are not ready to identify as the very places where they camped, made a fire, noticed lead or silver sweating out of the hearth, "located" the ledge, and entered the record in a book, which (if anybody doubts the story) is still to be seen. All these soldier-districts have since been re-explored, re-organized, and covered with successive crops of new claims; and the result is universal unsoundness of mining-titles. I do not think a United States patent was held, at the time of my visit, by any mine in Pioche; and I am sure there is not a mining company there concerning which I have not been wisely assured by some knowing outsider, that, "in reality, sir, they don't own a foot of their ground."

Out of all this confusion, two classes of persons reap a rich harvest, lawyers and "roughs." The former are paid to maintain the titles, and the latter to hold the ground. Pioche has been a bloody camp; but it is to be hoped that the days of violence are passing away. The lawyers, however, still have a strong hold, and the complexity of suits and cross-suits is such as no stranger can hope to unravel or comprehend. I notice that the Meadow Valley Company's report for the year ending July 31, 1872, contains an item of about $37,000 law expenses, more than balanced, however, by receipts of nearly $54,000 "in settlement of adverse claims;" while the Raymond and Ely, though it reports (for the year 1871) only $13,349 under the particular head of "law," returns a significant item of $108,798 for "lands, claims, and titles," a large part of which was undoubtedly expended to avoid the cost and risk of litigation.

The proportion which these two mines have furnished of the bullion-product of the district may be seen from the following statement for the year ending August 1, 1872—the period for which the total production has been given above:

Month.	Meadow Valley.	Raymond & Ely.
1871—August	$173,269 04	$119,190 10
September	150,643 98	191,826 39
October	182,335 40	207,202 71
November	156,423 30	261,692 34
December	123,016 78	167,123 07
1872—January	141,911 14	179,785 44
February	133,122 20	198,254 38
March	153,406 17	319,977 64
April	111,033 27	317,710 23
May	120,290 18	335,910 01
June	95,666 59	328,796 13
July	87,290 31	344,699 68
Total	1,628,408 36	2,972,168 12

It thus appears that these two companies have produced $4,600,576 out of $5,321,007, or nearly 87 per cent. of the total yield of the district. Their reduction-works comprise the 20-stamp mill of the first company, located at Lyonsville, in Dry Valley, and the two mills of the latter company, of 20 and 30 stamps respectively, located at Bullionville, Meadow Valley. The sudden increase of the Raymond and Ely monthly product, in March, 1872, indicates the time when the new 30-stamp mill went into operation.

The mines are situated in a range of hills running nearly east and west—contrary to the usual meridianal direction of the mountains of Nevada. The immediate country-rock is quartzite, dipping northward; but an anticlinal passes along the northern face of the mountain, above which (topographically speaking) the rocks dip south. The elevation on the two sides of the anticlinal has not been equal, and the result is that the rocks on the two sides correspond neither in character nor in position. On the north we have the quartzite, dipping in that direction; on the south, a belt of magnesian shale, lying steeply and closely across the edges of the quartzite strata, and above this shale, heavy beds of limestone, also dipping south. The principal silver-bearing vein is in the quartzite, and courses not far from the anticlinal, with a general parallelism, but dips south, from 50 to 80 degrees. It is beyond doubt a fissure. So far as it can be studied from present developments, this vein branches into two as it is followed eastward; and both these branches have been extensively and productively worked. To gain some notion of the relative position of the mines, let the reader imagine himself standing at the point of bifurcation, and looking north. Behind him rises the mountain, before and below him clusters the town of Pioche, and beyond that the wide prospect of a vast valley, bounded by mountain-ranges far away. To the right, the two divergent branches of the vein are thickly set with shafts and hoisting-works. They differ in their course about 20 degrees. To the left (west) the single vein continues, barring a break, caused by a barren cross-course of brecciated material, mischievously interjected by nature to help the lawyers. The different claims lie on the surface as follows: West of the bifurcation, the Meadow Valley Company holds 340 feet; east of the same point the same company holds 1,520 feet on the north branch, and 460 feet on the south branch, making, in all, 2,320 feet of continuous mining-ground, through the whole of which the workings of the company extend, constituting a magnificent mine.

Next to the Meadow Valley line on the west, comes the Panaca mine of the Raymond and Ely Company, covering, I believe, 600 feet, and containing the most remarkable body of high-grade ore now to be seen on this coast.

On the east, beyond the Meadow Valley line on the south branch, we have the Washington and Creole, 200 feet, and the Burke, Creole, and Vermillion mines of the Raymond and Ely Company, covering, I believe, about 1,500 feet. On the north branch, beyond the Meadow Valley line, comes the Pioche Company's ground, about 400 feet. Finally, there are on both ends, and hovering about the claims enumerated, countless "extensions" and adventures, which help to make things "lively" in the district; and high up on the hill, sometimes even in the limestone, hopeful and enterprising people are digging and boring into the bowels of things, and hoisting much rock. Among the outside mines of notoriety are the Sunbeam, Excelsior, Bowery, American Flag, Chief of the Hill, Desdemona, Hahn and Hunt, Alps, Spring Mountain, &c. Some of them are reported to be making money. I can vouch that they all make more or less noise. The following table shows the feet and shares in the principal incorporated mines of Ely mining-district:

Name of mine.	Feet in mine.	Shares per foot.	Total shares.
Alps	700	37½	30,000
American Flag	1,200	25	30,000
Bowery	1,000	30	30,000
Chapman	....	....	....
Chief of the Hill	800	25	30,000
Condor	1,200	20	24,000
Excelsior	....	....	12,000
Harper	....	....	....
Hahn and Hunt	1,000	30	30,000
Ingomar	1,000	30	30,000
Lillian Hall	1,000	15	15,000
Louise	....	....	....
Meadow Valley	24,023	....	60,000
Meadow Valley, west extension	200	30	60,000
Mocking Bird	1;000	30	30,000
Pacific Tunnel	1,200	25	30,000
Pioche	1,000	20	20,000
Pioche, west extension	....	....	....
Raymond and Ely	4,000	7½	30,000
Sterling	1,200	25	30,000
Washington and Creole	200	150	30,000

To return to the two principal mines.

The Meadow Valley was, for a while, the leading enterprise of the district; and the large amount and the favorable location of its ground will secure to it a long lease of life. But it is not denied that, for the past year, its brilliant prospects have waned into temporary eclipse. That is to say, the reserves of the rich ore have been reduced without the development by explorations of equivalent resources for the future, The superintendent reported, August 10, 4,500 tons of first-class ore in the developed sections of the mine, of the gross value of $360,000—about three months' work at the usual rate for the mill. At the time of my visit, however, the mine had assumed a more promising appearance at several points, and particularly in the bottom, at a depth on the vein of 750 feet—the deepest point yet attained in Pioche—where a body of rich ore of unknown size had been penetrated for a few feet. It is a curious illustration of the sensitiveness of the San Francisco stock-market, that the discovery of this body, before anything had been learned as to its size and value, being reported secretly by spies to parties in that city, caused a rise in the stock which represented an increase in the valuation of the mine of nearly a million dollars.

The Raymond and Ely is now the leading mine of Pioche. The older claims of this company, on the south branch, viz, the Creole, Burke, and Vermillion, have had their day. It was not an extraordinarily brilliant day, at the best; and whether it will ever dawn again is uncertain. Of course there are possibilities "in depth;" but at present no ore is extracted from them. It is the Panaca mine, away west of the bifurcation, and separated from the other property of the company by the intervening ground of the Meadow Valley and the Washington and Creole, which now forms the basis of the almost unexampled prosperity of the company. The vein does not here come to the surface at all. The Lightner shaft, sunk vertically, and almost at random through the magnesian shale, crossed the anticlinal, and entering the quartzite, struck immediately the upper edge of the vein, and developed a body of rich ore, which has produced already some $2,000,000, shows as much more in the reserves now standing, and gives as yet no sign of approaching termination in depth. The length of the body in the fifth level (vertical depth 423 feet) is upwards of 550 feet; its height thus far developed is 335 feet; and its thickness varies from one to four feet of first-class ore, assaying on the average, say $150. The mills, treating 90 tons daily, produce from $11,000 to $13,000 every twenty-four hours. The ore contains chloride of silver, with carbonates of lead and various of the true silver-ores. The Meadow Valley ore has been similar, but baser and poorer.

What reflects most credit on the management of the Raymond and Ely is, however, not the richness of the mine, for that is sheer luck, but the fact that, *in spite of its richness*, it is worked with care, economy, and skill. We are accustomed to see mines in bonanza butchered, and their proceeds squandered. There is no doubt that the Raymond and Ely, instead of paying regularly $210,000 monthly in dividends, could have been so pushed as to pay for a while a much larger amount, and the stock could have been driven up from $170 (representing $5,100,000 for the whole,) to above $200 per share. But the normal rate of extraction for a mine is determined by the rate at which shafts can be sunk and new levels opened in depth, not by the ease with which existing stopes can be stripped; and this principle had here been borne in mind. The result was great steadiness in the value of the stock, and confidence on the part of the stockholders, whose interests are not made the foot-balls of the street.

Fine-bullion product of the Ely district, Nevada, for 1872.

Date.	Amount.	Date.	Amount.
January	$278,206 92	July	$522,785 84
February	314,054 29	August	427,241 54
March	502,954 74	September	450,865 42
April	421,920 16	October	454,557 05
May	508,276 61	November	508,086 19
June	467 431 52	December	420,343 89
Total amount of fine bullion			5,276,724 17

Amount of fine bullion produced by the Meadow Valley Mining Company for 1872	$1,180,447 81
Amount of base bullion	123,068 09
Total yield for the Meadow Valley Mining Company	1,303,515 90

Gross amount of fine bullion	$5,276,724 17
Gross amount of Meadow Valley Mining Company's base bullion	123,068 09
Total yield of bullion for 1872	5,399,792 26

Dividends paid during the year ending December 31, 1872.

Date.	Raymond & Ely Company.	Meadow Valley Company.	Pioche Company.	Grand total.
January	$90,000,00	....	....	....
February	....	....	....	....
March	150,000 00	$90,000 00	....	....
April	210,000 00	90,000 00	....	....
May	210,000 00	60,000 00	....	....
June	210,000 00	60,000 00	....	....
July	210,000 00	....	$20,000 00	....
August	210,000 00	....	20,000 00	....
September	210,000 00	....	....	....
October	210,000 00	....	....	....
November	210,000 00	....	....	....
December	150,000 00	60,000 00	....	....
Total	2,070,000 00	360,000 00	40,000 00	$2,470,000 00

The following statements are taken from the secretary's report of the Meadow Valley Company for the fiscal year ending July 31, 1872:

Cost of production of bullion, and profits realized.

MINING-DEPARTMENT.			
Exploration and dead work		$130,472 54	
Labor in extracting ores		222,425 17	
Mining-supplies		109,873 88	
Freight from San Francisco on supplies		9,629 87	
Contingent mine-expenses		4,833 16	
Salaries		16,516 62	
Total expenditures in mining-department		493,751 24	
Deduct amount of inventory of supplies on hand at date		19,041 11	
			$474,710 13
MILLING-DEPARTMENT.			
Ore-transportation from mine to mill, (ten miles)		81,595 56	
Chemicals, quicksilver, and other supplies		238,158 27	
Freight from San Francisco on supplies		41,548 09	
Labor in reduction of ores		67,419 95	
Contingent milling-expenses		2,668 00	
Assay-office expenses		9,916 10	
Total expenditures of milling-department		441,305 97	
Deduct amount of inventory supplies on hand at date	$76,090 52		
In transitu	3,409 31		
		79,499 83	
			361,806 14
MISCELLANEOUS.			
Freight on base bullion to San Francisco		3,016 52	
Discount on bullion-yield for current year		45,516 68	
State of Nevada taxes on bullion, $24,267 79; mill, $1,935		26,202 79	
Exchange		1,578 32	
Insurance premiums on mill-property		2,385 62	
Telegrams		2,325 96	
San Francisco incidentals		6,709 77	
San Francisco salaries and trustees' fees		8,825 04	
			96,560 70
Total expenses			933,076 97
Net profits for the year			710,012 62
			1,643,089 59

Receipts from bullion and other sources.

By bullion proceeds of company's reduction-works at Lyonsville, as per tabular statements of general superintendent for the fiscal year ending this date		$1,628,408 36
By rents of boarding-houses for workmen	$1,000 00	
By sales of materials—		
Mine-supplies	3,013 73	
Mill-supplies	8,326 95	
By interest	91 47	
By foundery-account—		
Net sales of castings	2,249 08	
		14,681 23
		1,643,089 59

The following is a summary of the fiscal transactions of the same company for the full corporate term ending July 31, 1872:

Permanent investments, dividends, and current resources.

PERMANENT INVESTMENTS.

In mine-properties—			
For the fiscal term 1869–'71	$289,588 17		
For the fiscal year 1871–'72	37,402 56		
		$326,960 73	
In construction of mining-works—			
For the fiscal term 1869–'71	44,808 53		
For the fiscal year 1871–'72	21,657 07		
		66,460 60	
In construction of reduction-works—			
For the fiscal term 1869–'71	214,066 32		
For the fiscal year 1871–'72	30,422 45		
		244,488 77	
Total permanent investment			$637,910 10

DIVIDENDS.

Paid to stockholders, for the fiscal term 1869–'71	330,000 00	
Paid to stockholders, for the fiscal year 1871–'72	690,000 00	
		1,020,000 00
Total		1,657,910 10

CURRENT RESOURCES.

Inventory of supplies at mine	19,041 11	
Inventory of supplies at mill	79,499 83	
H. H. Day, general superintendent	2,408 63	
Bullion in transitu	38,342 76	
Cash	71,980 73	
		211,273 06
		1,869,183 16

Assessments, bullion product, net profits, adverse claims, and current liabilities.

Assessments, for the fiscal term 1869–'71			$210,000 00
Bullion product—			
For the fiscal term 1869–'71	$1,671,465 66		
For the fiscal year 1871–'72	1,628,408 36		
Total gross yield		$3,299,874 02	

Bullion cost-sheets—				
For the fiscal term 1869–'71		$862, 011 22		
For the fiscal year 1871–'72		933, 076 97		
Total cost-sheets		1, 795, 088 19		
Deduct rentals and sales of supplies—				
For the fiscal term 1869–'71	$4, 213 94			
For the fiscal year 1871–'72	14, 681 23			
		18, 895 17		
			$1, 776, 193 02	
Total net profits on yield—				
For the fiscal term 1869–'71		813, 668 38		
For the fiscal year 1871–'72		710, 012 62		
				$1, 523, 681 00
Adverse claims—				
Received in settlement thereof				53, 811 24

CURRENT LIABILITIES.

Superintendent's drafts unpresented	81, 690 92
	1, 869, 183 16

The following is an abstract of the superintendent's report of the Raymond and Ely Company for the fiscal year ending December 31, 1872:

The ores worked at the mills during the year have yielded over 75 per cent. of the pulp assay. The two mills, 20 and 30 stamps, are in good condition, and the completion of the railroad between Pioche and Bullionville will greatly reduce the cost of transportation. The Lightner shaft in the mine is now down 623 feet—seventh level—and they are still sinking it. In this shaft above the seventh level there are 24,000 tons of ore, assaying $125 per ton; and there are 4,000 tons of the same average value in the Creole mine, with over 12,000 tons of third-class ore on the dumps. The summary of operations for the year is as follows:

	Tons.
Ore on hand at beginning of year	1, 707
Ore extracted during the year	39, 369
Total	41, 067
Ore shipped to mills	28, 874
Ore reduced at mills	28, 626
Ore on hand at mills	600
Ore on hand at the dumps	12, 193

In the secretary's report are some very interesting items. The mine has only been in operation about two years, and since March, 1871, it has paid as dividends to stockholders the sum of $2,685,000, including the December dividend. The dividends in 1871 averaged $20.50 per share, and $69 in 1872; and were at the rate of 55 per cent. of the gross receipts in 1872, against 46 per cent. in 1871. The bullion-production in 1871 was $1,361,590, against $3,693,936 in 1872. The total dividends have been as follows:

	1871.	1872.
January	......	$90, 000
February	......	......
March	$30, 000	150, 000
April	30, 000	210, 000
May		210, 000
June	30, 000	210, 000
July	30, 000	210, 000
August	30, 000	210, 000
September	45, 000	210, 000
October	120, 000	210, 000
November	150, 000	210, 000
December	150, 000	150, 000
Totals	615, 000	2, 070, 000

RECEIPTS.

From bullion	$3,698,936
Superintendent's drafts not presented	18,005
Miscellaneous	7,473
Total receipts	3,784,414
Cash, per previous report	64,681
Total	3,784,095

DISBURSEMENTS.

Lands, claims, and titles	$49,781
Law-expenses	48,385
For mining	568,700
For milling	411,443
Hauling ore to mills	152,944
Mine-improvements	3,890
Mill-improvements	14,110
Completion of mill	26,650
Taxes	80,434
Dividends	2,070,000
Discount on bullion	55,569
Advanced to Nevada Central Railroad	100,000
Insurance on mills	7,322
Office-salaries	7,200
Miscellaneous	8,568
Outstanding drafts paid	30,521
Total disbursements	3,635,517
Cash on hand	148,578
Total	3,784,095

Following is a statement of the assets and liabilities of the company:

ASSETS.

Improvements at mines	$34,525
Stores at mines	12,954
Ores on dumps	640,146
Mills, &c	198,109
Stores at mills	100,517
Ores at mills	33,600
Tailings at mills	670,960
Advanced to railroad	100,000
Advanced to telegraph	836
Office-furniture	1,344
Cash on hand	148,578
Total	1,941,571

The only liabilities consist of the superintendent's drafts advised, but not presented, amounting to $18,005.

Treatment of ores.—I am indebted to Mr. G. F. Williams, of the Meadow Valley Company's mill, for the following highly-interesting account of the mill-process employed in this district:

The ore of the Pioche mines contains gold, silver, and lead. Small quantities of ore from the Meadow Valley mine have assayed as high as $7,384 per ton in gold. The value of the ore per ton, in silver, varies very much. The average ore sent to the mills gives a pulp-assay of from $100 to $200 per ton. The silver is partly in the form of chloride (from 40 per cent. to 85 per cent.) and partly in the form of sulphide. The percentage of lead varies from 5 per cent. to 60 per cent. As the processes of milling Pioche ores differ somewhat, they are separately given in the following:

The Meadow Valley Mining Company's mill, situated in Dry Valley, ten miles distant from Pioche, is a 30-stamp mill, dry crusher. The battery and pans are driven by separate engines. The speed of the battery is from 95 to 98 blows per minute. With this speed the company is able to crush from 75 to 90 tons every twenty-four hours. The weight of the stamps is 750 pounds each; the ore is crushed through a No. 6 screen, the holes being one-fortieth of an inch in diameter. There are fourteen "Horn" pans of a capacity of 1½ tons per charge. As soon as a pan is charged with pulp, from 8 to 10 pounds of bluestone, (sulphate of copper) and 25 pounds of common salt are added. The charge is then ground from four to five hours. At the expiration of this time, the muller is raised, and from 300 to 500 pounds of quicksilver (according to the richness of the ore) are added, and the amalgamation is continued for three or four hours. The object of raising the muller is to prevent the grinding of the base amalgam and the consequent loss of quicksilver. The time of working the charge is from seven to eight hours. The bullion from the amalgam, as it comes from the pans, is from .300 to .400 fine. This fineness is raised by a very simple and cheap method of refining, viz, the quicksilver and amalgam, when drawn from the settlers, are poured into strainers suspended in water, which is heated by steam. The lead-amalgam and a small portion of the silver-amalgam pass through the strainer, leaving the silver and copper amalgam behind. The hot quicksilver containing the lead is drawn off into a tank and cooled with water. When cold, it is again strained, and base amalgam is the result. By this refining process, bullion from .500 to .700 fine, and base bullion from .070 to .150 fine, is obtained. The finer bullion is sent to England, and the base bullion to San Francisco. The average percentage extracted is about .75, though it has been as high as .89½. In Bullionville, twelve miles from Pioche, there are five mills, aggregating 85 stamps.

The Raymond and Ely Company has two mills; one is a 20-stamp wet crusher, and the other is a 30-stamp dry crusher. The process of amalgamating at these mills is as follows: When the pans are charged with pulp, about three pounds of sulphate of copper and thirty pounds of salt are added. The muller is kept continually raised, so that *no grinding* takes place in the pans. The result of not grinding is, that finer bullion is produced. The time of working the charge is eight hours. The bullion is from .900 to .950 fine. It is claimed that from 75 per cent. to 80 per cent. of the silver is extracted. It is the intention of this company to change the dry crusher to a wet crusher, the percentage obtained being equally high from wet as from dry crushing, while much more ore can be worked in the same time by crushing wet. W. H. Raymond owns two mills, one a 10-stamp and the other a 5-stamp mill. These mills are kept constantly running, partly on ore from his own mines and partly on custom-ore. The process of working is the same as at the Raymond and Ely mills. The American-Flag mill is a 20-stamp mill. It was changed from a wet to a dry crusher, and a Stetefeldt furnace erected in connection with it. At this mill, chloridizing roasting was attempted, but the amount of sulphurets necessary to decompose the salt were not present in the ore. In order to remedy this difficulty, sulphur from the mines of Utah was mixed with the ore. With what success this experiment was attended I do not know; suffice it to say, the Stetefeldt furnace has not been in use for many months. During the past summer the Condor Company built a roller mill. It is a mill without stamps. The ore is first put through a rock-breaker, then passes between two rollers, and is crushed to about the size of hazelnuts. In this state it goes into the pans, where, in the course of two or three hours, it is ground very fine. The pan used is the Hepburn roller pan. The result of this process was very base bullion, and a very low percentage extracted. The mill is now idle, awaiting the arrival of stamps.

The slimes from the Pioche ores are poorer in silver but richer in gold than the ore itself. The percentage of gold amalgamated is only about .40 in a wet-crushing mill. This is due to the loss of gold, which floats off in the water and settles with the slimes. Mr. Williams experimented considerably on tailings, which have been in the pit for about a year. He found that by the present process he could extract about 66 per cent. of the silver from them. The bullion, however, is baser than that which was first extracted from the ore. There are, also, experiments on the Meadow Valley ore in contemplation, to ascertain the percentage which can be obtained by *not grinding* in the pans.

It is, however, probable that a thorough grinding of the pulp, from wet crushing, will give the best percentage, and that the fine bullion and fair percentage obtained by the Raymond and Ely Company are due to the nature of their ore. The result of chlorination tests, made by Mr. Williams several months since on Raymond & Ely ore, gave 85 per cent. of the silver in the form of chloride.

Some little work has been done during the summer in *Timber Mountain* and *Chief districts*. The former lies north of Yellow Pine district. The Little Johnnie, a galena mine, was prospected by the Elgin Company, which has also resumed operations with sixteen men in *El Dorado Cañon district*, where, it is reported, they intend to erect a new mill. *Chief district* is situated twelve miles south of Pioche, and three miles west of Meadow Valley. Work has been commenced on the Black Hawk ledge by Messrs. Raymond & Co. The ore extracted is estimated to be worth $100 per ton.

BORAX, SODA, AND SALT DEPOSITS.

The following is extracted from a letter sent from "Sink O'Carson," Churchill County, Nevada, prepared by H. Degroot, and published in the San Francisco Evening Bulletin, April 24, 1872:

Borax.—There are in this vicinity several extensive beds of borax, the principal one being near Sand Springs, about fifty miles east of Wadsworth. There are at this point over a thousand acres covered with the borates of lime and soda; and although the deposits are not so heavy here as at Fish Lake and Columbus, they are, nevertheless, very ample, and can be gathered at little cost. Works having capacity to manufacture nearly one ton of marketable borax per day have lately been put up on the ground, and are being run with success and profit. On an alkali flat, twenty miles southwest of the above locality, the borates also occur in considerable quantities, as well as near the Hot Springs, nineteen miles northeast of Wadsworth. This crude material, being so abundant and lying so convenient to the railroad, will yet become a source of much wealth to this region of country.

Soda and salt.—These also occur in incredible quantities and very pure form in this part of Nevada. Situate near Sand Springs is a salt-bed covering several hundred acres; and in Great Salt Valley, fifty miles north of that place, another of much larger dimensions. From the former the Washoe mills obtained their supplies of salt for a number of years. Now, however, they procure this article in part from San Francisco, and in part from a bed lying sixteen miles northeast of Wadsworth and close to the railroad.

Two miles northeast of Ragtown exists a remarkable deposit of the carbonate of soda. It lies in the midst of a dismal sage heath, in a circular valley, about one-third of a mile in circumference, its bottom depressed 50 feet below the surface of the surrounding plain. In ordinary seasons this basin remains dry, though covered sometimes with a foot or two of water. The bottom is a solid mass of the carbonate of soda, hard, white, and sufficiently pure to answer most of the purposes for which this article is usually employed. This soda occurs in strata about a foot thick, separated from each other by seams of clay half an inch thick. The deposit is worked after the manner of an open quarry, the soda being broken out in blocks and piled up on the inner side of the basin, where several hundred tons of it lie corded up. This substance has been excavated to a depth of about 30 feet without any signs of approaching the bottom. The owner of this deposit having supplied the millmen of Washoe and the soap-makers of Reno with soda, will hereafter ship the article to San Francisco, where it can be delivered at a cost of not more than $20 per ton, all expenses included.

A few hundred yards to the northeast of this soda-quarry is a lake, about one and a half miles in circumference, the water of which is supersaturated with salts of various kinds, a large proportion being borax. This lake, which occupies an oval basin, lies 150 feet below the level of the plain, the banks shelving down with as much symmetry as if shaped by artificial means. The water of this lake is impregnated with soluble substances, mostly borax, soda, and salt, to a degree that renders it fairly slimy, and so dense that a person can float on it without effort. Bathing, however, is attended with unpleasant consequences, the water causing a smarting of the flesh if one remains in it for more than a few moments. This lake has no visible outlet or inlet, but, being of great depth, is probably fed by deep seated springs.

A few years ago a scheme for the production of borax was attempted here by some San Francisco parties, the plan being to pump up this water and carry it in troughs out upon an alkali flat, lying a quarter of a mile away, there to be evaporated, when it was supposed this valuable salt would be left in the form of a deposit behind. The enterprise failed of success, partly because it was inherently defective, but chiefly because extensive beds of the borates were soon after discovered in the country adjacent. The buildings erected for housing the machinery and workmen still stand on the shore of the lake, solitary and tenantless, adding, if possible, to the lonely and desolate appearance of the place.

Eagle Salt-Works, Humboldt County.—These works* are situated in an oblong basin surrounded by basaltic hills, nearly equally distant from the Humboldt and Carson sinks, and Pyramid Lake, being about twenty miles from each. It receives the drainage of about three hundred square miles. The basin was formerly known as the Truckee Desert. Its general direction is northeast and southwest, and its flat or central portion is about one mile and a half wide by twelve miles long, and entirely destitute of vegetable life. The Central Pacific Railroad skirts the northwestern side, about one mile from the salt-vats.

The salt-deposit is similar in character to those which are so widely distributed through the desert portion of the Inland Basin. It was discovered in March, 1870, by Mr. Lute, during a trip of more than two thousand miles, undertaken with a view of exploring for salt, in the course of which he calculates that he visited at least a million acres of salt-lands. The ground was located early in the same year, (under the Nevada statute of February 24, 1865, entitled "An act to provide for the location of lands containing salt,") by twenty-two citizens, each claiming 160 acres. The basin lying in unsurveyed public lands, no Government title was obtained; indeed, there exists no special provision in the United States law for deposits of this character, unless they can be located and patented under the "placer law." Since the commencement of operations the company has been steadily engaged in developing the property, employing from ten to thirty-five men and twelve to twenty draught horses.

From July 1, 1871, to June 30, 1872, the company marketed 25,832 bushels of mining-salt, and 2,202 bushels of table and dairy salt. Mining-salt cost 21 cents per bushel, and was sold at 28 cents; table and dairy salt cost 31½ cents per bushel, and was sold at 42 cents. Operations were interfered with, during the year, by a water-spout, on the night of July 18, 1871, which flooded the works, ruining about 2½ acres of vats, and destroying an estimated quantity of 70,000 bushels of salt. Precautions have been taken to prevent similar disastrous results in future.

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*This description is taken from a manuscript of Mr. B. F. Lute, kindly put at my disposal by Mr. E. S. Davis, surveyor-general of Nevada.

Mode of manufacture.—On the portion of the lands thus far improved salt-springs are found, from 2½ to 4 feet below the natural surface, furnishing when opened a saturated brine. This is evaporated in rectangular vats or ponds, formed by removing from 2 to 4 feet of the top earth with plows and scrapers. These vats are usually laid out to contain one-fourth of an acre each, and sunk to such a depth as to gather by natural seepage about 4 inches of brine, which is then crystallized by solar evaporation.

The largest consumers are the silver-mills, for the use of which the salt is gathered with hoes, shovels, and wheelbarrows, and shipped without particular care to keep clean. For table and dairy purposes the clean crystals are taken with great care, dried, and reduced to flour in a burr-stone flouring-mill, and sent to market in convenient packages.

The following analysis, made by Mr. W. C. Bonsfield, of Virginia City, in June, 1870, shows the quality of the fine salt here manufactured:

	Per cent.
Chloride of sodium	99.38
Sulphate of soda	.13
Sulphate of magnesia, with trace of lime	.03
Water	.46
	100.00

The consumption of salt by the stamp-mills of Nevada, in the reduction of silver-ores, is not less than 10,000 tons per annum.

CHAPTER III.

IDAHO.

I have been able this year to pay more attention to the developments of this Territory than the meagerness of my means permitted me to bestow in former reports.

Besides Mr. J. M. Adams, who has again furnished me with very full statistics on the Owyhee mines, covering the time from July 1, 1871, to December 31, 1872, Mr. A. Wolters, assayer of the United States assay-office at Boise City, has been secured as a contributor to my report, and my deputy, Mr. A. Eilers, has visited and reported upon the new lead-silver mines of South Mountain district.

The bullion product of the Territory, as will be seen from the general account following, has fallen off to a large extent. The exhaustion of the placers is not the only cause of this decrease. It is partly due to the development of other mining regions by the great facilities of railroad communication, and the consequent activity of operations in those regions, which has attracted large numbers of miners from the fitful employment of gulch-mining to the more steady occupation furnished the year round by the regular industry of quartz-mining. To this must be added the effect of a very bad year at the silver-mines of the Owyhee.

The product of the Territory in 1872 is estimated as follows, on the basis of the express shipments:

Gold by express	$1,817,809
In private hands	454,452
Silver by express	423,609
Total	2,695,870

A comparison with the estimates of the reports of United States commissioners in former years will show how great has been the recent annual decline. Those reports give the following figures:

1864	$6,474,080	1869	$7,000,000
1865	6,581,440	1870	6,000,000
1866	8,023,680	1871	5,000,000
1867	6,500,000	1872	2,695,870
1868	7,000,000		

Owyhee district.—The Golden Chariot mine, as shown by the annexed statements, has been in low-grade ore for the last eighteen months. In the last two months, however, they have sorted the ore closely, and it is now paying about $36 per ton. They have straightened their shaft, (really a new one,) as the old one was going away from the vein, being about 100 feet away at the bottom. So a new shaft has been sunk, striking the vein at the ninth level. The mine is improving gradually under careful and economical management.

The low yield of the slums and tailings shows the average low grade of ore worked, and the past year has been one of assessments.

In the Poorman all the ore has been taken from old dumps and old stulls, and has paid well, as the expense was little.

In the Oro Fino, I regret to say, the ore has not held up well. There is always a good vein, but rarely much pay-ore. Much of the product came from old stulls. At present it is closed down.

The War Eagle mine is a soft vein, easily worked, and the last runs paid very well. The mine looks well to-day, but debts having been allowed to accumulate too much before assessments were levied, there was trouble with the miners, and the mine is now temporarily closed.

The Empire mine is a strong 3-foot vein of hard quartz, in places very rich. The returns have disappointed all, and there is now an assessment on it. But in the last week they have struck very rich ore, a 4-foot vein assaying $100 to $125. It was first struck 300 feet north of the shaft, on the second level; there a splice or fault was found. The ore beyond still continues rich. Meantime in the first level they have also struck the same ore, and also in the third level. The character of the ore and of the fault are alike in the three levels, and all indications are favorable for the existence of a large body of good ore. This fault is a seam, crossing the vein nearly at right angles, and running obliquely from 300 feet north of the shaft in the second level, toward a point much nearer to the shaft in the third; and, as it has been so very regular so far, it may be expected to be found still nearer to the shaft in the fourth level. For 60 feet before striking the rich ore there was a pay-vein 20 inches wide.

The South Oro Fino, bought by the Ida Elmore Company, proved a disappointment, like the main Oro Fino.

The Ida Elmore, after a long period of almost hopeless prospecting, is at last giving promise of a heavy body of ore in depth. It has just been reached on the ninth level, and it is hoped that the mine will produce more bullion in the next twelve months than is now produced by the entire camp.

The South Chariot has made little or no returns lately, but is being well opened, and lately has been developing a very promising body of ore.

The Red Jacket, after having lain idle for several years, has been reopened with very flattering prospects, and lately they have found a very rich body of ore, in places 8 feet wide. If continuous it will be the best mine of the camp. It has lately been incorporated in San Francisco.

The Minnesota has lately given indications of good ore, but it has proved so far to be only in spots, and much barren rock has been taken out to get a little pay-ore.

The Mahogany mine, after some bad management, has, for the last few months, been managed by a first-class superintendent. He has gradually worked the mine out of debt, and now it is the only mine that has money ahead to any extent. The mine is looking remarkably well throughout.

The Pauper and Morning Star are both closed down for the present, though showing very rich ore where work was stopped. They will probably start up in spring.

In Flint district the Rising Star mine is being opened very quietly but steadily, and next season probably will make a showing. The other ledges there are worked spasmodically. There is no material change in the placers, but much money has been taken out of which there is no record.

No. I.—*Statement of product of mines in Owyhee County, Idaho, from July* 1, 1871, *to January* 1, 1872.

[Reported by John M. Adams.]

Name of mine.	Worked at—	Tons of ore.	Total tons of ore.	Product.	Total product.	Yield per ton.
Golden Chariot	Owyhee Mill	3,155	4,405	$72,666	$111,487	$19 30
	Cosmos Mill	900		26,595		29 11
	Ida Elmore Mill	100		7,400		74 00
	South Chariot	250		4,826		19 30
Slums and tailings	Owyhee Mill	639	639	8,059	8,059	12 61
Poorman	do	567	567	12,043	12,043	21 24
Oro Fino	do	1,166	1,166	46,700	46,700	40 00
War Eagle	do	570	570	15,136	15,136	26 55
Empire	Cosmos Mill	80	80	9,270	9,270	116 00
Prospecting	Arrastras	200	984	16,000	56,623	80 00
	Cosmos Mill	284		25,000		116 75
	Webfoot Mill	500		15,623		31 25
South Oro Fino	Ida Elmore Mill	1,000	1,000	13,000	13,000	13 00
Ida Elmore	do	219	219	6,570	6,570	30 00
Minnesota	do	612	612	18,360	18,360	30 00
Mahogany	do	1,350	1,350	20,135	20,135	15 00
South Chariot	South Chariot Mill	250	250	10,414	10,414	41 65
Flint District	Black's Mill	68	68	10,810	10,810	159 00
Placers					56,000	
Total			11,910		394,607	

No. II.—*Statement of product of mines in Owyhee County, Idaho, from January* 1, 1872, *to December* 31, 1873.

[Reported by John M. Adams.]

Name of mine.	Worked at—	Tons of ore.	Total tons ore.	Total product.	Yield per ton.
War Eagle	Owyhee Mill	1,950	1,950	$47,863	$29 70
Oro Fino	do	2,262	2,262	39,243	17 35
Morning Star	do	41			
	Cosmos Mill	40	81	4,904	60 54
Poorman	Owyhee Mill	920	920	11,740	12 76
	do	1,924			
Empire	Cosmos Mill	250	2,280	55,394	24 30
	Ida Elmore Mill	106			
Pauper	Owyhee Mill	113	113	3,484	30 83
Slums and atilings	do	1,425	3,450	25,453	7 37
	Ida Elmore Mill	2,025			
	Owyhee Mill	100			
	Cosmos Mill	350			
Minnesota	Ida Elmore Mill	450	1,100	42,106	38 27
	South Chariot Mill	200			
	Owyhee Mill	934			
Golden Chariot	Cosmos Mill	40	1,651	34,374	20 82
	Ida Elmore Mill	677			
	Owyhee Mill	5			
Prospecting	Cosmos Mill	387	578	28,020	48 47
	Ida Elmore Mill	186			
	Cosmos Mill	196			
Mahogany	Ida Elmore Mill	638	1,834	73,100	40 00
	South Chariot Mill	1,000			
South Oro Fino	Ida Elmore Mill	1,018	1,018	14,150	13 90
Ida Elmore	do	560	560	25,915	46 27
Red Jacket	do	76	76	3,040	40 00
Flint district	Black's Mill	53	53	8,000	151 00
Placers				38,371	
Total			17,926	455,157	

No. III.—*Statement of ore worked by mills in Owyhee County, Idaho Territory, from July* 1, 1871, *to December* 31, 1871.

[Reported by John M. Adams.]

Name of mill.	Number of tons of ore.	Total tons per mill.	Mine.	Product.	Yield per ton.
Owyhee	3,155	6,097	Golden Chariot	$72,666	$23 00
	639		Slums and tailings	8,059	12 61
	567		Poorman	12,043	21 24
	1,166		Oro Fino	46,700	40 00
	570		War Eagle	15,136	26 55
Cosmos	900	1,264	Golden Chariot	26,595	29 11
	80		Empire	9,270	116 00
	284		Prospecting	25,000	116 75
Ida Elmore	1,000	3,281	South Oro Fino	13,000	13 00
	219		Ida Elmore	6,570	30 00
	612		Minnesota	18,300	30 00
	1,350		Mahogany	20,135	15 00
	100		Golden Chariot	7,400	74 00
Arrastras	200	200	Prospecting	16,000	80 00
Wobfoot	500	500	Prospecting	15,623	31 25
South Chariot*	250	500	Golden Chariot	4,826	19 30
	250	....	South Chariot†	10,414	41 65
Black's	68	68	Prospecting‡	10,810	159 00
Placers	....	11,910	....	56,000	....
Total	11,910	....	....	394,647	....

* Formerly Sinker Mill. † Formerly Peck & Porter mine. ‡ Flint district.

No. IV.—*Statement of ore worked by mills in Owyhee County, Idaho, from January* 1, 1872, *to December* 31, 1872.

[Reported by John M. Adams.]

Name of mill.	Number of tons of ore.	Total tons per mill.	Mine.	Product.	Yield per ton.
Owyhee	1,950	9,674	War Eagle	$47,863	$29 70
	2,262		Oro Fino	39,243	17 35
	41		Morning Star	2,404	58 63
	920		Poorman	11,740	12 76
	1,924		Empire	38,840	20 19
	113		Pauper	3,484	30 83
	1,425		Slums and tailings	9,841	6 90
	100		Minnesota	5,000	50 00
	934		Golden Chariot	14,800	15 84
	5		Prospecting	300	60 00
Cosmos	196	1,263	Mahogany	7,200	36 74
	350		Minnesota	10,482	30 00
	250		Empire	5,020	25 00
	40		Golden Chariot	983	24 60
	40		Morning Star	2,500	62 50
	387		Prospecting	19,350	50 00
Ida Elmore	106	5,736	Empire	11,534	109 00
	186		Prospecting	8,370	45 00
	450		Minnesota	19,124	42 22
	1,018		South Oro Fino	14,150	13 90
	2,025		Slums and tailings	15,612	7 78
	560		Ida Elmore	25,915	46 27
	638		Mahogany	34,900	54 70
	677		Golden Chariot	18,591	27 46
	76		Red Jacket	3,040	40 00
South Chariot	200	1,200	Minnesota	7,500	37 50
	1,000		Mahogany	31,000	31 00
Black's	53	53	Flint district	8,000	151 00
Placers	....	....	....	38,371	....
Total	....	17,926	....	455,157	....

South Mountain district.—The discovery of mineral-deposits and the organization of a new district at the South Mountain, twenty-five miles due south of Silver City, were briefly mentioned in my last report. But I could not, at that time, obtain accurate information as to the real merits of the new mines, and the district was therefore visited in the fall by Mr. Eilers, who reports as follows:

South Mountain is a range much lower than the Owyhee Mountains; it is situated south of the latter, and its main axis runs approximately parallel to that of the Owyhee, *i. e.*, northwest and southeast. There is, however, no connection between the two, either topographically or geologically, as some maps of Idaho give it. Traveling the direct route from Silver City to the new mining-camp in the South Mountain, crossing the southern part of the Owyhee Mountains, and descending to the Flint district, the South Mountain is continually in sight of the traveler. So far the road leads over granitic rocks. A few miles south of Flint district a table-land of basaltic lava, cut up into deep cañons by every little brook, is entered. The lowest part of this table-land is occupied by Trout Creek, which, running east and west, has cut a cañon into the lava of probably 500 feet in depth. Emerging from this the plateau gradually ascends, until, at a distance of about six miles from the creek, the first foot-hills of the South Mountain are reached. These consist also of lava, but the next higher ones are granite, a rock which forms entirely the northern slope and the body of the northern ridge of South Mountain proper. In traveling over the plateau the entire northern slope of the mountain is continually in full view. It is covered with a park-like forest of pines, stretching away to the right and left for many miles, which promises an abundance of fuel for many years. The plateau, as well as the mountains, is covered thickly with grass, and many small creeks leave the mountain on this side, wending their way through cañons, getting deeper and deeper toward Trout Creek. The new mines are located directly over the first ridge, locally called the "Rail ranch," in the deep cañon southwest of it. The route described is the nearest from Silver City, and supplies can be brought by it up to the top of the first ridge. The descent into the cañon beyond is, however, so steep that no road appears practicable without extraordinary outlay, not warranted at this time, and everything is therefore packed from here into camp. Nearly three-fourths of the southwestern slope of this ridge are composed of granite; lower down crystalline white limestone adjoins the granite. It underlies, together with comparatively thin layers of mica slate, the lower part of the slope just spoken of, the narrow valley, and the mountain on its southwest. Beyond it is again joined by granitic rocks. In the belt of metamorphic rocks, on both sides of the valley just mentioned, and principally toward its head, occur the mineral-deposits, which have caused the organization of the district. A direct communication with the Central Pacific Railroad has been secured by making a road from the mining-camp, where a town-plot, called Bullion City, has been laid out, by way of the head of the cañon, to old "Camp Three Forks," six miles distant. From this site of a former United States fort a good military road, forty-two miles long, leads to Camp McDermott, which lies on the present stage-route from Winnemucca to Silver City, and is eighty miles distant from the former place. The distance of the new mines from the railroad by direct route is therefore one hundred and twenty-eight miles.

Mineral was first discovered in these mountains about three years ago. It was gold, occurring in small veins, and the ore was poor. So the discovery was not followed up. In the fall of 1871, another set of prospectors visited South Mountain, and at this time most of the veins carrying argentiferous lead-ores were located. I say "veins," because the course of the mineral deposits appears to be different from that of the country-rock, and because they seem to occupy more or less regular fissures. But I am by no means certain in this regard, as the soil and vegetation which covers the rock everywhere prevent the following of the mineral for any distance, and the explorations thus far made on the various locations comprise in most cases only shallow shafts or short tunnels on the course of the deposits.

The Original is located high up, near the head of the cañon, on its northeast side. It is a large deposit of quartzose, slaty, iron-stained rock, which, in a cross-cut tunnel 45 feet in, shows here and there weak streaks of carbonate of lead and carbonate of copper. The average value of the whole mineral matter was given me by Mr. Von Liebenan, a resident metallurgist, as about 6 per cent. of lead, and $4 to $6 per ton of silver. The cross-cut tunnel above mentioned does not penetrate the whole of the mineral matter. Besides this there are several other tunnels and prospecting cuts, arranged in a planless manner, none of which show anything encouraging.

The Golconda.—This claim was located on September 6, 1871. It is near the Original, and a little lower down the cañon, on the same mountain-side. The work done on it, consisting of a tunnel and a shaft from the sole of the tunnel, shows this to be a vein. It runs northeast and southwest, as shown in the tunnel, which is run in along one wall for 57 feet. The width of the vein is here 8 feet, and it is well filled with carbonate of lead and galena, the gangue being quartz and some calc-spar. The walls are crystalline limestone. At the end of the tunnel the workmen pierced a cross-vein of barren quartz, lying between the crystalline limestone mentioned on the hanging wall and mica-slate on the foot-wall, which inclines strongly toward the mouth of the tunnel. There is no continuation of the lead-vein, in the same line, beyond the mica-slate, and work was stopped here, probably under the impression that this was the end of the vein in that direction. But the surface shows, some 8 or 10 feet to the right of the tunnel end, that the continuation of the vein must be looked for in that direction, and that we have here a well-developed fault in the vein. Near the mouth of the tunnel a shaft, 60 feet deep, has been sunk in the vein. At a depth of about 80 feet this shaft must strike the continuation in depth of the stratum of mica-slate, which cuts off the vein in the tunnel above, providing it retains the dip which it shows at the end of the tunnel. The croppings to the right of the fault mentioned above can be traced some 600 feet up the mountain side. There is considerable ore exposed by means of the tunnel and shaft, and a pile of about 75 tons is on the dump. It is reported to assay from $40 to $60 per ton in silver, and 34 per cent. of lead. The galena assayed separately assays much higher. There is little iron in this ore, and as considerable quartz is mixed with it, an iron plug is required for smelting, which is furnished by other mines in the district. This mine has been bonded for $60,000 until the middle of November. It was offered by the bondholder to San Francisco parties, I am informed, for $200,000; but the expert sent to the mine by them was unable to see as high a value as this exposed, and very properly advised against the purchase at the price asked. The net value of the ore in sight and out was not in the most favorable case more than one-sixth of the amount asked.

The Crown Point is located on the hill opposite the Golconda and a little lower down the cañon. It was discovered in the spring of 1872, and is now opened by an incline on the vein 35 feet deep. It runs north-east and southwest, dips northwest 30°, and is shown to be about 5 feet thick. On and near the top the ore was decomposed and soft, but at the depth above named it is galena and zinc-blende in hard quartz. It cannot be smelted economically without sorting and dressing nearly the whole of it. Assays show the assorted ore to contain from $50 to $60 of silver per ton, and from 30 to 40 per cent. of lead.

Lower down the cañon, at the site of Bullion City, a fork comes into the valley from the west. The mountain north of this fork, and north-west of the main cañon, contains a number of veins in limestone and mica-slate, which differ from those already described in the composition of nature of the minerals they contain. The ore is heavily stained with iron, and is so far, with the exception of ribs and large lumps of galena, soft and workable with the pick alone. Most of the lead is present as carbonate, with the exception of one mine, in which galena and carbonate are present in about equal quantities. Commencing from the angle made by the main and side cañons, and going down the main cañon, the first is—

The Cottonwood.—This is a heavy body of iron-ore about 10 feet thick, on which an incline 63 feet deep has been sunk. The ore is partly yellow and ocherous, partly brown, and very soft. Nests of carbonate of lead have been found in it, but the average is poor in lead and silver. Yet the possession of this deposit is of considerable importance to smelting-works, which may smelt the ores of the district, as it offers a flux for quartzose ores at once well adapted and cheaply obtainable. The strike of the vein is nearly east and west, and its dip, with some-what varying angle, to the south. There are 1,400 feet in the location.

The Independent is located on the top of the same hill. It runs also east and west, and dips south. A shaft 60 feet deep is sunk here, which is for the first 25 feet in good, almost solid gray carbonate of lead. This is 2 to 3 feet thick, and by its side run 8 to 15 inches of iron-stained carbonate. At the depth of 25 feet the ore-body, however, leaves the shaft, "sliding" to one side, and the shaft continues straight on in lime-stone. The ore-body has been followed for a short distance only along the limestone floor. There is excellent ore on the dump, which assays from $50 to $80 in silver, and 30 to 45 per cent. of lead. The location is 1,200 feet long.

Bay State.—Following along the hillside down the cañon for a short distance the Bay State is reached. It seems to run about east and west, and stands nearly perpendicular. On the top the vein is cross-cut to make room for starting the shaft. Here nearly 3 feet of splendidly pure galena are exposed, and several streaks of carbonate of lead. The shaft is 30 feet deep. In its bottom carbonate of lead with iron-ore pre-ponderates, but there are many streaks and lumps of galena in it. I was informed that the galena assayed over $200 in silver, and that the average of galena and carbonate from the bottom yielded $80. I took samples for assay from this vein, which I shall mention hereafter. The location is 1,200 feet long.

Yreka.—This is located lower down the cañon, runs east and west, and dips about 60° south. There is an inclined shaft on it which shows the deposit to be 8 feet thick. The ore is iron-stained carbonate, with some galena, which assays from $30 to $40 per ton in silver. The ore must be assorted for smelting. The claim includes 1,400 feet.

The Rose is a location of 800 feet in length, which has been opened very recently. The cross-cut shows two streaks of iron-ore, carbonate of lead, and some galena. The latter is reported to assay over $300 per ton in silver.

The Grant is the lowest location now opened in the cañon. It is 1,200 feet long and lies in a slaty limestone. It runs northeasterly and southwesterly, and dips northwest. A shaft 60 feet deep was sunk on it in the fall, which has since been deepened to 100 feet. The ore was at the time of my visit from 3 to 7 feet thick, and consisted of iron-stained carbonate of lead, in which were lumps of undecomposed galena. In the lower part of the shaft there was a streak of 3 to 6 inches of black manganese nearest to the foot-wall. The average of the ore was reported to me by Mr. von Liebenan to assay from $60 to $80 per ton in silver. Samples taken from it by myself assayed as given hereafter. There were about 130 tons on the dump at the time of my visit.

All the other mines above mentioned had from 30 to 50 tons of ore on their respective dumps. Besides the above, there are several other locations, which are, however, too little opened to merit mention.

A company has been formed in Silver City, which was to raise $10,000 for the purpose of erecting a blast-furnace to smelt the ore from these mines. Work was commenced at the district when about half the capital was subscribed. The company bought a saw-mill second-hand, and an old engine to furnish the power. At the same time the construction of the furnace was commenced; but the money really paid in soon gave out, and no more could be obtained. With the greatest difficulty the furnace, a rectangular shaft-furnace with three tuyeres, was so far completed that a trial-smelting could be undertaken in November, which, however, was unsuccessful. As the principal reason given is that the dilapidated condition of the steam-engine necessitated such frequent stoppages that the proper heat could not be maintained in the furnace, several other attempts were made, but none were successful, and at the latest accounts, received in December, the works and most of the mines were lying idle.

The following assays, made of samples which were personally taken from two of the mines of this district, will serve to show that in all probability, as far as judgment is possible at the present time, the district offers, in these two, at least, the basis of a remunerative enterprise:

Name of vein.	Kind of ore.	Lead, per cent.	Gold, per ton.		Silver, per ton.		Total value in gold and silver.	Remarks.
			Ounces.	Dollars.	Ounces.	Dollars.		
Grant......	Carbonate and galena.	20	0.5	10 33	44.5	57 54	67 87	Average across the lode at bottom of shaft.
Do......	Yellow carbonate and galena.	40	0.25	5 17	96.75	125 08	130 25	From hanging wall.
Do......	Solid gray carbonate and galena.	33	0.4	8 27	277.4	358 65	366 92	From middle of vein.
Do......	Galena............	48	0.3	6 20	182.9	236 47	242 67	From near foot-wall.
Bay State..	....do	67	0.25	5 17	208.65	269 76	274 93	From near the top.
Do......	Galena and gray carbonate.	61	0.35	7 23	172.55	223 09	230 32	Do.
Do......	Yellow and gray carbonate.	28	0.5	10 33	28	36 20	46 53	From 10 feet down the shaft.
Do......	Mixture of carbonates and galena.	30	0.3	6 23	58.2	75 25	81 48	Average across the vein.

There are several deposits of fire-clay in the vicinity of the new camp, but no fire-proof rock better than a very quartzose granite had been found up to the end of this year. The furnace was therefore lined with the granite mentioned. I am not informed as to its merits as determined by the trial-smelting.

The following statement of prices for labor and materials has been furnished by Mr. Charles von Liebenan.

Statement of prices at South Mountain district, Owyhee County, Idaho.

Wages of miners	$4 per day.
Wages of smelters	4 50 per day.
Wages of wood-choppers and coal-burners	65 to $75, and board, per month.
Wood	4 per cord.
Charcoal in small quantities	22 to 25 cents per bushel.
Transportation to railroad, by way of Trout Creek	35 per ton.
Transportation to railroad, by way of Camp Three Forks	25 per ton.

Castings are made in Silver City, twenty-five miles distant, for ten cents per pound.

Up freight from Winnemucca has, so far, been from 3 to 3½ cents per pound. But this is expected to become much cheaper as soon as a regular trade is commenced. Sinking, by contract, $10 per foot, (4 by 8 feet.)

Cattle and horses are cheap in the vicinity, and provisions are not very high, as much grain, &c., is raised in the valleys to the north, especially along Trout and Jordan Creeks, the Owyhee and Boise Rivers.

Three miles southeast from Bullion City, over the ridge, occur several very large veins of almost solid arsenical and iron pyrites, which contain small amounts of gold and copper. They are not opened, and at present of no value.

The prospected portion of South Mountain is a very small part of the range, but the mineral deposits found so far are sufficiently important to promise some prominence as a producing mining-district to the region.

MIDDLE AND NORTHERN IDAHO.

A large part of these sections of the Territory was visited during last fall by Mr. A. Wolters, to whom I am indebted for extensive notes. Mr. Wolters acknowledges valuable assistance rendered and courtesies shown him, during the prosecution of his work, by Mr. R. Hurley, of Idaho County, Mr. Mootry, of Placerville, Mr. Huffacker, of Atlanta, and Dr. Belknap, of Boise City.

While mining affairs in nearly every State and Territory have been steadily improving, those of Idaho, though unsurpassed by any of her sisters in mineral resources, are constantly declining. This is partly owing to the general exhaustion of the placer-diggings, but principally to the absence of facilities for cheap transportation, which makes quartz-mining unprofitable in many cases, by causing high prices of provisions, mining implements, and labor.

The yield of the once famous placer-claims of the Boise Basin and Northern Idaho, which footed up from seven to ten millions per annum up to 1868, has ever since decreased, until for this year the whole bullion product of the Territory has fallen off to less than three millions, though an abundance of water rendered the last season a very good one. Probably two-thirds of all the claims now worked are in the hands of Chinese, and yield only from $3 to $4 per day to the hands. The white population has correspondingly decreased, and the amount of taxable property gets less every year. Owyhee and Lemhi Counties are even asking for annexation to Nevada and Montana respectively, and to every unprejudiced mind it must be evident that, if this state of affairs is permitted to go on much longer, Idaho in a few years hence will probably have almost ceased to be a bullion-producing country. It is true that new deposits of placer-gold may be discovered yet, but as the Territory has been thoroughly overrun and searched in all directions by numerous parties of prospectors, we are not justified in looking for the discovery of very extensive and rich diggings. The future of Idaho as a mining country solely and undoubtedly rests on her vast deposits of rich gold and silver bearing quartz and base metals.

Mr. Wolters, who has made quite an extensive tour through the middle portion of Idaho, though not having been able to personally visit all the quartz-mining camps, declares that he is convinced that the mineral resources of Idaho are second to those of no other mining country, and that, if only a little more energy had been displayed in their development, and a few hundred thousand dollars had been legitimately expended in building good wagon-roads, and erecting proper reduction-works, Idaho would not now be surpassed by Colorado and Utah.

So far the owners of even the very best lodes have had to contend with a great many serious difficulties, especially in the northern part of the Territory. Since 1862, when the first quartz-mining began here, hundreds of the most valuable gold and silver-bearing lodes have been discovered, but, with a few exceptions, work has been discontinued on all of them a long time ago. The northern counties, as well as Limhi, are not connected by wagon-roads with either the Pacific Railroads or the Columbia River, and everything has to be packed in for long distances on rough mountain-trails. To bring large reduction-works into these districts is impossible, from the simple reason that part of the machinery is too heavy to be packed on two mules, and, even if this could be done, the cost would be enormous, and entirely out of proportion to the inducements offered. A 10-stamp mill, for instance, erected at Warren's Camp, has cost over $25,000, and, as nearly all the owners of mines are workingmen and poor, they cannot, even by co-operation, raise the necessary means to secure reduction-works.

The owners of the several small mills now existing can supply them with the ore from their own mines; and, owing to this, they do not care to do any custom-work. Their charges are therefore so high that they are largely in excess of the average yield of the ores. Thus the miners have no market for their ore; and, as they cannot afford to work or develop their mines without immediate returns, a large number of lodes carrying from 1 to 3 feet of ore, which mills from $20 to $50 per ton, are lying idle. Thus mining-camps become deserted, which, with a moderate amount of capital judiciously expended in the construction of roads, in the opening of the prominent lodes, and the erection of suitable reduction-works, would, within a few years, yield large returns. The worst obstacle in the way of removing these difficulties is, of course, the entire absence of railroad facilities in the Territory. Capitalists, who want to invest money in mining, will hardly go to a country where they have to travel hundreds of miles on horseback, or in not over-comfortable coaches, in order to reach the nearest railroad station. Such a trip involves considerable loss of time; it requires the undergoing of hardships and annoyance, and this alone is sufficient to induce many to go to other districts which can be reached by rail, though the mines there may not be at all equal to the remoter ones. The main point, though, is that the absence of railroads is always a sure indication of high rates for freight, wages, and materials, and that it requires extraordinarily good mines to yield a profit under such circumstances. It is therefore evident that Idaho cannot expect to secure a market for her ores unless she secures railroad facilities. That this fact has not been realized before is certainly strange; and even now the conflicting special interests of the different counties seem to prevent a combined effort to induce capitalists to come to the rescue in this respect. Two bills were introduced in the legislature to grant territorial aid to the construction of the Portland, Dalles and Salt Lake Railroad, and to a road from some point on the Central Pacific to Boise City. Neither of the bills, however, passed; Owyhee Company opposing the Portland, Dalles and Salt Lake Railroad; Oneida and Alturas the other one, and the delegates of the northern counties voting as a unit against both. After much exertion a bill was finally passed exempting all railroads built within the limits of the Territory from taxation for the next seven years; but it remains to be seen whether this, in the absence of land-grants, will be considered a sufficient inducement by capitalists. It is further reported that the Northern Railroad Company find that the original line fixed upon through the Territory is impracticable, and that they will change their route so as to go either along the Salmon or the Snake River. A corps of engineers has been surveying all summer along the former, but nothing positive has been decided upon so far.

The local facilities for quartz-mining are very good in all the different districts. The mountains abound in the most magnificent timber; the valleys, where no placer-mining has been done, have splendid soil, and yield good crops. Good pastures and ample supply of water are also met with throughout the mining sections, and the steep mountain-sides afford splendid chances for deep tunnels to drain the mines. In short, all that is needed to bring back the days of former prosperity in Middle and Northern Idaho is cheap transportation and a market for the ores.

The placer-mines in Northern Idaho are to the greatest extent worked out and in the hands of Chinamen. In the once famous camp of Florence there are now only two associations of white men at work. In Warren it is not much better, and I feel satisfied that $500,000 will cover the whole gold product of Idaho, Nez Percés, Shoshone, and Lemhi Counties for this year. The yield of the principal and most productive camps, as furnished to me by Mr. R. Hurley, county treasurer and assayer at Warren's, is as follows:

Florence	$78,000	Elk City	$40,000
Warren's	56,000	Newsome Creek	30,000
Oro Fino	70,000	Salmon River } Snake River }	40,000
Clear-Water Station	50,000		
		Total	364,000

The product of Leesburg and Loon Creek in Lemhi County I have not been able to ascertain.

Quartz-mining has so far received very little attention in Lemhi, Nez Perçés, and Shoshone Counties. In the latter large masses of float-rock have been found, assaying from $50 to $70 in gold; but all endeavors to find the lode or lodes from which the rock came have so far been unsuccessful. From Lemhi Mr. Wolters has received several pieces of good galena, assaying very high in gold and silver, but nothing has been done as yet to actively develop any of the lodes. Only in Idaho County enough work has been done to show the character and value of the veins.

In Warren's, the center of the quartz-mining region in Idaho County, there are three different classes of lodes, one carrying gold almost exclusively, the second both gold and silver ore, and the third only silver-ore, containing little or no gold. The bearing of these lodes ranges from nearly due east and west to northeast and southwest; they dip all considerably north, carry much water, and are exceedingly well defined. The mineral-bearing gangue is quartz, and the width of the ore-veins usually varies from 12 to 36 inches. Besides the quartz there is more or less decomposed gangue-matter, closely resembling the granite, which forms the country-rock.

The representative lode of the first class, and the best developed, is the Rescue lode, which is claimed for a distance of 4,500 feet, but the development is confined to the 1,200 feet now owned and worked by G. Gambel. The discovery-shaft has reached a depth of 182 feet. Three pairs of levels have been run, at a distance of 60 feet from each other. The uppermost extends 130 feet east and 118 feet west, the second 170 feet east and 80 feet west, the ground above them being worked out. The lowest level, started from the bottom of the shaft, runs 320 feet east and 150 feet west, and from the stopes between this and the second level ore was being raised at the time of Mr. Wolters' visit. A cross-cut tunnel, 460 feet in length, and provided with a tramway, comes to the third level with the mill. A tunnel has been run in on the vein a distance of 100 feet, showing a well-defined crevice and a vein of quartz, varying from 10 to 24 inches in width, but it has been discontinued, since no greater depth could be attained by it than by the lowest level. A deep tunnel has been driven on the vein 463 feet, which will intersect the discovery-shaft about 40 feet below the third level. The distance from the mouth of this tunnel to the shaft is 1,100 feet, and if a sufficient number of hands can be procured, it is the intention to complete this tunnel by next summer and make connection with the shaft. The ground is very soft, requiring hardly any blasting at all, the crevice well defined, and a strong body of ore is exposed the whole distance. After the completion of the tunnel, the mill, now located at the mouth of the cross-cut tunnel, will be removed to the creek, some 40 or 50 feet below the mouth of the lowest tunnel. The lode runs nearly due east and west, and dips considerably north. The crevice matter is quartz more or less and decomposed granite, closely resembling the surrounding country-rock. The distance between the well-defined walls varies from 3 to 4 feet; the width of the ore-vein from 6 to 30 inches. A clay selvage from 1 to 12 inches wide is found through the whole mine. The ore is in the upper workings on the hanging-wall, and in the lower tunnel on the foot-wall. The average yield in the mill is from $20 to $25. A late run of thirty-seven days, comprising 480 tons, gave $11,522.38, or at the rate of $24 per ton. The cost of mining is stated at $7 per ton, and of milling at $42 per ton. The wages paid miners are $5 per day. Lumber is worth from $50 to $70 per mill, powder $12 per keg, steel 37½ cents per pound, iron 30 cents, candles $8 per box, flour $8 per 100 pounds.

At the time of Mr. Wolters' visit there were only six hands at work, owing to a scarcity of miners in the camp, and work was confined to stoping between the second and third levels, and extending the lowest level east. Since then the shaft is reported to have been sunk 50 feet deeper, where a very rich body of ore was struck.

The mill erected at the mouth of the cross-cut tunnel contains 10 stamps of 500 pounds each, dropping 7 to 8 inches, and 80 to 90 times per minute. The motive-power is furnished by a 12 horse-power engine, which consumes from $1\frac{1}{2}$ to 2 cords of wood in 24 hours, worth $4 per cord delivered. Amalgamation is effected by plates in the battery and on copper tables; the tailings pass through 125 feet of sluice-boxes provided with copper plates and blankets. The concentrated tailings will be reworked in pans. The capacity of the mill is 15 tons in twenty-four hours.

The Charity lode is being worked under a lease by a party of Cornish miners. The development on the lode consists of two tunnels on the vein, respectively 150 and 300 feet long and 60 feet apart; the crevice is $2\frac{1}{2}$ feet wide, and contains 12 inches of quartz. Nearly all the ground above the tunnels is stoped out, and it is the intention of the owners to commence forthwith a third tunnel, and extend the shaft down to it. The ore taken out now is worked in a small mill at the foot of the hill, which contains five small wooden stamps and two large arrastras, 16 or 20 feet in diameter, all driven by a 36-foot overshot water-wheel. The last lot, of 16 tons, yielded at the rate of $26.90 per ton. A 10-stamp mill is in process of erection a short distance below the mouth of the proposed new tunnel, and as the present owners are all working men and good miners, it is to be expected that they will meet with success.

The Sampson lode.—There are two shafts on this lode, respectively 60 and 40 feet deep. The crevice is about 4 feet wide, and carries 2 feet of quartz. The richest ore is said to be in the bottom of the shaft. Two hundred tons crushed in the old water-mill yielded $35 per ton. On the surface the ore has been taken out for a length, along the vein, of about 150 feet.

The Keystone lode, owned by Bemis & Sanderson, has a shaft 53 feet deep, connected with a tunnel, driven in on the lode for a distance of about 300 feet. The crevice is $2\frac{1}{2}$ to 3 feet wide, and contains 8 to 9 inches of ore, which is said to have yielded as high as $75 in a stamp-mill.

The following lodes are representative of the second class of veins, carrying both gold and silver:

The Martinez lode, owned by R. Hurley and others, developed by two shafts, respectively 60 and 50 feet deep, and 60 feet apart. The crevice is 3 to $3\frac{1}{2}$ feet wide and carries 2 feet of quartz at a depth of 30 feet, and one-third of a foot at the bottom of the deepest shaft. At a depth of 25 feet a streak of exceedingly rich silver-ore comes in, and widens out to 10 inches in the bottom of the shaft. The rest of the pay-streak is gold-quartz, yielding at the rate of $15 per ton. A great number of assays have been made from the silver-ore, all yielding from $500 to $8,000 per ton. As there are no works for the reduction of silver-ores, this unusually rich lode, as well as all the other good silver lodes, is lying idle.

The Hunt lode runs parallel to the former, at a distance of about 350 feet, and has a shaft sunk to a depth of 40 feet, which shows a vein of 12 inches of ore, five-sixths being gold-quartz, and 2 inches silver-ore of the same character as that in the Martinez.

The Washington lode: shaft, 20 feet deep; crevice, 5 feet wide; ore-vein 15 to 18 inches; gold-quartz on the hanging-wall; silver-ore in the center of crevice. A deep cross-cut tunnel has been started, which will intersect the lode at a depth of several hundred feet.

The third class of veins, carrying silver-ore only, with little or no gold, is represented by the No. 1 Treasure, Laurel, and Bullion lodes, but there is no development done on them worth speaking of.

The lodes in this district are mostly narrow veins, but they are exceedingly well defined and carry a large amount of ore in proportion to their width. The ore, compared with the average value of gold-quartz in California, Colorado, and Arizona, is unusually rich. A great drawback to mining is the large amount of water encountered in all the lodes, but this is more than counterbalanced by the fact that the mountains are very steep, and as the majority of the lodes cross them there are splendid facilities for running deep tunnels in right on the vein, to drain the mine and work it very cheaply. Even the lodes not crossing the mountains are in nearly every case easily reached by cross-cut tunnels of a few hundred feet in length.

The future of this camp cannot but be a very bright one. My general remarks about the present condition of quartz-mining in Idaho apply, however, *par excellence*, to Warren's diggings.

In Florence the Harper mine, owned by Hall & Co., is the only lode which has been somewhat developed. The company were offered last fall $3 net per ton if they would allow another party to take out 1,000 tons of ore, and the fact that they declined the offer shows that the proprietors are well satisfied of having a good mine. There are several hundred feet of tunneling and shafting done, and very little ground has been stoped out so far.

Boise County.—A great number of very promising-looking lodes occur on Granite Creek, but only a few of them are worked at present.

The Gold Hill lode, owned by the Gold Hill Company, runs northeast and southwest, dipping about 70° south. The vein-matter is decomposed granite, containing several streaks of quartz and iron pyrites, the pay-streaks varying in width from a few inches to 6 feet. The lode is opened by three tunnels. The lower one is a cross-cut for a length of 400 feet, strikes the lode at a depth of about 240 feet, and then runs along the vein 450 feet more. In this level the ore has for some time been of a rather poor character; there is, however, a better prospect now. The ground above is stoped out to the surface for a distance of about 120 feet. Two hundred feet above the cross-cut a tunnel 1,100 feet long has been run on the vein, and another one, 600 feet long, is 100 feet higher up. Out of both tunnels very rich rock was obtained, until a talcose rock appeared, which did not pay expenses, and at present there is no work going on in this portion of the mine.

The Gold Hill lode is on the northeast side of the gulch, crosses the latter, and then is known under the name of the Dunlap lode, which, for a distance of 1,600 feet, is also owned by the Gold Hill Company.

A tunnel along the vein has been lately driven on a level with the creek, and so far extended about 200 feet; 30 feet above another tunnel has been driven for a length of 600 feet. The ore-vein in the latter varies from 3 to 6 feet in thickness, in the former from 18 to 20 inches. The crevice-matter is the same as in the Gold Hill proper; the quartz-seams contain more or less antimony, and whenever the antimony becomes frequent and concentrated the quartz is invariably exceedingly rich in gold. The ground above the upper tunnel has been stoped out only about 28 feet high for a distance of 150 feet, and the reserves at this mine are therefore very large. The average value of the ore is estimated to be about $20 per ton, and since September, 1869, there have been taken out about $300,000 from the Dunlap and Gold Hill lodes.

The ore from both lodes is brought out in cars through the lowest levels, and on the extension of the same track it is taken directly into the mill and dumped behind the batteries.

The mill, also owned by the Gold Hill Company, is a very spacious and substantial building of about 80 by 100 feet. There are 25 stamps, weighing 600 pounds each, dropping 7½ to 8 inches sixty times per minute, crushing 45 tons per day, the ore being very soft. Two copper plates in the mortar-boxes and copper tables are used to amalgamate. The tailings from each battery run separately into a concentrating-machine, where the large amount of sulphurets is concentrated and saved for further treatment. There are now from 1,200 to 1,500 tons on hand, representing a net cash value of at least $50,000. The managers of the works, Messrs. R. Mootry and D. Coughenour, intend to erect chlorination-works for their reduction as soon as practicable.

The tailings from the concentrators are run through sluice-boxes, provided with copper plates, in order to catch the last particles of quicksilver and amalgam escaping the buddles.

The motive-power is furnished by an 80-horse power engine with two tubular boilers, which consume four cords of wood per day, worth $4 per cord, delivered. Miners receive $75 and board per month.

Both the mill and the mines of this company are specimens of good management. Everything is done in the most substantial and at the same time economical manner, and owing to this fact they are enabled to realize, in spite of the high cost of labor and materials, a handsome profit from ore which, on an average, yields probably less than $15 per ton. Thirty thousand dollars' worth of supplies, such as wood, timbers, lumber, and other materials, are on hand.

Ninety feet north of the Gold Hill is the Lone Star lode, owned by R. Mootry, J. C. Isaacs, and others, for a length of 1,600 feet. The outcroppings of this lode have, by sluicing, yielded, in several places, a large amount of money, and it is generally believed to be one of the best, if not the best lode in the camp. Besides the work on the surface, there is only one tunnel 80 feet long, started on a level with the creek. The lode runs northeast and southwest. The dip changes constantly on the surface, the lode being considerably broken up for nearly its whole length. The property is at present in litigation, and has not been worked for a long time. If the suit is decided in favor of the above-mentioned parties, the mine will be worked from the lowest level of the Gold Hill and in connection with that mine.

The Pioneer lode, situated 200 feet south of the Gold Hill, has been claimed for 2,000 feet. Course, northeast and southwest. Dip, 70° south. The lode has yielded about $100,000 from different small but exceedingly rich pockets near the surface.

The Golden Gate lode is close to the Dunlap and south of it. It was worked during the winter of 1863, and the stock sold, at one time, as high as $50 a foot. A tunnel 150 feet long has been run in on the vein, and shows a uniform pay-streak 2 feet in width.

Adjoining the Dunlap on the north side is the Granite lode. It is claimed for 800 feet. The work is confined to the surface, from which about $1,500 have been taken by sluicing.

Besides the above, there are the Gray Eagle, with a tunnel 150 feet long; the Columbia, with 200 feet of tunnels; Webfoot, 600 feet; California; the Dictator, with 100 feet of tunnel; the Gold Bar, 100 feet of tunnel; Yellow Jacket, and others, all of which have yielded more or less rich ore, but the works are now mostly caved in, and the mines are idle. The new mining-law will probably do much to rouse considerable activity in this district for the next year.

In the neighborhood of Pioneer there are several silver-bearing galena lodes. Smelting-works were erected, several years ago, to work these over, but they are idle now. The Duncan and Justitia are considered the best veins.

Some work has been carried on in *Banner district*, about twenty-eight miles northeast of Idaho City, in the Banner, Wolverine, and a few other lodes. The two named have furnished a quantity of very nice silver-ore, and further development will, in all probability, prove these lodes to be valuable property. At the time of Mr. Wolters's visit, work had been stopped, ladders and ropes were removed, and it was therefore impossible to examine the mines.

The yield of the placer-mines of the Boise Basin is steadily decreasing, though not as fast as that of the northern placer-mines. There are several good claims yet yielding from $10,000 to $20,000, but the majority are in the hands of Chinese, and an estimate of their yield is therefore very difficult.

Alturas County.—The placers of Atlanta district have never yielded large returns. They are not extensive, and some of them can procure a sufficient supply of water only for a very limited season. Quartz Gulch, which is crossed by the Atlanta and all other lodes north of it, has been worked ever since it was discovered, and has yielded from $6 to $20 per day to the hands. In a northern direction, about three miles from the Atlanta lode, are other placers, high up on the ridge, which have to obtain their water mostly from the melting snow, and can be worked only for a few weeks in the spring. They are, however, reported to be very rich.

Fifteen to sixteen miles below Atlanta are the placers of Middle Boise. There are two or three extensive claims worked, and two companies of Chinamen are working on the Yuba. In the other camps there are only a few Chinese. The yield of the placers of Atlanta and Rocky Bar for the last year is estimated by Mr. Dilley at $150,000; I am, however, inclined to think this estimate too high. The lodes of Alturas County are numerous, and have always enjoyed the reputation of being rich. Eastern capitalists have invested in several of the prominent veins, but very little work has been done, owing to several circumstances, which it would lead me too far to enumerate. The main lode is—

The Atlanta: It runs east 17° north, dips north near the surface, but changes in this respect at a slight depth, and dips then southerly. There is one tunnel on the lode, 380 feet long, gaining a depth of 180 or 190 feet. At the end of the tunnel a shaft has been sunk 43 feet deep, under a lease, which gave the working-party all the ore taken out in sinking it. This ore yielded from $60 to $70 per ton in a stamp-mill. The tailings were worked over again and yielded from $30 to $40 per ton, and it is believed that they contain now as much as was taken out in the reworking. The Discovery claim is owned by Farras, Preston, and others. They have one tunnel on the vein, which gains about 70 feet in depth. On top the croppings are about 60 feet wide; at the end of the tunnel the vein measures 45 feet between walls. It carries two streaks of gold-bearing quartz, one on the north wall 2½ feet, and one on the south wall 1½ foot wide. The gangue matter is quartz and decomposed granite; the country-rock granite. Very nice specimens of ruby silver are occasionally obtained in the mine.

The Leonora lode runs nearly due east and west, dips south, is from.

3 to 5 feet wide, and carries, on an average, about 2 feet of ore. It was worked last summer by S. Mattingly. The yield of the ore was not ascertained; it is, however, known that several samples of tailings assayed at the rate of $90 per ton. There are three shafts on the lode, two of them are 100 feet apart, and measure respectively 85 and 60 feet in depth; the third is only 40 feet deep. Levels have been run from the bottom of the shafts, both ways, and the ground above is stoped out. *The predominating metal in this and the lode is gold.*

The Empire State runs nearly east and west, and dips slightly south. There is a tunnel on the vein 150 feet long, gaining 60 to 70 feet in depth. A lot of 14 tons of ore, worked by Mr. Huffacker, yielded at the rate of $74.90 per ton. Several smaller lots of a few tons each yielded from $70 to $85 per ton. The crevice is 5 feet wide the ore-streak 2 feet. Gold predominates largely.

The Tahoma runs parallel to the former, at a distance of 250 to 300 feet, is 12 to 14 feet wide, and carries from 2 to 3 feet of ore, in which silver predominates. Several tons were worked and yielded pretty fairly; the exact amount could not be ascertained. The developments on the lode consists of a couple of cross-cut tunnels, which intersect the vein at a depth of 40 to 50 feet.

The Stanley, owned to a great extent by English capitalists, is believed to be the extension of the Tahoma. A tunnel 400 feet long has been run partly on the lode, showing it to be from 16 to 20 feet wide. The ore occurs in bunches, the vein being considerably broken up. Small test-runs yielded about $100 per ton, and it is expected that more developments will prove this to be a very valuable lode. Ruby silver is frequently met with in the ore, which carries only very little gold.

Besides these lodes, there are the Union, Gray Eagle, Jessie Benton, John Bascom, Eclipse, Silver Tide, Old Chunk, all on the north side of the Atlanta. On the south side are the Golden Reef, Pacific, Minerva, Varieties, William Tell, Liza Hull, Hard Times, Confidence, and many others. All of them look very promising, but are developed only by prospecting-shafts and tunnels.

At Rocky Bar there are some excellent lodes. The Ida Elmore and Wide West have both been worked last summer, but it has been impossible for my agent to either visit this district in person or to obtain reliable data in regard to it.

CHAPTER IV.

OREGON.

From the western part of the State there is little to report. The languishing industry of the once productive counties of Jackson, &c., appears to have experienced no revival during the year. In Baker, Union, and Grant Counties, however, east of the Cascade range, considerable activity has prevailed. I estimate the yield of Oregon and Washington at $2,000,000. Mr. Dudley Evans, express-agent at Portland, estimates $1,900,000, to which I have added $100,000 to cover amounts produced near the California line, and finding their way directly southward.

COAL-FIELDS AND GOLD-BEACHES.

The following abstract of an interesting paper read before the California Academy of Sciences, by Mr. W. A. Goodyear, of the State geological survey, is taken from the Mining and Scientific Press:

After crossing the State-line, on descending the northern slope of the Siskiyou Mountains, in Oregon, we come to the little village of Ashland, on Bear Creek, a branch of the Rogue River. At this place I saw some marble tombstones, the material for which was said to have come from the Siskiyou Mountains on the south. The Valley of Bear Creek is underlaid by unaltered sandstones.

The mountains, which rise quite high on the north side, present every appearance, for many miles, of being also made up of unaltered sandstones and shales, beautifully stratified.

I saw nothing in Southern Oregon along this route which looked volcanic, excepting two or three flat-topped hills, a few miles northeast of Jacksonville, known as the "Table Rocks," and famous in Oregon as the locality of a desperate battle with the Indians in the early days. The capping of these hills is, in all probability, a table of basaltic lava.

Between the Rogue and the Umpqua Rivers the country is very mountainous and heavily timbered. The road here crosses two prominent mountain-ridges, descending at last to Canyonville, beyond which place it crosses the Umpqua River, along whose right bank it then continues to Roseberg. From here a newly-constructed wagon-road runs west sixty-three miles to Coos City, crossing the Coast Range of mountains at an altitude of 4,000 feet.

Coos Bay.—A peculiar feature of the country about Coos Bay is the numerous tide-water sloughs, which stretch far inland to distances ranging from ten to thirty miles from the coast. All the lower part of the Coquille River is a tide-water stream of this kind, and Coos Bay itself has half a dozen arms through which the tide ebbs and flows for miles back into the country in all directions.

So far as yet known, there is not more than one workable bed of coal in the Coos Bay coal region. The new mine recently opened by Messrs. Hardy & Goodale, on the north of the bay, is undoubtedly on the same bed as the Eastport and Newport mines to the south. Nevertheless, the coal-field about Coos Bay is very extensive, reaching certainly from the coast ten or twelve miles back, and from the bay south to the Coquille River, and north as far as the Umpqua. Coal of good quality is reported on the North Umpqua east of the coast range of mountains. It is needless to say, however, that in a region so cut up by gulches, the portion of this broad area, which is covered by coal of good quality and workable thickness, is comparatively small. In fact, there is no coal here which it will pay to work for many years to come, except that which is situated in close proximity to the shores of Coos Bay.

The coal-bed here consists of two strata, each from 2 to 2½ feet in thickness, separated by a stratum of clay-rock, from 6 inches to a foot thick. Above the upper layer of workable coal is another stratum of rather hard clay-rock, from a foot to 18 inches thick, and over this again another stratum of coal of nearly equal thickness. But this upper layer of coal, though generally of good quality in the Eastport and Newport mines, is not worked.

The quality of Coos Bay coal, as compared with that of the Mount Diablo mines, is better for some purposes, and for others not so good. For domestic use it is preferred to the Mount Diablo, as it does not crumble quite so badly in the fire as the latter coal, and consequently makes rather a freer and open-burning fire. It is also often said that the odor of the Coos Bay coal is less offensive than that of the Mount Diablo coal. But this is a statement in which there seems to be more of fancy than of truth.

For steam purposes, the evidence of chemical analysis goes to show that the Coos Bay coal is not worth quite so much per ton as the Mount Diablo coal. This fact appears to be chiefly due to the somewhat larger percentage of water which the Coos Bay coal contains, and which not only diminishes by an amount equal to its own weight the heat-producing substance of the coal, but also requires a considerable quantity of heat for its own volatilization. In the Coos Bay coal the texture of the wood from which it was formed is often beautifully preserved. Several of these facts, as well as some facts in the physical and geological features of the country itself, point to a probability that the Coos Bay coal is of somewhat more recent formation than the Mount Diablo beds. Before leaving Coos Bay I visited the site of the old town of Randolph, now deserted, on the mouth of Whisky Run, a small creek which enters the ocean some four miles north of the Coquille River. The surface of the country from Whisky Run to the Coquille River for a mile or so back from the coast consists of low rolling hills of sand and gravel, covered with a thin soil, which supports a scanty growth of grass and scattering trees. These hills front the sea in a continuous line of bluff. The sands of the beach along the foot of this bluff for three or four miles to the south of Whisky Run have been in the past extensively worked for gold, and are said to have been very rich. It was this beach-mining that gave rise to the town of Randolph, and that alone supported it as long as it continued to exist. The working was carried on chiefly with the shovel and long tom. The gold-sand was uniformly very fine, no single nuggets having ever been found of more than 4 or 5 cents in value. It was impossible, of course, to save all the gold. The loss in the tailings was constant and heavy, and a considerable portion of the ground here is said to have been worked over six or seven times in succession, paying well each time. The locality at and immediately south of Whisky Run is said to have been enormously rich; and it is stated that for a little while it was no rare thing for a single miner to take out a thousand dollars' worth of this fine gold-dust in a day..

My informant upon many points relating to the history of this work was F. G. Lockhart, who has been in this country some eighteen or twenty years, and is thoroughly familiar with it. He is now engaged in working a "black-sand" mine at a different locality, of which I shall presently speak. He tells me that the productive stratum along this beach was a layer of black sand, from 1 to 2 feet in thickness, generally buried from 2 to 5 feet deep beneath an accumulation of lighter sand. But this last accumulation appears to be a transient thing, as the action of the wind and waves on this beach varies greatly at different seasons, sometimes casting up large quantities of sand, and again sweeping it all away, so that the surface of the beach is constantly changing, and is at sometimes 5 or 6 feet higher than it is at others. It thus appears probable that the auriferous stratum of black sand lies at the bottom, and forms the floor of what may be called the *zone* of perpetual change of the beach. It is also said to have covered the whole width of the beach from the very base of the bluff as far out beneath the waves as it has ever been possible to carry explorations at the lowest tides.

It has long been a popular belief, and is still the opinion of many, that this black sand, together with the gold which it contains, have come from the depths of the sea, having been simply cast up by the action of the waves upon the beach. But such, in my opinion, is not the fact. I know of no argument in favor of such an idea beyond the simple fact that these sands are found upon the beach; while there is a strong *apriori* argument against its probability in the high specific gravity of the black sand itself as well as the gold, and, in fact, that the heaviest materials are not those which waves most readily throw up upon the beach.

There is no difficulty here in pointing the finger at once to a perfectly adequate source for all the gold without going to sea to hunt for it. In the first place there is no difficulty with the pan and shovel in finding the color of gold, not only throughout the material which forms the face of the bluff that fronts the beach, but also almost anywhere on the surface of the low rolling hills stretching backward from the bluff; and in the second place, there is plenty of evidence that the whole front of the bluff itself is wasting away with comparative rapidity by the action of the waves and storms.

The beach receding.—At one point I saw in the sands of the beach the stump of a tree 6 or 7 feet in diameter, evidently where it grew, the wood but partially carbonized, the fiber brown and soft, though still rather tough, and exactly resembling in character the woody fiber in a bed of incipient lignite or half-carbonized vegetable matter 2 or 3 feet thick, which crops out for a long distance, in the face of the bluff, a few feet only above the level of the beach, and buried under from 30 to 50 feet of the half-consolidated sand and fine gravel which form the upper part of the bluff. Mr. Lockhart states that when he first saw the stump, eighteen or twenty years ago, it was about half covered up by the foot of the bluff; now the foot of the bluff is at least 20 feet from the center of the stump.

At this point, when the tide is low, the tops of a number of other stumps may be seen, still standing upright where they grew, but ordinarily covered with water now, and some of them a hundred yards or more outside of present mean low water line.

A black-sand mine, which Mr. Lockhart is now working, is not on the present beach at all, but is back in the timbered country two or three miles southeast from the mouth of Whisky Run, and 190 feet above sea-level. This height of a former beach above the sea is another indication of the comparatively recent changes of level here.

In opening a tail-race from his mine to the sea, Mr. Lockhart has made, with the aid of water, a cut half or three-quarters of a mile in length and from 25 to 40 feet deep, straight through the low rolling hills that border the shore, thus exhibiting a fine section of their structure. Here, as well as in the bluffs along the beach, they are seen to consist of alternating beds of sand and fine gravel, lying everywhere nearly horizontal. Sticks and logs are not uncommon, scattered through the mass, and in the cut some trees have been unearthed, still standing where they grew. Two or three large stumps still remained upright in place at the time of my visit, with their roots about 40 feet beneath the present surface of the hills, and with their woody fiber in the same condition as that in the bed of half-formed lignite which crops in the bluff along the beach.

I was shown a human skull, probably that of an Indian woman, which was found some years ago in the bluff itself about 10 or 12 feet beneath the top and under several feet in thickness of the fine gravel deposit which helps so largely to make up this formation. The skull has evidently been long buried, but it might possibly have been covered by a slide, and I have little faith that it is really as old as the gravel of these hills.

Colonel Lane states that in his mine the black sand, so far as worked, has averaged from 5 to 6 feet thick. There is more or less fine gold scattered all through this sand, and also some platinum, mingled with more or less iridosmine.

The difficulty of saving gold from the black sand appears to be due chiefly to two causes: to its fineness, which permits it to be so readily washed away by a stream of running water; and from the fact that a portion of it seems to be coated with a substance which protects it from the action of the mercury. It is not so clear of what this film consists. Mr. Wright, who owns a black-sand mine north of Lockhart's, thinks that in his mine it consists chiefly of organic matter, perhaps of bituminous oils. He burns his sand in heaps before amalgamating it, so that it is exposed to a high degree of heat for several hours. He then works it in an arrastra, and by this treatment he obtained two or three times as much gold as he could without the burning.

At the time of my visit, Mr. Lockhart was making preparations to apply, on a large scale, Plattner's chlorination process, to extract the gold from these black sands.

With this material no expensive preliminary roasting will be required, and if the chlorine will dissolve with sufficient rapidity gold which is as coarse as this, I see no reason why it may not prove a complete success in the extraction of gold. The experiment is well worth trying, and it will be interesting to know the results which he obtains.

Volcanic formations.—I left Coos Bay on the 9th of November for Portland. Between Roseburg and the head of the Willamette Valley, I noticed considerable unaltered rock, both shales and sandstones, in various railroad cuts.

I saw nothing that I could recognize as volcanic till I reached the vicinity of Albany, where the gravel used in ballasting the road contains volcanic pebbles.

Some twenty-five or thirty miles before reaching Portland we struck the basaltic bluffs, on the right bank of the Willamette River, and from that time forward I saw no rocks except volcanic till after I left Portland for San Francisco.

I will not attempt to describe the magnificent cañon of the Columbia River, through the Cascade Mountains, between Portland and the Dalles, so familiar to all travelers in Oregon. I will only direct attention for a moment to one most striking contrast between the character of the volcanic matter here, and that on the western slope of the Sierra Nevada, in California. The Cascade Mountains, where the Columbia cuts through them, appear to be entirely made up of a series of superimposed sheets of lava, which, when it flowed, ran not into narrow streams, but spread its fiery floods both far and wide in all directions over the then smooth, or nearly level, or very gently sloping country. They, therefore, consist to-day of terraces of solid compact rock from base to summit, and the quantity of breccias, or fragmentary materials of any kind, is comparatively so small as to be hardly noticed.

The western slope of the Sierra Nevada, on the contrary, shows its volcanic matter almost exclusively in fragmentary forms. Beds of ashes, breccias, and volcanic gravels and conglomerates are everywhere; but lava-flows are few and far between.

This is true especially in the central portion of the State. But throughout the central and southeastern portion of the Sierra there is, so far as I know, on the western slope, but one great lava-flow—the Tuolumne County Table Mountain. Moreover, the total quantity of volcanic matter in the mining countries of the Sierra Nevada is utterly insignificant compared with the vast accumulations that have built up the Cascade range. The absolute quantity in the Sierra is indeed great; but that in the Cascade Mountains is more than great, it is stupendous.

GRANT COUNTY.

For the following information concerning the districts around Canyon City, I am principally indebted to my very courteous and intelligent correspondent, Mr. W. V. Rinehart, of that place. The mining industry of the region has declined in some camps and flourished in others.

Canyon City district is chiefly worked by Chinese, and the yield has been as large as in 1872. Several new claims are being successfully worked on the side-hill west of Canyon Creek. The hydraulic claims of Thompson & Co. and L. C. Hillis, at Marysville, have yielded fair returns. The claims (also hydraulic) of John Long & Co., in Town Gulch, have yielded good returns. These three are the principal ones worked by white labor in this district. Some very rich specimens of gold-bearing quartz were picked up during the summer near Marysville, inducing the belief that the vein from Prairie Diggings may be traced to the mountain south of Canyon City; and rich deposits are looked for. The quartz-mill at Prairie Diggings stopped for the season after a short and profitable run during the summer. The vein has been lost, and the rose-rock from which such rich pay was taken at first has been exhausted.

Dixie Creek is worked by Chinese, except four large claims, near the mouth of the stream, which yield well. The yield in this district is thought to be about equal to that of last year.

The Burnt River, Olive Creek, Granite, and Elk Creek districts have all declined perceptibly in their yield during the past year. The falling off in population is about one-fourth, and the decrease in the yield is proportionate. The quartz at Elk Creek remains untouched. A lack of confidence in quartz-mining seems to prevent investments in this line. Capital from abroad and an infusion of California energy are needed to develop this industry. Numbers of successful miners have invested in cattle during the past year, and forsaken their former occupation. The closest estimate that can be made of the gold-dust shipped from this section during the year gives an average monthly shipment of $21,500, besides what has been taken away by private hands, which will probably increase it to $30,000 per month, or an aggregate of $360,000 for Grant County for the year 1872. This looks large, considering the decline in several important districts, but, on the best information I can get, I feel sure the estimate is not too large. I think the counties of Baker and Union yield more together than Grant, while Jackson and Josephine in Southern Oregon yield about the same as Grant.

BAKER AND UNION COUNTIES.

For valuable notes from this part of Oregon, lying east of the Blue Range, I am chiefly indebted to Mr. E. W. Reynolds, of Baker City.

The water-supply has been greater during the past year than the year previous; but the late completion of the various ditches in the country prevented the miners from reaping much benefit therefrom. Still I estimate the yield in gold-dust as fully up to that of 1871; perhaps a little better. The mining population has apparently not increased much during the past year; the gain in population being in farmers, mechanics, traders, speculators, &c. Winter set in much earlier than usual. About the 8th or 9th of November, snow fell 6 inches deep in the valleys, and a foot or more in the mountains. After that time wet, windy, and disagreeable weather prevailed. At the close of the year the ground in the valleys and low foot-hills was bare of snow, and our roads were muddy and rough. The large rain-fall and a goodly supply of snow in the mountains indicate a season of abundant water in 1873. I think the amount of placer-gold carried out by private hands is not less than in the last year.

Trade has been good in town and in the mining-camps generally. There are, perhaps, fewer traders; but those that remain do a better business than formerly. Last summer Messrs. W. B. Crane & Co. sold their copper-mine and smelting-works, located about twenty-five miles northeast from Baker, in Union County, to Messrs. Carson, Williams & Co., of Detroit, Michigan. Crane & Co. also sold to the same company hill-diggings, with a 60-foot bank of gravel, situated on the head-waters of Grande Ronde River, in Union County. The new company at once put on a large force of Chinamen, and continued work until cold weather, bringing in a ditch from the river to the hills. They will resume work in the spring on a large scale with Chinamen and hydraulics, and expect a heavy yield. In the copper-works one smelting was made, the result being $4\frac{1}{2}$ tons copper, shipped recently from Portland by steamer to San Francisco, and thence by rail to the East. I am informed that the cost of the copper-pigs, delivered in the East, will be between $60 and $70 per ton.* As the company has plenty of good ore, easily accessible, a profitable business is anticipated.

At Hog Em, in Union County, there have been some new discoveries of rich quartz-lodes, carrying free gold. The district contains one small 3 or 5 stamp mill, besides the steam 10-stamp mill of Messrs. White & Myrick, removed thither last summer, and now doing custom-work.

Eagle Creek district.—This district, in Union County, contains the camps of Sparta and Gem City. The ditch was not finished until late in the summer, and is not of sufficient capacity to supply the district. Messrs. White & Myrick are doing well at Gem City with their 10-stamp steam quartz and saw mill in connection. They have recently struck good rock in the Gem lode, and are now at work. This district promises well for next season.

Pocahontas district.—Along the western side of Powder River Valley, in the Blue Mountain divide between Powder River and Grande Ronde, are the Pocahontas and the Rock Creek districts, the former of which has yielded well. The Salmon Creek, McCord Gulch, Ruan, and Frying-Pan claims have natural water early in the season, and, later, buy of the Auburn Canal Company.

Rock Creek district.—This district has a ditch affording an ample supply of water during the entire season, owned by Ingraham, Ford & Co., who also own a large tract of mining-ground on Little and Big Muddy Creeks, and during the season run three hydraulics. This ditch runs 1,000 inches of beautifully clear water. There is also a smaller ditch affording 300 inches, owned by Iler & McCord, who run two hydraulics. Mr. Ingraham reports that the claims are doing well and considers their ground and water-privileges invaluable. Further down the slope Bunch & Co. are running during the season one hydraulic on Wolf Creek with profit. All these parties can work from April until November and obtain an average of $8 per diem to the man.

Auburn.—This camp has been dull; but a few white companies have worked; and early in the season, for some reason, the Auburn Canal Company refused to sell water, so the little mining done was with natural water, except by Littlefield & Co., who have a small ditch from Elk

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* This must be the freight only. Never having visited these works, and knowing nothing of the local conditions, I merely repeat the statement furnished me.—R. W. R.

Creek, and have been running one pipe all summer, There is plenty of good ground about Auburn, and the camp may revive next season.

Beyond Auburn, at Fort Sumter, and still further toward Granite and Olive Creeks, are fine prospects for gold, quartz, silver, and galena. At Winter's diggings, Bull's Run, and along the gulches far up Burnt River, are scattered little camps, where a small population has done so well in placer-mining as to show that increase of labor and capital would be satisfactorily rewarded.

Clark's Creek.—In this camp and its vicinity the placers are as good as ever, and promise to be so for years to come. There has been no special new discovery.

Eldorado and Malheur City.—These camps have had a very limited supply of water, but, with what they had, they have accomplished much. One man is said to have cleaned up $10,000. There were no new quartz discoveries. The prospects for next season are good.

Amelia district.—This district has been dull and dry; will probably get water from the Big Eldorado ditch next season.

Humboldt or Mormon Basin.—This good old camp holds out as usual, and will for years to come. The ground is all claimed, and the water-privileges are all taken up. There is not nearly enough water to meet the demand. Colonel Colt and L. W. Getchell uncovered this summer their old ledge of rich decomposed gold-quartz, &c., and have been working it somewhat, with the aid of a small mill or crusher, of novel form, invented and erected by Colonel Colt. The success of the experiment has not been reported to me. The mine promises well.

Rye Valley.—This district, thirty miles southeast of Baker City, and just over the divide from Humboldt Basin, bids fair to become a noted silver-producing district. Although known for sometime, but little has been done in developing it. The placers continue to yield well, and the yield of 1872 is rather better than that of 1871. Mr. Green, of Rye Valley, estimates the amount at about $50,000, which is pretty good considering the short season, of sixty to ninety days only, caused by scarcity of water. The mining is done with hydraulics. With a good fall and 100 inches of water the ground pays from $30 to $100 per diem. There is plenty of such ground unworked, but all claimed.

The belt containing the silver-lodes is a granite ridge, about eight miles long and five miles wide. Its longer axis lies in a general northwest and southeast direction. Burnt River is north of it, the south fork of Dixie Creek is south and southeast, the north fork of Dixie, with the town of Rye Valley is east, and on the west are Humboldt Basin, Amelia, Malheur City, Eldorado, and Clarksville. Geologically it appears to be bounded on the east by limestone, and on the other three sides by slate. The lodes are in the granite. Among them may be mentioned, proceeding southward along the ridge, the Monumental, Green Discovery, Macedonia, Pinetree, Mountain, and Washington on the east slope, and the North Star and Rising Sun on the west slope. (The Washington is said to cut into the limestone.) Of these lodes, the Green Discovery and the Monumental, lying about three-fourths of a mile apart, are the only ones that have been developed to any extent, though many of the rest promise well, and the whole range invites more thorough prospecting. The Rye Valley placer-mines are on the north fork of Dixie Creek, between the town and the silver-lodes.

The Green Discovery, owned by Mr. Charles Green, is situated 3,000 feet above Rye Valley. The claim comprises 2,000 feet. It has been explored by four or five shafts of small depth, and three adits run near the surface on the vein, from intersecting gulches. The longest of these drifts has followed the vein 250 feet; and the deepest shaft is down 40 feet. The vein is said to improve with depth in width and value, and to average at present 3 feet. The ore is quartz, carrying oxidized iron, &c., near the surface, and black sulphurets below.

The Monumental claim, 2,000 feet, owned by the same person, lies 4,000 feet above Rye Valley, not far (though on the opposite slope) from the head of Grouse Creek, a tributary of Slate Creek. This mine resembles in character and dimensions the one just described. It has been opened by three shafts, the deepest of which (150 feet) is said to be in rich ore at the bottom, and to have furnished already a considerable amount of high-grade material. There are two cross-tunnels, one 140 feet long and within 15 feet of the lode; the other 125 feet long and estimated to be 50 feet from the lode.

Mr. Green has on the dumps of these two mines from 50 to 75 tons of ore, which he purposes to sort, and ship the selected ore to San Francisco, where he will then purchase a small mill for erection at the mine. One ton sent some time ago, as a test, from the Green Discovery, yielded in San Francisco $283 silver and $4 gold. From the Monumental, one ton yielded $330, and three tons, sold to Selby & Co., brought $270 per ton. In these instances but a trace of gold was reported.

Conner Creek.—This is a small stream putting in to Snake River about twenty miles below Farewell Bend Ferry. Three miles up this creek, *in June, 1871, Messrs. Wood & Edelman* discovered a gold-quartz lode, which they located and afterward sold. The discovery-claim (600 feet) is now owned by Maddox & Palmer, who have an open cut of 60 feet running in on the lode, and a tunnel of 40 feet some 150 feet below the open cut. They have erected and are now running a 5-stamp water-power mill. This being the extent of the available water-power, they purpose erecting in the spring a 15-stamp steam-mill. The ledge will average fully 5 feet in width, and carries white and decomposed quartz with free gold. The bullion is worth $16.78 per ounce, and the rock-mill yields about $23 per ton. The first extension northeast is owned by Hover & McCartney, who have an open cut on the lode, 40 feet long, exposing a good prospect. Other quartz-veins have been struck in this vicinity, but no paying placers have yet been discovered on this creek.

Snake River Bars.—These are mined at every season of low water, near the mouth of Conner Creek, and down the river below Pine Creek, with fair results. Four men worked this season near Connor Creek.

On Burnt River, below Express Ranch, some placer-mining has been done; and during the past season Messrs. Sisley & Weatherbee discovered, near their ranch, eight miles below Express Ranch, an old channel, which has proved quite rich. The parties named have taken out a large amount of money; the yield running even as high as $50 per diem to the man.

Next summer I hope to be able to report rich lodes of argentiferous galena, copper, &c., near Olive Creek, in Grant County, some sixty miles southwest from Baker City. Fine specimens have been brought from that section and several lodes have been located. One called the Mammoth is said to be 5 feet wide. Wood and water are plenty in this vicinity.

The Virtue or Ruckel's mine.—Rockafellow or Union lode, owned by the Virtue Gold-Mining Company, has been repeatedly described in former reports. The present superintendent, Mr. D. H. Jackson, has brought this mine into excellent condition. He is now working twenty Chinamen and twelve white men at the mine. Mr. Jackson is the first man to work Chinamen in quartz-mines north of California. He reports a saving of 50 per cent. from their employment. They work in every capacity—single-hand drilling, &c.

The present workings are 308 feet south of the main shaft, and 85 feet below the level of the long tunnel. The company have steam hoisting-works erected over the main shaft in the tunnel, and run a Blake's pump. The main shaft is down 100 feet below the level of the big tunnel. I learn that my former opinion in regard to the junction of the two veins, the Union and Rockafellow, has been proved correct. They came together in the south shaft, at a depth of 85 feet, giving a 7-foot ledge of gold-ore, and occasionally very rich. Mr. Jackson recently established communication with the old Union works above, and in event of anything occurring to stop work below operations can be continued in the upper levels.

The company have all the machinery on the ground at the mine for a [illegible]-stamp steam-mill, which will be put up at the mine in early spring, to save the cost of hauling seven miles to the present 10-stamp mill at Baker City. The present owners of the mine are Californians. The clean-up for the month of December, 1872, was over $13,000. I am informed that the mine has produced over $80,000 during the past year.

Coal.—In French Gulch, Auburn district, several parallel veins of coal have been discovered, and Mr. Reynolds, of Baker City, has located and partially explored a mine upon them. At the depth of 20 feet the principal bed is $2\frac{1}{2}$ feet thick. A sample from near the surface, and doubtless of inferior quality, was sent me by Mr. Reynolds. According to a proximate analysis by Dr. T. M. Drown, of Philadelphia, this sample contained—

Moisture	14.68
Volatile matters	38.95
Fixed carbon	42.57
Ash	3.80
	100.00

As pointed out in a subsequent chapter, (on water in western lignites,) analyses which do not determine the ultimate constituents afford us reliable data for comparisons of heating power of lignites, since these coals always contain oxygen, as well as hydrogen and carbon, among the so-called volatile matters. The following is the ultimate analysis of the Reynolds lignite, by the same chemist:

Moisture	14.68
Carbon	60.72
Hydrogen	4.30
Oxygen	14.42
Sulphur	2.08
Ash	3.80
	100.00

Or—

Moisture	14.68
Combined water	16.22
Hydrogen	2.50
Sulphur	2.08
Carbon	60.72
Ash	3.80
	100.00

I presume from these analyses that the coal will prove valuable for steam-generation and domestic uses; that it will not coke well, and that it is not suitable for metallurgical uses, except in gas-generators.

CHAPTER V.

MONTANA.

The collection of the mining-statistics of this Territory for 1872 I have intrusted to Mr. William F. Wheeler, of Helena, Montana, whose extensive acquaintance in the Territory has enabled him to send me detailed estimates of the product, and, considering the means at his command, very full data in regard to the several districts. His estimates of the yield of gold and silver of Montana for the year 1872 are derived from shipments by express, from purchases made by bankers, brokers and merchants, and from miners and others who have not shipped by express, and who have given him what they believe to have been the yield of their several mining-districts.

Gold shipped by Wells, Fargo & Co*	$3,471,395
Gold from Missoula, by "pack-trains," to Walla Walla	200,000
Gold taken out of the country in private hands, overland and down the Missouri†	1,500,000
Gold taken out retained in hand by miners for winter expenses	550,000
Total gold	5,721,395

* In regard to this item, Mr. Wheeler says: "I have taken the actual shipments by 'express' of gold-dust and refined-silver bars. But I find by inquiry of the several banks and brokers that they have *purchased* nearly half a million more than the amount reported *shipped* by express, in the Territory. The contracts of the banks in the Territory with the express company begin with May 1, 1872, and end with May 1, 1873. The bankers all say they will be able to fulfill their contracts, as they have four months to make shipments in; therefore the amount will have to be furnished from the yield of 1872, and I am thus justified in adding that sum to the amount named as the yield for 1872 in my report, which will make the total yield of the Territory for 1872 upwards of $7,000,000.

[I quote the above statement, without adopting the suggestion, since it seems to me that there would be no fairness in adding the first shipments of 1873, on the ground that they contained product of 1872, to an aggregate, which, by the same reasoning, must contain a part of the product of 1871. I have, therefore, retained the original figures, representing simply the shipments of 1872.—R. W. R.]

† On this point Mr. Wheeler says: "Toward autumn, after the season's work in our placer-mines is done, large numbers of miners go to Utah, Nevada, and California to seek employment for the winter in the numerous silver and gold-quartz mines there, and return in the spring to work their placer-mines here. They generally go in companies of ten to twenty, and carry with them the product of their past summer's work, in order to avoid 'express charges,' which are from 2 to 3 per cent., and for mutual protection. The sums which they take away are large in the aggregate, and the express company is the least likely to know the amounts, in the case of travelers by the coaches, since the express company assume to charge for all gold carried in this way. Many passengers in the stages take from $1,000 to $5,000 with them secretly, to avoid paying these express charges. I know of one company of miners who traveled by their own conveyance and took out last fall $60,000. I doubt if I have sufficiently estimated the amount thus taken out, by a quarter of a million. Much of this gold is sold in Utah, Colorado, and California, and is deposited in the mints at Denver and San Francisco, and is not reported as the yield of Montana."

SILVER.

Refined-silver bars shipped by express	$97,944	
220 tons base bullion, shipped by wagon to Corinne, value $500 per ton	110,000	
60 tons base bullion, shipped East, via Fort Benton, at $500 per ton	30,000	
410 tons silver-ore,* shipped by wagon to Corinne, value $200 per ton	82,000	
135 tons silver-ore, shipped East—75 tons via Fort Benton, and 60 tons by wagon to Corinne—value $200 per ton	27,000	
		346,944
Value of copper-ore shipped for assay		5,000
Total coin value		6,073,339

The foregoing estimate is accompanied with the following certificate from leading citizens of Montana, which refers to the estimate for the previous year also:

The undersigned, citizens of Montana, have examined the data upon which the foregoing estimates are based, and are satisfied that Mr. Wheeler has made a very moderate statement of the gold and silver yield of Montana for the year 1872. We have also examined his report for 1871, and consider his estimate of $8,050,000, as the yield for that year of gold and silver from the mines of Montana, as very correct.

D. C. CORBIN,
Cashier of the First National Bank, Helena.
T. H. KLEINSCHMIDT,
Assistant Cashier First National Bank, Helena.
GEORGE W. FOX, of FOX, LYSTER & ROE,
Bankers.
L. H. HIRSCHFELDT & BRO.,
Bankers.
R. E. FISK,
Editor of the Helena Herald.
D. S. WADE,
Chief Justice.

I am confident that the above estimate is largely *under* the actual yield.

S. T. HAUSER,
President of First National Bank.

I have deemed it unnecessary to go again, in the present chapter on Montana, over the whole ground treated in my former reports, especially as the changes in the placer-mines, as well as in the older quartz-districts, are not great. I have, therefore, mainly confined myself in the present report to the description of the new silver-districts, which, through the stimulus exerted by the success of the silver-mines of Utah and Nevada, and the near approach of railroads, have sprung up in all parts of the Territory.

I have always, and especially since my personal visit to the Territory, considered Montana an excellent field for this branch of mining, and the developments made during last year have confirmed me in the high opinion which I have heretofore held in regard to the great value of the Montana silver-ores.

*Mr. Wheeler says: "There are, to my own knowledge, more than 3,000 tons of silver-ore lying on dumps at the mines, and waiting for purchasers, or for spring to permit shipments, &c., of which I have made no account. This cannot probably be included, the value being uncertain, and the amount, whatever it is, sure to find a place in the aggregate for a succeeding year.

It is noteworthy that most of the silver-ores in Montana occur in fissure-veins, and not in limestone-deposits. This circumstance encourages the hope that the silver-mining industry of Montana, if it does not bring forth such an immediately brilliant and voluminous product as certain districts in Utah and Nevada have done, will at all events be more enduring and permanent.

BEAVER-HEAD COUNTY.

Notes in regard to the silver-districts of this county have been furnished by Mr. S. F. Dunlap, of Bannock.

The yield of gold and silver for the year 1872 is estimated by him to have been over $300,000, $50,000 of which was in silver-bullion. There were also shipped to the East over 100 tons of lead-bullion. Two tons of lead and two tons of rich silver-ores, from the Del Monte and Huron lodes, were shipped to Swansea, but up to the present time nothing has been heard in regard to the proceeds. There were also several tons of copper-bullion smelted from the Greenwich and shipped East. The value in gold and silver of this shipment is not stated.

The principal silver-developments during the past year have been made in the Blue Wing district, which is situated from two to five miles east of Bannock. There has also been a good deal done in Vipond district, about forty miles north of Bannock. But little has been done at Argenta. Argenta is about fifteen miles north of Bannock. It has been much neglected the past two years, on account of the greater richness of the mines developed in the other districts.

In Blue Wing district the lode from which the district takes its name was the first discovered and recorded. It occurs in limestone. The ore is a rich argentiferous galena, and the vein is on an average 6 inches wide, opening out now and then into large pockets. It was not traceable on the surface, but has been opened for 80 feet along the course. The shaft is 150 feet deep. In the last few feet the ore pinched, but the workmen are still sinking, with every prospect of developing another body of ore. About 200 tons of the Blue Wing ore was sold to the Argenta furnaces, bringing at first $35 per ton, but lately $65 has been paid. At present there are only 3 or 4 tons of first-class ore on the dump.

The Whopper is in the vicinity of the Blue Wing, and contains both smelting and amalgamating ores. The ore-streak is 12 inches wide, in a crevice of 3 feet. It is not traceable on the surface, but has been uncovered in length for 80 feet. The main shaft is 70 feet deep, and shows plenty of ore in view. The ore occurs rather in pockets, the country-rock being limestone. About 200 tons of ore have been raised, which brought $35 per ton.

Some work was done on this level during the winter, but, owing to the insecurity of the shaft, the prospector, Mr. Larwell, took his men off, and put them to work on the Potosi, an undeveloped lead of great promise, and traceable on the surface by the rich croppings over 1,000 feet.

The Joe Davis is located several hundred feet east of the Whopper. The vein is 8 feet wide. The ore is a brownish-black mineral, containing much blende and a small percentage of galena. There are 75 tons on the dump. The wall-rock is galena.

The Kent is a large vein of silver-bearing rock in the same hill. It contains principally amalgamating-ore, with a small percentage of galena. There are 60 to 70 tons of ore on the dump.

The Charter Oak is a large vein containing first-class silver-ore. It is not traceable on the surface. There is one shaft 40 feet deep. The crevice in it is 8 feet wide, and uniform in size from top to bottom. The ore is a mixture of green and blue carbonates of copper, and gray and brownish-black lead and silver minerals, sulphuret and chloride of silver being quite frequent. Over three-fourths of the ore is good smelting material. Of the 135 tons on the dump, over 100 tons are first-class ore. The owners, Messrs. Nay & Herr, have resumed work, and will sink during the winter months. There is very little waste or gangue in this lead. It occurs on the dividing-line between limestone and granite, as are also the Puritan and Silver Rose. There has been a good deal of work done on these latter leads, but they are idle at present. From 25 or 30 tons of ore are on the dump of the Silver Rose. Quite a lot has been sold.

The John Wesley is a pockety vein in limestone. The shaft is 40 feet deep. The ore is very rich, according to assays which have been made, and is excellent milling-ore. Several tons were crushed in the Butterfield mill the past summer with most satisfactory results, although the mill was poorly fitted up for silver ores. This was the only satisfactory experiment in amalgamating silver-ores ever made in the country.

The Rollins is an 8-foot vein cropping out in the limestone for a distance of 1,000 feet. It is one of the new discoveries, and but little work has been done on it. There are 8 or 10 tons of ore on the dump. The vein is of uniform width so far as it has been developed.

The Whittrick is another strong ledge cropping above the surface in the same formation, and is visible over 500 feet. There is a shaft 15 feet deep, in which the vein is 5 feet wide, and the ore assays high. The two last named leads are now lying idle.

The Sibley, situated in limestone, has two shafts 35 to 40 feet deep, and a tunnel 200 feet long driven on the course of the vein, which is 3 feet wide. A large amount of ore has been smelted, but it is really milling-ore. It averages $70 per ton by numerous tests which have been made. There are 50 tons on the dump. The proprietors, Wright & McMeen, are resuming work again.

The New Departure, belonging to the Hon. G. W. Stapleton, is in limestone. The vein is irregular and full of pockets. Mr. Stapleton is now running tunnels and otherwise developing the lead. The vein proper is 3 feet wide. There are two tunnels of respectively 90 and 100 feet in length, developing the vein for a distance of 300 feet. Twenty tons of ore were sold to the Argenta furnaces for from $45 to $60 per ton. There were also shipped seven tons to the Bank of California, for which a return of $1,900 currency was made. The lead contains both smelting and amalgamating ores.

The Del Monte lies in granite, but the ore is easily dug out with pick and shovel. The shaft is 50 feet deep and exposes well-defined wall-rocks. There is one tunnel being run along the vein, 190 feet long. The vein-matter is 2 feet thick at the surface and 6 feet at the bottom of the shaft. The ore-streak of black and brittle silver-ores is 6 inches wide. Forty tons were sold to Bohen & Co., of Argenta, at $40 per ton. One ton was shipped to Swansea last summer, but no return has yet been made. The assay, however, gives $331.82 per ton. The lead is one of the best developed in the district. It is traceable for 500 feet on the surface.

The Czar is also in granite, and easily worked. The vein is 3 feet wide, and there is a tunnel along its course 75 feet long. A shaft on it is 55 feet deep. Fifty tons, sold to Bohen & Co., brought $30 per ton.

Over 50 tons are now on the dump. The lead is traceable for 550 feet. The walls are smooth and the vein regular. The ore is the same as that occurring in the Del Monte, but is harder and contains less lead and more copper.

The two last-named leads belong to Messrs. Sears & Smith, who are at work on them, putting them in shape for selling ore.

The Pony is also in granite; it is a galena vein and easily worked. The ore assays rich in silver. The vein is one foot thick in the bottom of a shaft 45 feet deep. The walls are smooth and regular.

The Snow Drop and Good Friday are both on the same hill, and in limestone foundation. The Good Friday runs along the apex of the ridge, cropping out, and traceable for a thousand feet. A tunnel 50 feet long has been run to intersect the vein, which is exposed in several places. The Snow Drop is 200 feet below, on the south side of the hill. It is a pockety deposit of excellent amalgamating ore. According to assays, the ore contains several hundred dollars per ton. The mine is now being worked, and there are 25 or 30 tons of ore on the dump.

The Great Western is an 8-foot ledge, cropping out in the limestone for a length of over 400 feet. A shaft 15 feet deep has been sunk; it exposes amalgamating ore, an assay of which yielded $143 per ton. There are 25 tons of ore on the dump. Bohen & Co. offered $25 per ton for this ore. The owners, Messrs. Sears & Smith, have neglected this claim somewhat, spending their time in developing other leads.

The Black Hawk No. 2 is owned by J. C. Taylor, who is constantly working on the vein. At this time he is down 247 feet, the vein lying in granite. It shows a uniform size of about 3½ feet. The walls are smooth and regular. The ore contains a considerable amount of iron pyrites, and many assays give a value of from $50 to $150 per ton. There is a large amount of ore on the dump, probably not less than 350 tons, 25 tons of which are expected to assay $150 and the balance $50 per ton.

The Huron is one of the old discoveries in the limestone. There are seven shafts along the lead, from 35 to 80 feet deep. The vein is prospective for 600 feet in length, and is rather irregular, but may be set down at an average width of 3 feet, opening, now and then, into larger pockets. This ore is a sulphuret of silver, and occasionally specimens of chloride of silver have been found. Assays have yielded from $500 to over $900 per ton. Mr. Batchelder, the owner, sold 35 tons of ore at $100 per ton. There are now 65 tons of first-class ore on the dump, and from 15 to 20 of second class. One ton of ore from this mine was shipped, with the Del Monte ore, to Swansea. No return has been made.

The Bonaparte lies in granite. The shaft is 35 feet deep, and shows the vein-matter to be 6 feet wide between walls. The pay-streak of solid ore is 2½ feet thick, and contains much galena. The lode is prospective in length for 150 feet. Thirty-eight tons were sold, at $25 per ton, to Bohen & Co. Assays have varied from $276 to $1,100 per ton. This ore contains also $70 in gold per ton. The owners, Messrs. Bassett & Ney, are now taking out ore, and have probably 150 tons on the dump.

The British Empire is a newly-discovered lead of great promise. It is traceable for about 400 feet. Fifty tons of milling-ore are on the dump. The vein crosses a limestone ridge. The ore is decomposed and of a cream color. An assay made of it yielded $372 per ton.

The Pomeroy runs along the apex of a limestone ridge, northeast and southwest. It has the largest croppings in the district, protruding as high as 8 feet above the surface. It is 8 feet wide, traceable for 2,000 feet, and for 1,100 feet on the extension. There are seven shafts sunk on this ledge, from 20 to 70 feet deep. The vein has been prospected for 1,400 feet. At a point where the vein crosses a deep ravine, it is 20 feet wide. The ore is yellow and often stained blue and green. There are over 500 tons of this ore on the dump. Thirty-three tons were sold to Bohen & Co. at $35 per ton. The vein dips to the north, and is shown 8 feet wide in the bottom of the deepest shaft, but the north wall has not been reached. Messrs. A. Bassett and A. J. Ney are the owners. They have recently bonded the property for a large sum of money, and have suspended work for the present to await results.

The Queen of the West and the Nodoway are on the Black Hawk Hill, and in granite. The shaft on the latter vein is 40 feet deep, showing a vein of uniform size for the entire distance. These leads are idle at present.

The Union, in the limestone and in the vicinity of the New Departure, is a large vein of most excellent yellow ore, tinted with blue and green. Mr. Bassett is now developing this lead preparatory to the production of ore. It may be asked why the owners of these rich leads have not continually taken out and sold or shipped ore. The answer is simple. The smelting-works, which had been run by Mr. Bohen, were shut up in the middle of the summer, and no other furnaces were prepared to run. There was consequently no demand at home. As for shipping the ores, it had first to be proved that they would pay to ship. Matters came thus to a dead stand. The owners of the various leads, being poor men, were obliged to look elsewhere for work, to obtain the necessaries of living. Some went to Utah and Nevada in search of employment. At this time Mr. Isaac Roe shipped one ton of Del Monte and one of Huron ore, together with two tons of argentiferous lead, to Swansea as a test, but, so far, he has not received any returns.

In the mean time Mr. Stapleton shipped 7 tons of the ore from the New Departure to the Bank of California, and recently obtained an answer with results as before stated. It is now probable that considerable ore will be shipped during the next summer, although the means of shipment are so slow—ox-teams and mules—that it requires a whole season to get a return.

At the same time much enterprise cannot be expected until transportation is certain, quick, and cheap; and this can only be furnished by railroads.

Argenta district was the first-discovered silver-district in the Territory.

There are many leads recorded in it. The formation is limestone, and the mineral-deposits are pockety and frequently broken. They contain more lead and iron than those of the Blue Wing district. The hill on the north side of Rattlesnake Creek is full of pockets of all sizes.

The Legal Tender is traceable on the surface for 700 feet, and has been prospected for a thousand feet. There are three shafts from 70 to 130 feet deep. In the early days of smelting at Argenta, over 300 tons of ore were sold from this mine, which yielded an average of $200 per ton. The vein is irregular, and about 16 inches wide on an average. The ore is rather solid galena.

The Kate is 6 feet wide. The gangue is iron-ore, containing a small percentage of galena. Forty tons of this ore brought $30 per ton on the dump.

The Stapleton is 3 feet wide, and contains amalgamating-ore. The shaft is 130 feet deep. Two hundred tons of ore were sold to the Saint Louis Company at $40 per ton.

The Brownell has two shafts 75 feet deep, and a tunnel of 60 feet along the vein, which is 2½ feet wide. The ore is carbonate of lead.

The Silver Light has a shaft 50 feet deep, the vein being 18 inches wide. The ore is rich argentiferous galena.

The Cable is an 8-foot vein of carbonate of lead, and has a shaft 40 feet deep. Over 300 tons of ore have been taken out and sold for from $5 to $10 per ton.

The Tuscarora contains carbonate of lead, and is rich in silver.

Besides these there are hundreds of holes sunk on other leads, from a few feet in depth to 40 or 50 feet.

The failure of the furnace last summer put a stop to all further development. The permanence and richness of the leads in the new Blue Wing district did also their share to attract the attention of the miners, and to draw them away from Argenta.

Bald Mountain, ten miles northwest of Bannock, contains many leads of gold, silver, galena, and copper, but few of them have been developed.

The Badger is a 2-foot vein of argentiferous galena and milling-ore. There is a shaft on it 18 feet deep. Average assays gave $100 per ton. There are 25 tons on the dump.

The Bald Mountain has a 3-foot vein of argentiferous galena. A tunnel has been run 80 feet along the vein. There are 70 tons on the dump. Thirty tons have been sold to the Bannock furnace at $25 per ton.

The Shoo-Fly is a carbonate-of-lead vein, 2 feet wide, and traceable on the surface for 300 feet. A shaft 30 feet deep has been sunk. There are 60 tons of ore on the dump. A few tons were sold at $25 per ton to the Bannock furnace.

The Muck-a-Muck is a strong copper-deposit, rich in gold. By crushing the ore the gold is easily panned out. There is a shaft 15 feet deep, and 75 tons of ore on the dump. It is from 30 to 40 per cent. copper.

There is no work being done on these leads this winter.

On the Big Hole, from sixty to eighty miles northwest of Bannock, there are numerous leads of copper, iron, and gold. The Sherman is the only one recorded. It is a prominent ledge, 10 feet wide. The ore is copper, and bears gold. There is a shaft 10 feet deep, exposing to view a vast amount of ore. It is traceable on the surface several thousand feet, cropping out.

In the hills twenty-five to forty miles west of Bannock, are rich copper-croppings, but no attention is paid to them.

Birch Creek is pre-eminently a copper-district. Besides the copper-veins there are extensive ledges of magnetic iron.

The Greenwich is a strong copper-vein, bearing both gold and silver. The croppings are easily traceable for five miles, and the vein is 8 feet wide. There have been seven extensions recorded. The shaft on the Greenwich is 80 feet deep, and shows smooth granite and slate walls. The vein is of uniform width to the bottom of the shaft. Over 100 tons of ore have been taken out, and about 50 have been sold to Bohm & Co. at about $10 per ton on the dump. The veins of this district run north and south, and are in granite or slate. The first Greenwich Extension has a shaft 130 feet deep, showing the same width of vein and characteristics as the Greenwich. There are perhaps over 200 tons of ore on the dump.

The Treasury has a shaft 30 feet deep. It is richer in copper than the Greenwich. This ore is said to yield $800 worth of metals per ton.

The Treasury Extension lies between the Treasury and Greenwich, and in a direct line with them. There is a shaft down about 10 feet, showing the same width of crevice and character of ore as the Treasury.

The Algoma is several hundred feet east of the Greenwich. This vein is 3½ feet wide, and about one-third of the ore is copper-ore. The lead is not traceable on the surface.

There is also an extensive tract of country west of Beaver Head Valley along the foot-hills and mountains, in which there are numerous ledges of iron, copper, and gold. But few of these have been opened, and this so long ago that they are now almost lost and abandoned for the present.

Vipond district.—From this district, which is described at length in my last report, I have the following additional notes furnished by Mr. Charles Wunderlich:

The developments during the past year are slight, the isolated position of the district in the rough Big Hole country keeping back investments of capital. The ores are mainly milling-ores.

Banner, course east and west, crops out prominently for 800 feet; width, 6 feet; depth of shaft, 40 feet; ore on dump, 40 tons; average assay value, $200 per ton.

Argyle, course east and west, dip north, crops out for 1,000 feet; width, 8 feet; depth of shaft, 20 feet; ore on dump, 15 tons; average assay value, $165 per ton. Great quantities of "float"-rock are found below the lode, much of which is rich ore.

Bismarck, course north and south, crops out for 500 feet. This lode was recently discovered, and no developments of consequence have been made. The surface ores assay well.

Humboldt, course north and south, crops out 400 feet; width, 6 feet; ore on dump, 35 tons; average assay value, $200.

Gray Eagle, course north and south; width, 10 feet; ore on dump, 100 tons; average assay value, $90 per ton.

Mammoth, course north and south, crops out for 1,000 feet; width, 7 feet; ore on dump, 200 tons; average assay value, $100 per ton. Some of this ore was sold on the dump, broken up, sacked, and packed on mules to Argenta, a distance of thirty miles. It was there put through the smelter, but as the ore contained but little, if any, lead, it was thought it would not pay to work it by that process.

Juno, course north and south, crops out 700 feet; width, 5 feet; ore on dump, 25 tons; average assay value, $125 per ton.

Horace Greeley, course north and south; width, 10 feet; ore on dump, 25 tons.

Gray Jockey, course north and south; width, 14 feet; ore on dump, 300 tons; average assay value, $50 per ton.

A wagon-road to the district was made last fall. A Pittsburgh company contemplate building a mill next spring on the Big Hole River, about four miles distant from the principal claims.

DEER LODGE COUNTY.

From this county I have received very little specific information; and especially of the placer-mines of the county, from which by far the largest part of the gold-product is derived, the returns have been very meager.

Mr. Conrad Kohrs, of Deer Lodge City, the owner of the rich placer-ground immediately below the Atlantic Cable lode, which has been described in my last report, is the only one who has sent a report.

Work on this ground was commenced on June 10, and continued, with several intermissions, until October 20. The amount taken out during that time was $37,000, 25 per cent. of this amount having paid all expenses of working the mine.

More important in the present stage of development of the Territory are the quartz-veins, especially as, to all appearances, the time is near at hand when railroad-communication will render economical reduction of ores and transportation at low prices feasible.

The best-known silver-district in the county is

Flint Creek district.—This district is situated some thirty-five miles to the northwest of Deer Lodge City, and twenty-five miles above the junction of Flint Creek with the Hell Gate River. The silver-bearing lodes are located in the foot-hills south of the creek, three small streams flowing into it passing through the district.

The country-rock is limestone, highly crystalline in some places, so much so that it approaches marble in its purity and appearance. The lodes of most value are found near the contact of the overlying stratified rocks with the granite, into which several of the ledges are known to penetrate, although in such cases the ore has been found to yield less per ton than in the other formation. The limestone is regularly stratified, and the greater number of the ledges run parallel to each other, crossing the stratification of the country-rock at right angles. The general course of the veins is from northwest to southeast. The character of the ores in the ledges is, in one portion of the district, that of "free milling-ores," while in the other "base-metal" ores abound, the latter being far richer than the former. These base ores consist of copper, lead, antimony, zinc, arsenic, and manganese, associated, in their several forms of chemical combinations, with the sulphurets and other ores of silver.

In 1866 a party of prospectors from Idaho, journeying to the then celebrated Blackfoot diggings, discovered "float" silver-quartz in the valley of Flint Creek, and returning the following autumn they went up into the foot-hills and found silver ledges cropping above the country-rock in every direction. They at once proceeded to lay out the district and record the ledges. During the winter the exhibition of ore from the Poor Man and other lodes, by C. W. Frost and others in Helena, caused considerable excitement, which culminated, early in the spring of 1867, in a grand rush to that camp, which was believed to be another "Washoe." The town of Philipsburgh, containing some three hundred houses, sprung up as if by magic, and some four hundred locations of ledges (?) were made, very many being "wild-cat." The Saint Louis and Montana Mining Company* erected a 10-stamp mill at an enormous expense, but owing to the company's complications the mill has run but a comparatively short time since its construction, having produced probably about $250,000 in the aggregate. There were few in the county who understood the proper means of reducing refractory ore,

*From the Hope Mining Company, of Saint Louis, successor to the Saint Louis and Montana Mining Company, I have received a letter protesting against the statement on page 278 of my last (fourth annual) report, in which that company is charged with injuring the district by a system of "freezing out." The letter says: "Our companies are composed of honorable and prominent men, and we have expended nearly $800,000 in money in Montana, not including interest. The property we hold was obtained by purchase, and we owe no debts. The various causes which led to a suspension of milling-work have not the most distant connection with a desire to 'freeze out,' falsely ascribed to us."—R. W. R.

and hence attempts to work those of a base character by the ordinary free-milling process resulted disastrously. Mr. Cole Saunders, in 1868, shipped 15 tons of base ores from the Poor Man's Joy lode to Newark and Swansea, which yielded $300 in coin per ton, but owing to the excessive charges for transportation the shipment of ores was then abandoned. As the base ores could not be profitably reduced by the process adopted in the Saint Louis mill, it was concluded that they would therefore smelt, as they contained some galena. Mr. Saunders, with limited means and encountering many difficulties, erected smelting-works, consisting of two cupola and a cupelling furnace, using horn-blowers driven by steam-power. In the fall of 1870 the works were completed, but thirteen attempts to smelt the ore of the Speckled Trout mine resulted all disastrously, producing in the aggregate not over $1,500; so this method was abandoned. The cause of the failure was the lack of proper fluxes. Saunders & Co. were bankrupt, with liens and mortgages resting over both mine and works, and in this condition the latter were leased to Colonel J. J. Lyon, who proceeded also without capital to take ore from the Speckled Trout mine, crush and ship it to Nevada and San Francisco, obtaining cash advances thereon from the First National Bank of Helena sufficient to pay current expenses. Becoming satisfied that the ore could be reduced in the district, and that the heavy transportation charges could thus be saved, he began converting the smelting-works into a dry-crushing mill. Unable to secure capital or machinery, and depending on credit alone, five wooden-stemmed stamps were made, also an amalgamating barrel of one ton capacity, and a wooden settler, while the cupelling furnace was changed into a reverberatory for roasting purposes. At length, with green and inexperienced men, the old Reese River process was tested in November, 1871, and proved more successful than had been anticipated, an average of nearly 90 per cent. of the sulphurets of silver being chloridized and saved by amalgamation. At the start 10 per cent, of salt was used, but experience has reduced this to 6 per cent., giving equally satisfactory results. The home-made machinery was imperfect, and not adapted to constant work. The cold weather of the past winter delayed operations. In the spring of 1872 arrangements were made by which the Saint Louis mill was changed, as far as practicable, into a dry-crushing mill, and furnaces were erected with drying-kiln, &c., attached *at the expense of the lessees*. Five hundred tons and over of Speckled Trout ore were run through at the rate of less than 5 tons per day, producing from $125 to $138 per ton. Twelve tons of ore from the same mine, and of no more than average richness, were recently worked by barrel-amalgamation, and yielded $148 per ton. Efforts are being made to induce capital to invest in the Speckled Trout mine, for the purpose of clearing the incumbrances resting over it, and the erection of approved machinery to reduce its rich ores. Shipments of ore from the Speckled Trout mine to San Francisco yielded $166 per ton. A small quantity sent to Reno yielded over $190 per ton.

The Speckled Trout mine is the leading and richest mine in the camp, and is opened by a shaft, on the discovery, by a tunnel on No. 3 southwest, and also by an incline on No. 2 northeast. The ore has peculiar characteristics, which enable it to be readily distinguished from all others found in its vicinity. On discovery, where the principal work has been done, the dip of the vein is about 15° from a perpendicular. At the surface the vein is 7 feet wide and over; at the depth of 50 feet it is over 8 feet in width, and at the deepest working of the mine it is 9⅔ feet wide. At the surface the average assay of ore has been $143 per ton; at the depth of 50 feet it averages $155, while in the bottom of the incline (deepest point reached) the average yield, by fire-assay, has been $173 per ton. The main shaft is 85 feet in depth; from its top runs an incline, on the vein, at an angle of 45°, which intersects a level running northeast from the bottom of the shaft for 100 feet from it, and continues below this level some 26 feet. The ore on No. 2 northeast and 3 southwest is not so wide nor quite so rich as on discovery. On the former number the vein enters the granite, but the point of connection is not fully developed.

The Cliff.—This lode is located on the Front Hill, and crops out for a considerable distance. It is developed by a shaft of 60 feet in depth, and assays some $70 per ton. Owned by Saint Louis and Montana Mining Company *et al.*

The Cliff Extension.—Developed by a shaft of 40 feet in depth; vein, 4 feet wide; assays (average) $120 per ton; owned by Estell & Holland.

The Franklin lode, has several shafts sunk upon it; width about 2 feet; assays $80 to $100 per ton. Owned by Ullery & Merrill.

The Cordova, opened by a tunnel, about 3 feet wide, assays about $50 per ton. Owned by H. Horton and others. This was the first lode discovered in the district.

The Comanche lode is called free-milling, but later developments show it to be of the baser class. Opened by tunnel on the vein over 1,000 feet and shafts on nearly all claims. It varies in width from 2 to 20 feet, and assays from $25 to $50; native silver (leaf) is found occasionally in this ore. Owned by Brown Brothers, Merrill, Saint Louis and Montana Mining Company, and others.

The Emma lode, opened by a shaft 60 feet deep, vein 6 to 8 feet wide, assays over $100 per ton and is free-milling ore. Owned by Estell, Holland & Ullery.

Poor Man's Joy lode, opened by a cut 160 feet long, showing face of vein, has about 6 inches of ore, which assays over $1,000 per ton. Owned by many persons.

The Pocahontas lode, located near the "Trout," crops out 800 feet, and is about 4 feet wide; opened by tunnel, running on the vein 64 feet; assays 75 per ton. Owned by M. L. Saunders, C. W. Frost, and others.

Kitty Clyde, on Trout Hill; 3 feet wide; assays $40 to $60 per ton, and opened by cut.

Potosi lode, opened by shaft 70 feet deep, vein 4 feet wide; assays about $40, and is free-milling ore.

There are quite a number of other ledges which bid fair, if opened, to prove valuable, but the above are the principal ones which can now be classed as lodes.

There is an abundance of water for milling purposes in the district, and all the lodes are readily accessible by teams. The supply of wood consists of spruce and pine, and is sufficient for many years to come. Brick of a fair quality is made from clay obtained a mile from town. The valley affords a fine range for stock and is of sufficient extent to furnish subsistence for many herds. A fine road leads to Deer Lodge, and the district needs but machinery and capital to operate with, to annually add much to the silver production of the country.

The quartz-lodes of Butte City.—The following is a synopsis of a report on the quartz-lodes of the vicinity of Butte City by the late Professor James P. Hodge, geologist, which has been re-arranged and brought down to date, by Mr. Granville Stuart, of Deer Lodge City. These lodes have never been described in detail in former reports. At the present time, however, all discoveries of quartz-lodes, and especially of such valuable ones, have acquired new importance from the fact that they can now be profitably brought to add to the product of the Territory.

Near the placer-mines of Silver Bow and Butte City are found some very promising veins of argentiferous copper and lead ores. The best of these are from one to two miles northeast of a remarkable conical hill on the north side of Silver Bow Creek, known as the Butte, which gives to the group of miners' cabins in the gulch near the veins the name of Butte City.

It is a peculiarity of the placer-gold found in this vicinity, that it is largely alloyed with silver; so that its real value is only about $14 per ounce; hence, one would naturally expect the lodes or veins to be of an argentiferous character. A remarkable series of veins crosses the principal gulch or ravine of the neighborhood, about a mile north of the main branch of Silver Bow Creek, and about half a mile west of the east branch of this stream. The veins pursue a general northeast and southwest course, through a granite formation. Some are conspicuous quartz-ledges, rising prominently above the surface, the greater hardness of this material over that of the granite around having enabled them to better withstand the denuding and disintegrating agencies which have in the course of ages worn away the country-rock.

These quartz-ledges sometimes present as their outcrop a fine display of copper-ores; others are marked by narrow naked belts or strips of ground, and still others by pieces of vein-stone and ores scattered along air line.

The lode called the Original is very remarkable for the extraordinary exhibition of green and blue carbonates of copper it presents for several yards in width, and for over 2,800 feet in length. The surface is almost completely covered with these ores. Along the line of the lead the appearance is as of a road over which the ores had been hauled and profusely scattered. By means of these croppings the line of the lead can be traced continuously for over half a mile, embracing the Original and Parrott lodes, which are, undoubtedly, both on the same great fissure. Below the surface on these lodes, red oxide of copper makes its appearance intermixed with the carbonates. These, as in other copper-mines, will be found mostly as surface ores, resulting from the effects of the atmospheric and other agencies upon the still richer oxides and sulphurets of copper of greater depths. Their abundance at the surface, and the great width of the veins in the shafts, give sure promise of large quantities of ore.

On the discovery claim a shaft has been sunk 14 feet deep, and in this the vein is seen well defined from 30 to 34 inches wide, consisting of green carbonate intermixed with red oxide. The walls are of granite and well defined, the south wall is hard, and the north or foot wall is soft and somewhat decomposed. The vein throughout both of these lodes dips to the south at an angle of about 80°.

On claim No. 3 east from discovery (each claim, and also discovery-claim, consists of 200 feet along the lode by about 100 feet wide) is a shaft 20 feet deep, in which the vein appears 4½ feet thick, and filled with fragmentary green carbonate of copper. The wall-rocks are very well defined, and of granite. The vein-matter in this claim is said to assay well in gold. On claim No. 4 east, is a shaft about ten feet deep, and it shows about the same vein-matter as on No. 3 east. On No. 5 east is a shaft about 16 feet deep, in which the vein-matter is solid and well defined, gradually widening as it goes down, until at the bottom of the shaft it is 2½ feet of green and blue carbonates, showing many fine specimens of native silver. On each side of the solid ore are 3 or 4 inches of "gossan," or iron-stained, decomposed vein-matter, and the wall-rock is a granite which is soft and partly decomposed, giving great facilities for sinking on the lode. On No. 6 east are two shafts, about 8 and 10 feet deep respectively, and about 40 feet apart, from which the surface-ores are said to assay as high as $200 to the ton. At the bottom of the shafts the ores seem of about the same character as that of the claims before mentioned.

At or near claim No. 9 east, on the Original lode, the vein is supposed to connect with or run into the Parrott lode, for, as before stated, there is no doubt but these lodes are both situated on the same fissure.

The claims on the Original lode west of the discovery-claim are also very promising as far as claim No. 5 west, but not so well developed as those lying east of discovery. The course of the Original and Parrott lodes is N. 60° E. and S. 60° W. by compass, the needle varying about 21° east. The Parrott lode has a shaft sunk on No. 5 west of discovery, about 100 feet deep, in which the vein is about 2½ feet wide. Twelve inches on the south or hanging-wall are green and blue carbonates, while the other 1½ feet of ore are of a different character. This ore is said to be gold-bearing rock of good quality. There is a shaft on the discovery-claim about 24 feet deep in which the vein is about 16 inches thick, well filled with green copper ores, and well marked by distinct walls of granite.

There is also a shaft on No. 3 east of discovery-claim which is down 72 feet, and which shows about the same width and character of ore as discovery and No. 5 west. The owner of this claim has refused $25 a ton for his ore on the dump. There is a shaft on No. 7 east, down 7 or 8 feet, exposing the vein, which is about the same in every respect as that shown in the other shafts. The assay for silver as seen below does not give so large a proportion of this metal as the ore of the Original lode is found to contain.

The Gray Eagle lode lies near the Original, and the indications are very strong that it is only a short branch or spur of that lode. For, at No. 4 east on the latter, the Gray Eagle is about 300 feet south, and its general course is such as to create the belief that it unites with the Original at or near No. 2 west and with the Parrott lode at or about discovery-claim, while the vein itself dips north towards the Original at an angle of about 40°. They will therefore probably unite at no great depth. There is a shallow hole sunk on the Gray Eagle in a gulch or ravine, which shows some beautiful ores of copper, and galena or lead ore. There seems to be a greater proportion of galena in this lode than in the Original, but working-tests will most likely prove the ores to be identical. On the discovery-claim on the Gray Eagle is a shaft, 8 or 10 feet deep in the soil and 12 to 15 feet deeper in the loose rubble. The green and blue carbonates and red oxide of copper appear in a streak about 8 feet below the surface. Under this the vein consists of a species of hematite, from 1 to 1½ feet thick, and is not very well defined. The iron-ore may be regarded the same as the "gossan" of the Cornish miners, which, with them, is considered a favorable feature when occurring on the upper or hanging wall. They have a popular saying that "gossan always rides a good horse."

About the east end of the Parrott lode begins another lode, called the Mountain Chief, which some think an extension of the Parrott, while others think it runs parallel to the latter. The vein is from 4 to 5 feet wide, but is not very well defined, and is of about the same appearance as the Gray Eagle, but it seems to contain no metal of any consequence, except copper, of which the ore is claimed to contain about 65 per cent.

Another promising vein of argentiferous copper-ore is called the Moscow. It is opened on the summit of a high hill about 300 yards northeast from the Original. But little work has been done on the lode, the outcrop being sufficiently conspicuous to exhibit its surface-character. The course of this ledge is east-northeast, its thickness about 10 feet, the ores green and blue carbonate of copper, mostly concentrated in 3 feet on the southeast side of the vein. The chief exposure is on the discovery-claim.

The Buffalo lode is opened in a ravine some distance east of the Moscow. From the shaft have been taken considerable quantities of galena, which comes out in large masses evidently from a large vein. Intermixed with this ore are black and yellow blende (sulphuret of zinc) and pyrites of iron and copper. Such mixtures would be difficult to reduce, and will only be of value for the silver that may accompany them. By my own assay I found none of this metal in one sample, and in another a proportion equal to $101 to 2,000 pounds of lead. Should further assays indicate the probability of suitable proportions of silver, no doubt need be entertained as to the sufficiency of the ore.

The Pacific Slope lode is a vein near the Original, of which the miners have a high opinion. The discovery-shaft is on the crest of a knoll, but presented nothing that attracted my attention as valuable. There are numerous veins of galena in this vicinity, some of which may prove to be sufficiently argentiferous to encourage their development, and at any rate they are likely to be of importance at some future time for furnishing lead to be employed in separating silver from the copper. They are not themselves so rich in this metal as some of the copper-ores. The proportion of silver obtained from some of them will be seen in the table below.

There are also a number of veins in this vicinity claimed to be auriferous only, to which I gave little or no attention.

Further assays are especially needed of the Parrott and Moscow ores, as these veins appear to be almost as promising as the Original lode. Of this last, numerous assays have been made by others, and, as far as I have learned, they all agree in giving a high value to the proportion of silver in the ore. Professor Eaton estimated the ore as worth about $1,000 per ton for the two metals it would produce.

I have not estimated the proportions of copper nor of lead, for the ores obtained near the surface can hardly be regarded as fair representatives of what will be found below, while I have supposed the metal at greater depths, whether copper or lead, would be more uniform in its proportions of silver. Besides, there can be no question as to obtaining copper and lead ores enough. What is of consequence to ascertain is how much silver will these metals afford or yield to the ton. It may, however, be stated that the copper-ores may be depended upon to yield from 30 to 65 per cent. Some of them contain over 80 per cent. of the metal, and the galena will produce from 50 to 70 per cent. of lead.

Statement of the production in silver of the copper and lead obtained from the ores of the vicinity of Butte City, Deer Lodge County, Montana.

	Silver.
Original lode, 2,000 pounds copper, first assay, give	$445 90
Do., 2,000 pounds copper, second assay, give	396 00
Gray Eagle lode, 2,000 pounds green carbonate, give	442 95
Do., 2,000 pounds red oxide, give	90 96

	Silver.
Gray Eagle lode, 2,000 pounds lead, give	$77 69
Parrott lode, 2,000 pounds green carbonate of copper, give	47 37
Moscow lode, 2,000 pounds green carbonate of copper, give	83 19
Mountain Chief lode, 2,000 pounds red-oxide copper, give	172 44
Buffalo lode, 2,000 pounds lead, give	101 00
Mound lode, 2,000 pounds lead, give	63 17
Clara Moreland lode, 2,000 pounds lead, give	30 32
Wild Pat lode, 2,000 pounds lead, give	56 85
Harper lode, 2,000 pounds lead, give	19 00

Pine and fir timber is found near these lodes, but, to obtain it in great abundance, it would soon have to be brought from a distance of several miles. Forests of great extent and medium quality commence a short distance up the east branch of Silver-Bow Creek.

Moose Creek mining-district.—This mining-district is located in the southeastern portion of Deer Lodge County, and near the silver district known as Vipond, and the gold district of Highland. It is near the main range of the Rocky Mountains, and six miles from the Deer Lodge Pass, a good wagon-road leading to the main traveled road running through the said pass.

The Harvey, Day, and Ben Seymour lodes were discovered during the year 1867, and, during that and the succeeding year, were thoroughly prospected. These lodes crop out upon a high and abrupt elevation, which rises from the banks of Moose Creek. This stream affords an unfailing supply of water—during the melting of the snows in the lower ranges of the mountains as much as 1,000 inches, (miners' measurement,) and never less than 250 inches are available.

The original locators of these lodes first sunk a shaft, following down from the surface-croppings, upon the Harvey lode; and, finding a well-defined vein of rich ore, they went below on the face of the hill and drove in a tunnel, which taps the vein at a depth of about 80 feet. At the point where the tunnel intersects the vein the ore is about 5 feet in thickness, and of a very rich and excellent quality. They then raised a shaft up through the ledge to connect with the opening from the shaft above. In so doing they developed a continuous vein of rich ore encased in granite, the same being from 3 to 5 feet in thickness, and gradually widening as it descends. It contains the richest and finest quality of silver ore ever found in Montana.

The quartz is what is known as free-milling ore, containing no base metals. It is full of rich sulphurets and chlorides of silver, and contains also ruby-silver. There are large quantities of the black sulphurets found all through the ore.

The average assay of all the rock removed is near $400 per ton, the lowest being $200, and reaching as high as $3,500 per ton.

Some 200 tons of ore have been taken from the drift heretofore mentioned. Ten tons of first-class ore were sold to G. W. Stapleton at $100 per ton on the dump, and hauled to Argenta, where the same was worked by the smelting-process, yielding about $375 per ton. Ten tons were sold to S. H. Bohm & Co. for $200 per ton on the dump, and also worked at Argenta by smelting. This lot yielded about $400 per ton. One hundred tons of second-class ore were worked in a gold-mill at Red Mountain City, six miles from these mines, by Professor Swallow, and yielded about $200 per ton.

A sufficient amount of work has been done upon the Day and Ben

Seymour lodes to demonstrate that they carry a vein of good ore of the same character as the Harvey lode, and of nearly the same thickness.

No work has been done since the year 1868, owing to continuous litigation among the owners of the property; but this has now been settled.

The present owners, W. F. Chadwick & Co., of Helena, Montana Territory, who have furnished this description of their veins, are now making application for United States patents for these lodes; and also for three mill-sites situate in front of the said mines and upon Moose Creek.

The rock from these lodes can be dumped from the tunnels directly into the mill to be erected upon the sites above referred to.

There is a great abundance of wood upon the unclaimed lands of the Government in the immediate vicinity of the mines.

By the kindness of Mr. H. L. Wolf, of Red Mountain City, I am enabled to give the following in regard to other lodes in this district:

The Dixie lode is owned by Parks & Dickey. It runs northeast and southwest, and lies in granite. There is an incline on it of 150 feet depth, which exposes good gold-quartz. During 1872 two men were at work on the vein, who have taken out and reduced 280 tons of ore, yielding $14 per ton. Cost of mining and reduction, $4 per ton.

The Canada, owned by Marceau & Lapointe, carries also gold-quartz. The course of this vein is north and south, the dip east as far as worked. An incline is down on it 125 feet, and tunnel, now in 400 feet, will tap the vein at a depth of 100 feet from the surface. Four men were employed in this lode during the year. The number of tons of ore taken out and reduced in arrastras was 300. The average yield per ton was $18; the cost of raising and reducing, $8 per ton.

The superintendent of the Nevins and Last Chance lodes, in Highland, has refused to give any information in regard to these lodes and their working.

Shortly after the close of the year twelve men were employed in these mines running levels.

The yield of the placer-mines in Highland Gulch during 1872 was only about $1,700; that of Black Tail Gulch, (seven miles north of Red Mountain City,) $1,400; and that of Moose Creek district, (Blue Gulch and Dodge Gulch,) $2,000.

JEFFERSON COUNTY.

In this county the principal new developments of the year have been made.

It has been known for several years that rich veins of argentiferous galena, as well as of the true silver-ores, existed in various parts of the county. The erection of the new smelting-works at Helena, in the fall of 1871, however, first created a home-market for ores of that class, and many new mines were therefore opened, of which few of the best-developed are mentioned in the following:

For notes in regard to the new silver-mines, I am indebted to Messrs. B. F. Marsh, C. W. Higley, H. R. Comley, and the owners of the Legal Tender lode.

Jefferson district.—Alta California. Course of lode, northeast and southwest; length of claim, 2,200 feet; dip at an angle with the horizon of 40°; width of crevice, 9 feet; depth of shaft, 100 feet; tunnel, 200 feet long, strikes the bottom of shaft, running southwesterly on the lode; amount of ore taken out during 1872, 300 tons; average assay value, $70 per ton; specimens of pure galena assay $216 per ton.

The War Eagle. Claimants, Embody & Company; length of claim 1,500 feet; width of crevice, 3 feet; paying-vein, 6 to 8 inches; ore very rich; some chloride of silver, assaying $400 to $1,400 per ton, with galena worth $150 to $200 per ton.

The Gregory lode is 2,200 feet long; one shaft 150 feet deep, and two others, each 60 feet deep; also one shaft 40 feet deep; width of crevice, 4 feet; four tunnels, aggregate length, 350 feet; amount of ore taken out not less than 1,500 tons; ore, galena; value of first-class, $125 per ton; value of second-class, $70 per ton.

Minnesota lode. Length of claim, 2,200 feet; depth of shaft, 104 feet; there is also a tunnel 140 feet long; amount of ore taken out, 500 tons; value of first-class (galena) ore, $100 per ton; value of second-class ore, $60 per ton.

Mina lode. Length of claim, 2,200 feet; there is one shaft 150 feet deep on the lode; width of crevice, 4 feet. It contains milling-ore, except a vein 16 inches thick, of galena; average assay value, $70 per ton; amount of ore taken out, 100 tons.

Little Giant lode. Length of claim, 1,500 feet; shaft, 65 feet deep; width of crevice, 4 feet; there is one tunnel, length not known; amount of ore taken out, 75 tons; it is galena, assaying $175 per ton, and milling-ore, assaying $100 per ton.

Michigan lode. Claimed by Kemp and others for a length of 1,500 feet; shaft, 80 feet deep; ore, galena, with milling-ore; amount taken out, 100 tons; average value, $80 per ton.

There are many other lodes in this district recently discovered and undeveloped, but known to contain valuable milling-ores, yielding from $50 to $100 per ton.

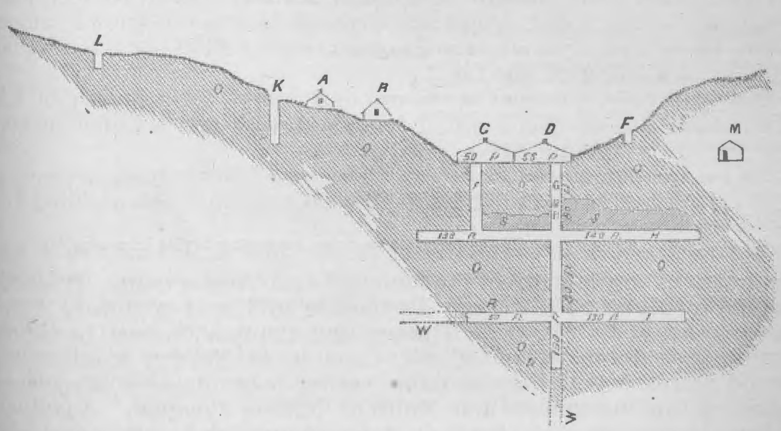
Hot Spring district.—The Legal Tender lode is situated on Prickly Pear Creek, opposite the mouth of Clancey Creek, in the Hot Spring mining-district, fourteen miles from Helena, and is owned by Messrs. Lewis, Bull & Co. This lode is a true fissure-vein, cutting through granite, and is considered the richest and best developed silver-property in the Territory. The ore and vein matter varies in thickness from 1 to 3 feet, increasing gradually in width as depth is obtained. A portion of the ore in the vein is a very rich argentiferous galena, carrying a larger or smaller quantity of dark-brown zinc-blende, sulphurets, and carbonates of lead, oxide of manganese, iron, copper, and antimony, with streaks in which native wire, flake, sheet, and ruby silver occur abundantly. The heaviest galena-ores contain black and gray sulphurets of silver, and yield from $2,000 to $4,000 per ton. A fine blue quartzose ore predominates, in which occurs very frequently native and ruby silver. A small portion of these ores can be successfully reduced by the smelting process, as has been demonstrated in the works at Helena and Jefferson City; but the larger portion of the ore from this mine can be most profitably reduced by the milling (roasting, chloridizing, and amalgamating) process. The lode was first discovered by Joseph Fultz in 1866, but no work of development was accomplished until 1872, under the management of its present owners, who came into possession in the winter of 1871–'72. Up to May 1, 1872, a shaft was sunk only to the depth of 60 feet, which, however, demonstrated the existence of a true vein, and a body of very rich ore. Since that time work has been prosecuted with vigor, and large and commodious whim, shaft, and ore houses have been erected, with company-office, assay-office, and other necessary buildings.

The mine is developed to the depth of 160 feet, showing an increasing width of vein with depth. At the depth of 80 feet levels were run 140 feet east and 90 feet west, and at the depth of 160 feet the east level is out 130 feet. Some stoping has been done east of the main shaft. An air-shaft 60 feet west of main shaft extends down to the 80-foot level.

From the commencement of work by the present owners up to January 1, 1873, the mine has produced 7 tons of ore yielding \$6,090, coin value, or at the rate of \$870 per ton; also, 130 tons of ore yielding \$54,000, coin value, or at the rate of \$417.78½ per ton; and 240 tons yielding \$31,607, coin value, in lots, at rates varying from \$128.42 to \$202.49 per ton. About 175 tons of second-class ore are now on hand.

Average number of men employed per day up to January 1, 1873, as follows: six miners, three windlass and whim workers, one bucket-filler and car-tender, three men assorting, cobbing, breaking, and sacking ore. Average cost of labor and board per day to the hand, \$3.09. Total cost of powder, fuse, and tools used, \$1,750. The hoisting is done by horse-power and whim.

The first-class ores have mostly been shipped out of the Territory in wagons to Corinne, thence to San Francisco and Europe.

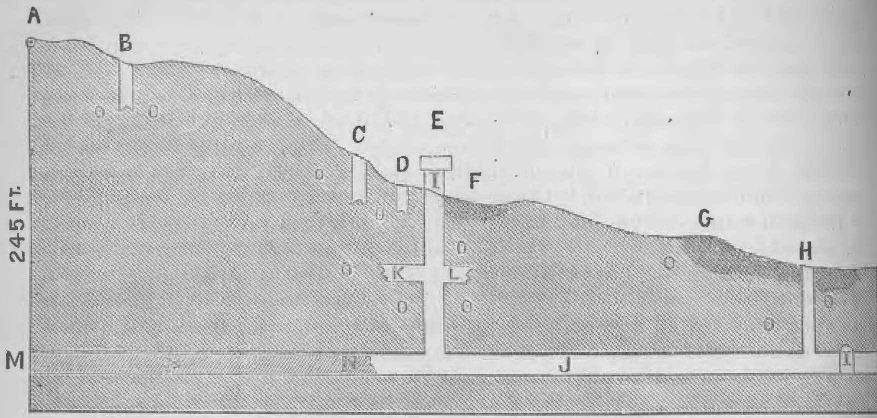


LEGAL TENDER LODE, CLANCEY, MONTANA.

Scale 100 feet to inch.

A.—Assay-office.
B.—Business-office.
C.—Ore-house.
D.—Shaft and whim-house.
E.—Original discovery shaft. Ore assaying \$400 per ton.
F.—Air and entrance shaft.
G.—Main working shaft, vertical and 190 feet in depth.
H.—Level 80 feet from surface.
I.—Level 160 feet from surface.
K.—Shaft on the vein 40 feet deep. First-class ore from surface, continuous.
L.—Shaft on the vein 500 feet west of main shaft.
M.—Magazine.
O.—Ore not stoped out. (Reserves.)
S.—Showing section of vein stoped out, which has paid the original purchase-money and all improvements on and all expenses of the mine, including boarding and sleeping houses, teams, &c.
W.—Dotted lines, work in progress. The vein is vertical, and courses N. 77° E.
R.—Body of rich ore just struck, February 1, 1873. Assay \$2,740 per ton of 2,000 pounds.

The Mammoth. This is a true fissure-vein, situated on the east side of Prickly Pear Creek in the Hot Spring district, near Clancey City, and



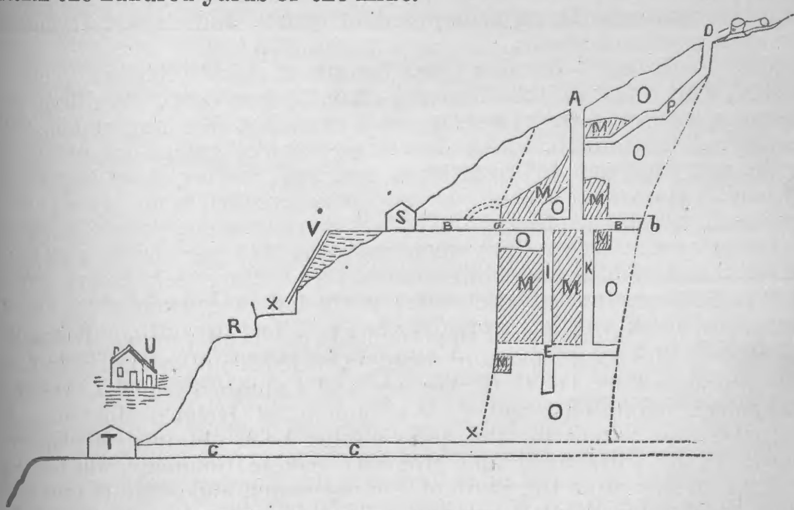
MAMMOTH LODE, CLANCEY, MONTANA.

A.—North line; 245 feet vertically above drift M.
B.—Discovery shaft; vein 2½ feet wide, showing good ores.
C.—Shaft; vein 3 feet wide, showing good ores.
D.—Shaft; vein 3½ feet wide, showing good ores.
E.—Main shaft; vein 5 feet wide, showing good ores.
F.—Vein exposed on surface; good mining-ores.
G.—Vein exposed on surface; good mining-ores. Vein 3 feet wide.
H.—Shaft on vein 73 feet from surface.
I.—Cross-cut tunnel or adit 165 feet to bottom of shaft H.
J.—Drift from shafts H to E on the vein.
K.—Drift in 23 feet; vein 4 feet. Choice milling-ores.
L.—Drift in 15 feet; vein 3½ feet. Choice milling-ores.
N.—Proposed continuation of drift.
O.—Reserved ores. Drifts and shafts show continuous veins, no stoping having been done.

one-fourth of a mile south of the famous Legal Tender mine. It was discovered by Messrs. Fisher and Frohner in 1871, and in March, 1872, it was purchased by Dr. C. G. Hussey and Captain Samuel Lewis, two Pittsburgh capitalists, and C. W. Cannon, of Helena, Montana. A United States patent for the mine having been obtained, a company, known as the Pittsburgh and Montana Mining Company, was formed under a charter from the State of Pennsylvania, and with its principal office at Pittsburgh, Pennsylvania. This company is now vigorously developing the mine.

The course of the vein is nearly north and south, and it dips at an angle of about 75°. In its course the ledge crosses large dikes or reefs of rocks that cross the country from east to west. The main shaft, passing for its entire depth through a good body of ore, shows 2½ feet of good milling-ore at the bottom, which will yield $112 to the ton. The crevice is at no point less than 5 feet in width, and has perfectly smooth and solid walls. These walls are of granite, as is also the country-rock of the entire district. When work was commenced upon this ledge it was supposed that it yielded only smelting-ores, and 128 tons of the ore first extracted, the average assay value of which was $126 per ton, were sold to the Helena reduction-works for $25 per ton on the dump. Twenty tons of second-class ore now on hand at the mine will average $82 to the ton.

Further developments have proven the mine to contain free milling-ores, in large quantities and of a very rich character. At the depth of 46 feet drifts have been run north and south on the vein from the main shaft. The face of the north drift shows a crevice 4 feet in width, 2½ feet of this being rich ore, 10 inches of which contain brown and yellow chloride, intermixed with decomposed honeycomb-rock, having an average assay value of $762 to the ton. Specimens of the brown chloride have assayed as high as $18,000 per ton. Commencing at a point 280 feet south of the main shaft, the ledge has been exposed on the surface for a distance of 75 feet, showing a vein 3½ feet in width, the ores from which are of the same character as in the shaft, and assay $279 to the ton. An adit is now being run which will tap the vein at a depth of 135 feet from the top of the shaft, thus providing for drainage and giving sufficient stope to work for at least five years. The situation of the Mammoth mine, convenient to the best of water-power and with timber in abundance, adds greatly to its value. Some of the best farms in Montana, raising all kinds of grain and vegetables, large dairies and excellent stock-ranches, are in this immediate vicinity. The city of Helena, from which all kinds of supplies may be obtained, is but fifteen miles distant, the stage-road, from that town to Corinne, Utah, running within one hundred yards of the mine.



ARGENTUM LODE, MONTANA.

The cut represents a diagonal cross-section of the lode, drawn to a scale of 1 inch to 100 feet. The average width of the vein is 30 feet; the diagram shows about 60 feet, because it is drawn in the vertical plane of the working tunnels, and not in the plane of the right cross-section.

D is the discovery shaft, connecting with the air-shaft A by the irregular incline P.
A is the original working-shaft, 63 feet deep at the level of the tunnel BB.
BB is the upper working-tunnel, 119 feet in length, cutting the hanging-wall of the lode at *a* and crossing the vein diagonally 75 feet to *b*.
I and K are two shafts, I 87 feet deep and K 67 feet deep.
CC is the lower tunnel, cutting the hanging-wall at X. This tunnel is at the present time 212 feet long, and is known as the *Fountain Head tunnel*, and is claimed under the last act of Congress.
S is a blacksmith-shop and ore-house.
V is a chute to conduct the ore to the bin X, where it is loaded on wagons on the wagon-road R.
T is an ore and sorting-house.
U is the boarding and lodging house.
O. ore.
M, stopes, ore removed.

Colorado mining-district is situated about twenty miles south of Helena. The principal mine is, so far, the Argentum, discovered November 18, 1866, by N. Merriman and Hershel Axe; but little work was done on it until February, 1872. The present owners of the portion now worked, as shown by the diagram, are C. F. Anderson, W. E. Cullen and Harry R. Comly. The lead is a true fissure-vein in granite, carrying argentiferous galena and true silver ores. Since February, 1872, there have been taken from this ground the following amounts of ore:

473 tons, first-class, yielding $230 per ton	$111,090
250 tons, second-class, yielding $96 per ton	24,000
Total value in coin	135,090

This amount of ore has been taken out at a total expense of $9,120.

The first-class ore is argentiferous galena, free from spathose iron or blende, carrying from $140 to $175 coin value in silver, and 78 per cent. of its weight in lead.

The second-class ore is a combination of galena, quartz, blende, and copper-pyrites, carrying from $60 to $75 coin value per ton in silver, and about 35 per cent. of its weight in lead. The course of the lode, as near as can be ascertained from the present workings, is N. 40° E., and the dip about 10° to 15° from the perpendicular toward the northwest. The vein-matter is largely composed of quartz and clays, carrying the ore in masses and seams.

Bowlder district.—Rumley lode. Length of claim 2,200 feet. There is a shaft 6 by 8 feet on the discovery-claim 50 feet deep. Width of vein between walls 60 feet. There is also a tunnel 36 feet long running from bottom of shaft north, which shows two veins of galena-ore each 6 feet wide, assaying from $65 to $200 per ton, and carrying about 50 per cent. of lead. There are 8 feet of quartzite, what is called in mining "a horse" or "wedge," between the two. There is also a stratum, about 2 feet wide, of white quartz, free milling rock, assaying $45 per ton in gold; also about 8 feet of blue and white quartz, free milling rock, assaying from $40 to $120 per ton. There is also in the lode a stratum of brown carbonate of lead, varying from 6 inches to 3 feet in width, and assaying from $150 to $400 per ton. About 500 tons of ore are on the dump; this will be all shipped in the spring. The lead is being speedily developed with encouraging prospects.

Mary Virginia. This lode is an extension east of the Rumley lode, 2,000 feet in length, with a shaft on discovery 20 feet deep, showing about 6 feet of galena, similar to that in the Rumley, and assaying from $160 to $150 per ton. It carries about 50 per cent. of lead. Only the south wall is defined.

The London is an eastern extension of the Mary Virginia lode, and is 2,200 feet in length, with a shaft 50 feet deep. Shows some lead, but there is nothing defined as yet.

Western Extension of Rumley lode. This lode is situated directly west of the Rumley lode, and is an extension of the same. Shows large deposits of galena, similar to the Rumley. Length of claim 2,200 feet.

North Pacific. Situated directly north of the western extension of the Rumley, and running parallel to it. There is a tunnel now being constructed to tap the western extension of the Rumley and North Pacific at about 100 feet depth. The tunnel at present is 200 feet long, and shows large deposits of galena, resembling that of the Rumley. The ore also assays about the same, carrying some 50 per cent. of lead. The tunnel has not yet reached to where the level dips perpendicularly. Length of claim 2,200 feet.

Silver Hill. Situated about one-half mile northeast from London lode. Shaft about 25 feet deep, crevice 2½ feet wide, carbonate ores, assaying from $200 to $500 per ton. About ten tons of ore on the dump. Length of claim 2,200 feet.

Australia. Situated about 60 feet north of the Silver Hill, and running parallel to it; shaft, 30 feet deep; crevice, 2 feet wide; iron and lead ores. On No. 4 west a shaft 25 feet deep shows a vein of 3 feet wide, assaying from $60 to $150 per ton. Sixty tons of ore have been shipped the past summer. Length of claim, 2,200 feet.

Bismarck. Situated east of the Australia and Silver Hill lodes; shaft, 40 feet deep, shows vein 6 feet wide. Galena and milling-ores. A tunnel is run about 60 feet, tapping the vein about 50 feet deep. It shows a vein of about 5 feet, one-half of which is galena, and the other half milling-ore. A tunnel is now constructing from the east to tap the lode at the depth of 280 feet. Length of claim, 2,200 feet. There have been forty tons of ore shipped the past summer, and at present 10 tons of ore are on the dump.

Magna-Charta. Shaft on discovery, 120 feet deep. From the surface to the depth of 40 feet the crevice is about 4 feet wide, containing chiefly galena, assaying $120 per ton. Below this the galena disappears, and is replaced by milling-ores, assaying in gold from $40 to $50 per ton. Length of claim, 2,200 feet.

Paul Jones. Situated about one-half mile north of the "Magna Charta." Discovery-shaft, 42 feet deep, showing 4½ feet crevice. Galena ores, assaying from $160 to $200 per ton. On claim No. 2 east the crevice at the depth of 30 feet is 4 feet wide; ore from galena, assaying from $150 to to $300 per ton. Length of claim, 2,200 feet. The galena carries 65 per cent. of lead.

Amazon. Situated about one-fourth of a mile southwest from the Magna Charta. Discovery-shaft, 45 feet deep. The vein varies from 5 to to 10 feet in width, and carries chiefly galena and brown carbonate. In claim No. 2 west the crevice is 12 feet wide on the surface, and contains solid galena; average assay, $150, silver, per ton, and 65 per cent. of lead. Length of claim, 2,200 feet.

Spencer lode. Shaft on discovery claim, 25 feet deep; crevice, 2½ feet wide; ore assays $1,010 per ton; it is galena, carrying 65 per cent. of lead; length of claim, 2,200 feet.

Fenian, Welling, and O'Connell lodes. Situated near the Spencer and Paul Jones; shaft on each about 25 feet deep; width of crevice from 4 to 6 feet, carrying chiefly galena, similar to the Paul Jones, but a change is indicated at the present depth to milling-ores; length of claim, 2,200 feet.

The Columbia is situated in the vicinity of the Paul Jones; the ore is entirely free from galena; the shaft will reach this winter 100 feet in depth; width of crevice, 4 feet; ore, free-milling quartz, assaying $60 per ton at the present depth of 31 feet; length of claim, 2,200 feet.

Cedar Plains district.—In regard to this district, Messrs. Keating and Blacker have furnished me with the following information:

Names of lodes in and near Cedar Plains mining district, Jefferson County, Montana, (near Radersburgh,) on which work has been prosecuted during the year 1872.

Hidden Treasure lode, worked (and owned) by Messrs. Richards & Dodson.

Metropolitan lode, worked by Messrs. Webb & Cogshall.

Mammoth lode, worked by Messrs. Barclay, Nave & Co.

Belleview lode, worked by Messrs. Chappel, Davis & Co.

Ironclad lode, worked by Messrs. Hallbeck, Nave & Co.
Allen lode, worked by Messrs. Hallbeck & Allen.
Left-Hand lode, worked by Messrs. Davis & Clancy.
Ohio lode, worked by Messrs. Keating & Blacker.

The amount of work done on these lodes I have no means of estimating. I only know that work has been prosecuted on them in 1872, by the parties named. Work is now going on in all the above, except the Ironclad and Allen, Left Hand, and Ohio.

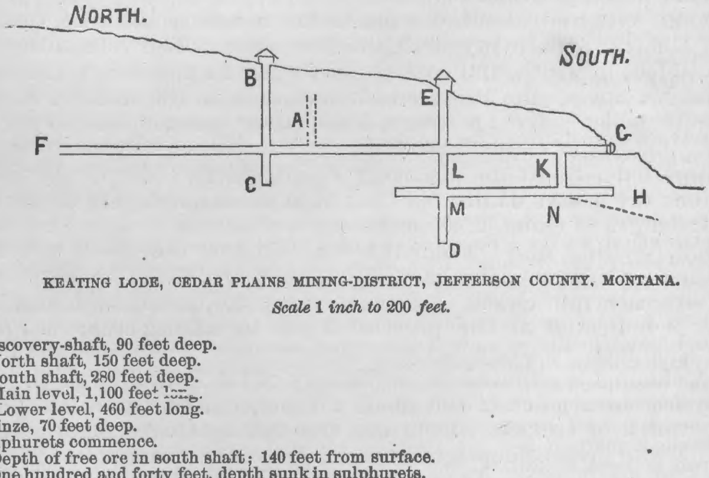
On the Keating lode, the property of Messrs. Keating & Blacker, the work done in 1872 is as follows:

Number of lineal feet of levels run, 626.
Number of cubic feet of quartz stoped, 60,184.
Number tons of quartz taken out, 4,014.

Present condition of mine

Length of main level, 1,100 feet.
Length of lower level, 460 feet.
Depth between levels, 70 feet.
Depth of main level from surface, 90 and 100 feet.
Depth of south shaft from surface, 280 feet.
Depth of north shaft from surface, 150 feet.
Sulphurets in south shaft appear 140 feet deep from surface.

Work continuing in running levels and stoping. No sulphurets have so far been treated in the mill.



KEATING LODE, CEDAR PLAINS MINING-DISTRICT, JEFFERSON COUNTY, MONTANA.

Scale 1 inch to 200 feet.

A.—Discovery-shaft, 90 feet deep.
BC.—North shaft, 150 feet deep.
DE.—South shaft, 280 feet deep.
FG.—Main level, 1,100 feet long.
MN.—Lower level, 460 feet long.
K.—Winze, 70 feet deep.
L.—Sulphurets commence.
EL.—Depth of free ore in south shaft; 140 feet from surface.
LD.—One hundred and forty feet, depth sunk in sulphurets.
NH.—Line of free ore, lower than at L.

General direction of lode, north and south; vein nearly vertical, dipping slightly to the west; walls well defined, of granite and slate. Quartz for crushing has been furnished regularly, since the summer of 1870, in quantity sufficient to keep a 15-stamp mill running. At H free ore of good quality appears; its depth from the surface seems to be increasing. Work progressing in lower levels at H and I, and in the stopes.

Silver Star district.—Mr. Thomas J. Johns, superintendent of the Everett Green Campbell Mining Company, writes in regard to this district:

Having had but little opportunity to familiarize myself with the results of the mining operations in this district during the past year, I will give you at least a brief summary of the work prosecuted by this company, which, though unsatisfactory, may be of some service to you in compiling your annual report.

Owing to the severity of the preceding winter, we did not resume work upon the Green-Campbell until May, of last year, having been idle about four months, when we erected a horse-whim for the purpose of "sinking" below our old tunnel-level, which at whim-shaft was 104 feet below the surface. We had previously mined and milled all available "pay" to this depth. Before suspending work for the winter, we "raised" a vertical shaft, 10 by 5 feet in the clear, from the tunnel-level to the surface, to better accommodate a whim; and in sinking, started our shaft at about the center of our old pay shute, on which we had placed our main reliance since first commencing work on the lode. At a depth of about 30 feet we lost our "pay," and penetrated a mixed mass of clay, barren quartz, and sulphurets, the latter not carrying free gold. The lead also widened considerably, and exposed occasionally small seams of galena-ore, which assayed largely in gold and silver. Aside from these changes the vein maintained its general features to the whole depth attained with the whim, being 120 feet, having at every point penetrated beautiful and well-defined walls, and a width of vein varying from 12 to 20 feet, with, however, an irregular dip. At a depth of about 60 feet water became so exceedingly strong that we were compelled to add another to the force of animals employed on the whim, making four shifts per day, and under a lively trot continually.

Under these disadvantages we sank a depth of 120 feet without penetrating "pay" in sufficient quantities, when we determined to abandon the work of sinking and confine ourselves to the work of "proving-up" the ground made accessible by the shaft. To this end we started drifts east and west from shaft, at a point 20 feet from bottom of shaft, which would have given us 100 feet of stoping-ground had we captured pay in said drifts. Having no inducements to go any considerable distance east, we soon stopped this, and pushed the drift west to a length of 100 feet, in the hope of finding our old pay shute, which had before shown an almost uniform dip west. Not accomplishing our object, we then connected this drift at its westerly terminus with our old tunnel-level above, by "raising" from below and sinking from above, in all of which work we did not obtain "pay" in quantities to justify its working; and having then effected all or more than a whim ought to do under such adverse circumstances, we concluded to suspend its operations and substitute a more fitting method of working the ground. And, finally, in view of the actual scarcity of skilled labor, and the exceedingly high price of all labor and supplies, the company has decided to "lay up their mine," and to suspend further work indefinitely, in the hope that the advent of railroads, or some near approach to civilization, will tend to facilitate the means of operating mines, and lend stronger encouragement to capitalists to risk the uncertainties of developing a quartz-mine.

The greatest depth attained on the "Green-Campbell" is now 230 feet. This company has not milled any ore since November, 1871.

Of the other leads in this (Silver Star) district, the Bedford, a small but rich crevice, has figured conspicuously. It was discovered about a year since by Charles Heinemann, and leased by him to the miners, who have worked it the past season with good success. It continues to look well at every point. Mr. Heinemann is the fortunate possessor of several well-defined leads, among which the "Morning Star" has gained much prominence, and I think deservedly so. But little work has been done on it the past season, the principal reason, I presume, being a lack of means. The work of "representation" is generally observed by resident-owners, yet, from appearances, I predict that many "feet" will be left to the unrelenting persecution of "jumpers." In fact, a general gloom seems to pervade throughout the length and breadth of the quartz domains, and really but little progress has been made in the development of quartz the past season, at least in this section.

LEWIS AND CLARKE COUNTY.

Ten Mile district.—Red Mountain, upon whose sides and spurs the mines are situated, is about sixteen miles southwesterly from Helena, and its summit is over 11,000 feet above the level of the sea. The principal stream, rushing by its base, is Ten Mile Creek, whose waters, running north and east, when they emerge from the cañon are taken up by a ditch and carried around and above Helena, and furnishing water to the placer-mines in Last Chance and Dry Gulches, and finally emptying in the Missouri River. Upon the east slope of the mountain other streams rise and flow northeasterly, spreading like a tilted open fan, the handle of which is the mountain proper. Around the base, and nearly to the summit, vast bodies of timber are seen, mostly of pine, spruce, and balsam-fir, which would give an abundance of fuel for several generations. The finest grasses in the world for stock-raising spread throughout the valleys, and thousands of animals could be raised and fattened on the hills and valleys contiguous to the mines. The numerous and never-failing streams which abound in the vicinity can be made to supply sufficient motive-power for dozens of blast-furnaces. The Northern Pacific Railroad surveys run along the westerly base of Red Mountain, crossing the divide which here separates the waters of the Atlantic and Pacific.

In 1865 prospectors, in searching here for gold, discovered galena in considerable quantities, but it was not thought to be of any value; hence nothing was done to develop the leads. However, good bar-diggings having been struck, there has always been a small gold-mining camp at Clarkson, twenty miles from Helena, and on the other side of the range, in Basin and Overland Gulches. Some few men, however, possessed with a mania for locating claims, have wandered all over the mountains, staking and naming every ledge that appeared to carry minerals. No work was done of any consequence upon any of the locations up to the passage of the new mining-law of May, 1871, and the passage of this act will ultimately prove of great benefit to the whole Territory, causing individual locators to drop their recorded interests in hundreds of claims, and consequently to let miners and capitalists work and develop the mineral wealth under foot.

The veins run in parallel bands across the mountain at no great distance apart. The lodes appear strongest east of the Ten Mile stream. Nearly all have a stake across the creek, which is shut in in several places by precipitous banks of a granitic appearance. The granite bowlders and broken slides, with wash-gravel, show in places 1,000 feet above this, and cover up the leads so that prospectors have as yet only found the veins apparently strongest high up above the creek. This difficulty, combined with the rank growth of pine, grasses, numerous springs, and heavy timber, has prevented the finding of many leads believed to exist, hence a good field is still offered for the miner and explorer for silver or lead. Although granite and other crystalline rocks abound, the mountain proper is not granite, but of a sedimentary character; and at comparatively shallow depths the country-rock is found in nearly vertical layers, with bands of mineral, ranging from 6 inches to 17 feet in width, lying between. The colors are mostly of a light drab, approaching gray, except where the oxides have stained the walls. The shallow holes sunk by prospectors are mostly in granite or gneiss, and sand, having ferruginous veins interspersed throughout. The apparent course of the leads is northeast and southwest.

Le Mountain. Vein carries galena, carbonates, decomposed sulphurets, with copper and antimony and iron-pyrites; assays from $30 to $250 per ton of 2,000 pounds; width, 17 feet.

Little Jennie. Dip of lead, vertical; width of vein, 16 feet; carries rich carbonate of galena and iron-pyrites; assays from $50 to $320 per ton in silver. Owners running a tunnel to tap and drain lode.

Bismarck. Depth of shaft, 40 feet; body of galena, 3 feet; carries $70 to the ton.

Daniel Stanton. Width of vein, 3 feet; very pure galena on surface; yields $150 to the ton in silver, and 70 per cent. lead. This, with some twenty-five other lodes, has been lately purchased by parties in New York, who are actively engaged in developing their claims.

Try Again. Depth of shaft, 55 feet; width of vein, 5 feet; character of ore, galena and pyrites; carries 40 per cent. lead, and $100 to the ton in silver.

North Pacific and Little Emma. New locations taken up under new mining-law; both same vein; depth of openings, 10 feet; width of vein, 3 feet; galena, 15 inches.

Knight of Gwynne. Shows 8 inches galena.

Michigoma. Shows galena on surface; the vein is being tapped by a tunnel driven in about 300 feet.

Nearly all the leads can be worked by tunnel to good advantage.

In addition to the above there are numerous small veins found in the belt, which is about ten miles wide, and which show conclusively that the whole locality needs but practical miners and small capital to develop. Vast bodies of lead and silver bearing rock may thus be easily worked. Though the snow falls heavily through the winter, the climate, tempered by the warm Chenook winds, offers no impediment to successful mining operations. There are now six companies at work taking out ore.

MADISON COUNTY.

Brown's district.—This district is about four miles southwest from Virginia City. There are about one hundred recorded leads in it, one-fourth of which are believed to be good paying veins.

The principal lodes developed to any extent are the Pacific Railroad, Belton, Black, True Silver, Eumenia, Louane, Roma, Black Extension, Easton, Gould and Curry, Miners' Relief, and South Boise. The general course of these leads is north and south.

The Black lode is opened on each 200 feet for a distance of 1,200 feet, showing a well-defined crevice of quartz from 4 to 10 feet in width, assaying from $30 to $500 per ton. Discovery claim has been opened to the depth of 60 feet, and claim No. 4 north to about the same depth.

The Pacific Railroad lode is opened on different claims for 1,000 feet along the vein, the greater part of the work being done on the north half of discovery and No. 1 north. This claim is tapped by two tunnels, the lowest at a depth of 120 feet, with a shaft raised from the latter to the surface, and levels run along the vein for 170 feet. The width of crevice varies from 3 feet to 10 feet, the ore being very rich. There have been 1,000 tons of ore taken from this claim and worked in mills, furnaces, and arrastras. Part has been shipped to San Francisco and Europe, paying from $60 to $500 per ton.

The Louane lode is opened on several claims. On the discovery there is a shaft sunk about 60 feet, with a crevice 3 feet wide. The quartz assays from $60 to $500 per ton.

The Eumenia is opened on several claims, showing a crevice of 3 feet wide of good milling-ore.

The Roma is opened on the discovery claim by a shaft 125 feet deep, showing a crevice 18 inches wide, paying by mill-process $125 per ton.

The Miners' Relief has a shaft sunk on discovery claim 30 feet deep. The crevice is 5 feet wide, and the ore is very rich.

The Black Extension lead has a shaft sunk on claim No. 1 south 30 feet deep, with a crevice 3 feet wide. The ore assays $80 per ton on the average.

The Gould and Curry has a shaft on discovery 120 feet deep, showing a crevice 5 feet wide of good paying ore.

The Easton has a tunnel tapping the discovery claim. The crevice is 2 feet wide, and the ore assays from $100 to $500 per ton.

The Dalton lode is opened on the discovery-claim, and No. 2 north, to the depth of 30 feet, each showing a crevice 5 feet wide, of good milling-ore.

The True Silver lode joins the Pacific Railroad lode on the north. There are two tunnels on claim No. 2 north. The upper tunnel is 130 feet long, and taps the lode at a depth of 60 feet. The crevice averages 8 feet in width, with well-defined walls. The lower* tunnel is 200 feet long, and taps the vein 50 feet from the surface. It is well timbered, and has a good car-track and drain. At this point the vein is 15 feet wide, inclosed in solid granite-walls. The ore is free milling-ore, and averages $178 per ton. There is plenty of timber and water for all purposes in the immediate vicinity.

All the lodes of this district carry true silver-ores, and all the silver-bullion contains from $2 to $10 of gold per ounce. Without mills for working the ore, or convenient markets, there is, however, not much inducement to work the veins at the present time; and the advent of railroads in the Territory is anxiously awaited by the miners.

Cherry Creek district was organized upon the discovery of several rich silver-veins during the winter of 1871. It is situated on Cherry Creek, an affluent from the east of the Madison River, and a little to the northeast of Virginia City. The district is not much developed, but rated very highly. So far, very rich ores have been found, the veins being usually of small size.

The Euselman is a 2-foot vein, carrying some native silver, but principally ores having the silver in combination with sulphur and antimony. Twenty-five tons of first-class ore are on the dump.

The Eberhardt, a 2-foot vein, has a shaft now down 83 feet. Fifty tons of ore are out. The owners intend to erect a 5-stamp mill, about a mile from their mine, and are preparing the site.

The Davis is a 6-foot vein, on which a shaft 40 feet deep has been sunk.

The Home, 2 feet wide, has been sunk upon by a shaft over 50 feet deep.

The few tests so far made of ores from these leads, indicate a richness of the ore of from $75 to $300 per ton. This is, of course, setting aside assays of selected specimens. A town named Havana has been laid out in the district.

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* The terms "upper" and "lower," as here used by my correspondent, apparently refer to the position of the tunnels in the gulch, one being farther up stream than the other. It would otherwise seem absurd that the lower tunnel should strike the lode nearer the surface.—R. W. R.

MEAGHER COUNTY.

No work of any consequence has been done, during the year, in the quartz-districts of this county. Mr. J. E. Hall, of Diamond City, is my authority for the following statement in regard to the mining-industry of this part of the Territory.

Mr. Hall thinks $350,000 a just and nearly correct estimate of the amount of gold taken from the placers of this district during the year ending January 1, 1873.

A great many copper and silver lodes have been located and recorded; but as very little work has been done, it is impossible to say how many of these locations are even on true veins.

On the head-waters of the Mussel-Shell River a number of lodes, containing copper, have been located. One of these is the St. John, located, in 1866, by Messrs. Hall & Hawkins for the Rocky Mountain Quartz Company. A shaft has been sunk on this lode to a depth of 70 feet. The ore assays from 40 to 75 per cent. copper, and, so far, has shown a small percentage of gold. The vein on which the St. John is located can be traced on the surface for about three miles, and several other locations have been made upon what is supposed to be the same vein. Of these locations the St. John and Ohio lodes have been patented by the Rocky Mountain Quartz Company.

The amount of quartz on the dump in the Mussel-Shell district is small, some of it having been hauled away and sent to the States. The reason why more work has not been done in this district is the exposure of the locality to attacks from Indians. The expense of transporting the ore has also retarded development.

Some locations have been made on Birch Creek; the ore assayed from $60 to $100 per ton in silver, one specimen running as high as $1,500 per ton. As yet there has been no work of any consequence done in this district, no shaft having been sunk to a greater depth than 10 feet. Some men are working there this winter, however, and by spring something more will be known concerning the mines. The ore of Birch Creek district is milling-ore.

Some lodes of argentiferous galena have been located on Greyson Creek; but, since no work has been done before this winter, I am unable to give any information concerning the mines. From present appearances the prospects are not particularly good.

There are other localities in this county where there are croppings of silver and copper ore to be found, but no work has been done as yet.

CHAPTER VI.

UTAH.

The general results of the mining industry of this Territory have been very satisfactory during 1872, and a considerable increase in the production of lead and the precious metals over that of last year testifies that the preliminary stage of speculative talk is passed, and that earnest work has been fairly begun.

The mineral resources of the Territory are very great, and the facilities for utilizing them are superior to those of almost any other Territory. I have devoted considerable space in my last report to the discussion of the advantages which Utah has in starting her mining industry at the present time, thus being able to profit by the experience of her neighbors, and I need not recur to them here. Nor is it necessary to repeat an elaborate description of her mineral deposits; and I shall confine myself in this report to a brief account of the progress of the leading mines and smelting-works during the year, together with an exhibit of the production in the whole Territory.

The following statement of the product of gold, silver, and lead of the Territory of Utah, during 1872, has been made up with care from authentic sources. I am particularly indebted for most of the data to Mr. George J. Johnson, of Salt Lake City, who, favored with the courteous co-operation of the various officials of mines, smelting-works, and railway and express companies, has procured for me the most trustworthy returns which the circumstances would permit:

Base bullion, (lead, silver, and gold,) 8,125 tons, produced as follows:

Flagstaff Works, 3,000 tons, at $250		$750,000
Miller Works, 1,536 tons, at $178.21*		291,840
Winnemuck Works, 1,232 tons, at $286.97		353,551
Utah Works, 650 tons, at $125		81,250
Saturn Works, 1,207 tons, at $233.07		282,287
Wahsatch Works, (approximately,) 150 tons, at $250		37,500
All other smelting-works, (estimated,) 350 tons, at $250		87,500
Silver shipped by express, 170,191 ounces, at $1.18		200,825
Gold bars and dust shipped by express, 5,556 ounces, at $18		100,008
Ore shipped, according to Utah Central Railroad, 20,693,692 pounds, worth in gold and silver $88 per ton		910,523
30 per cent., or 6,208,107 pounds, of the above ore may be assumed as lead, worth $2\frac{1}{2}$ cents per pound in the ore		155,203
Total value of gold, silver, and lead		3,250,487
To obtain the product of the Territory in gold and silver alone, there should be deducted from the aggregate the value of the lead, viz:		
8,125 tons of unrefined lead, at $80	$650,000	
6,208,107 pounds of lead in the ore, worth $2\frac{1}{2}$ cents per pound	155,203	
		805,203
Total gold and silver		2,445,284

* The value of the Miller bullion is calculated from the report of the superintendent, which gives $110 per ton as the value in currency of the gold and silver in this bullion, to which $80 is added, as the value of the unparted lead, at 4 cents per pound.

The items of base bullion in this statement are given in currency, but the currency price at Salt Lake is not far from the probable yield in coin value after refining, and hence may be taken to represent in this instance the actual amount of gold and silver added to the world's available stock, which is the object of inquiry.

From the published statements of shipments by the Utah Central Railroad and Messrs. Wells, Fargo & Co., and the report of the Germania refining-works, communicated to me by H. Engelmann, M. E., of Salt Lake City, the following figures are arrived at:

Ore shipped, 20,693,692 pounds, estimated worth in silver and gold $88 per ton		$910, 523
Base bullion shipped, 11,066,853 pounds, worth in gold and silver $151.87* per ton		840, 360
Base bullion bought by the Germania refining-works, 925 tons, worth in gold and silver $151.87 per ton		140,480
Silver shipped by express, according to Wells, Fargo & Co., of Salt Lake City, 170,191 ounces, at $1.18		200, 825
Gold shipped by express, according to the same source, 5,556 ounces, at $18		100, 008
Total gold and silver		2, 192, 196
To this may be added for lead:		
11,066,853 pounds, shipped as base bullion, unrefined, at 4 cents per pound	$442, 674	
1,670,000 pounds on hand, unrefined, at Germania refining-works, at 4 cents	66, 800	
180,000 pounds, refined, shipped by Germania Works, at 5 cents	10, 800	
30 per cent. of amount of ore shipped=6,208,107 pounds, at 2½ cents	155, 203	
		675, 477
Total apparent product of metals		$2, 867, 873

In comparing the number of tons of base bullion shipped, and the amount bought by the Germania refining-works, as per last statement, with the total number of tons reported by Mr. Johnson as produced in the various works, it is seen that 1,666.5 tons more have been produced than shipped. At the end of the year this base bullion must, therefore, have been at the different furnaces and in transitu to the railroad. If we add the silver value of these 1,666.5 tons at the above average valuation per ton, viz, $151.87, to the total amount of gold and silver in the second statement, we have:

Total gold and silver shipped, or bought by the Germania works	$2, 192, 196
Add 1,666.5 tons, silver and gold value $151.87 per ton	253, 091
Total	2, 445, 287

Mr. J. J. Valentine, superintendent of Wells, Fargo & Co., at San Francisco, in a statement published shortly after January 1, 1873, gave the product of Utah for 1872 as follows:

* Average obtained from the foregoing statement.

Gold by express	$415,166 77
Silver by express	365,285 32
Ores and base bullion	2,740,568 00
Total	3,521,020 09

This statement gives Utah credit for over one million more than she has really produced in gold and silver. There are large errors in all three items, about half a million being caused in the first two alone, by including the express shipments of coin as part of the produce of the Territory. The large overvaluation of ores and base bullion must be referred to the difficulty of obtaining exact figures so early in the year.

During the summer and fall the mining and smelting business in Utah was highly favored by the extravagant prices paid at Salt Lake for both ores and bullion, by the competing agents of rival establishments, particularly in Saint Louis and Chicago. These agents may understand better than any outsider what they are doing; but it certainly seems as if they could not have maintained a profitable business and paid for their crude material so recklessly. A couple of examples will illustrate my meaning.

In July thirty tons of bullion from the Saturn smelting-works, near this city, were sold to the highest bidder. It contained by assay 99.16 ounces silver and 0.3 ounces gold per ton. The price paid by the agent of the Chicago Smelting and Refining Company was $231.31 per ton. Assuming the value of the lead at Salt Lake City at 4½ cents per pound, (which is liberal,) and reckoning $6.20 per ton for the gold, this would be $1.41 paid in Utah for each ounce of silver, or, looking more closely into details, at $1.34 per ounce, the silver would be worth per ton of bullion in Chicago, after separation, $132.08 coin or $151.52 currency. The lead, at 7 cents, would be worth $140, and the gold, say, $4 net. Total, $295.52, value of bullion per ton in Chicago. On the other side of the account we have the price, $231.31, paid for the bullion; freight to Ogden, $2.50; to Omaha, $20; to Chicago, $6; total freight, $28.50; cost of treatment, say $12 per ton; loss, say 5 per cent., or $11.50 per ton; total cost, $283.31, leaving a margin of only $12.21 for commissions, interest, risk, and profit. This margin, I think, any metallurgist would consider dangerously small for the time and place.

The same establishment has been buying ores in the same style. Two hundred tons of Emma ore were sold, assaying 67.8 ounces silver per ton, and 47.5 per cent. lead. For this ore the agent of Selby's San Francisco works bid $64.53 per ton; other parties bid $70 and $72, but the Chicago works carried it off at $84 per ton! Add to this the freight ($25 for ore,) smelting cost, $20, refining, $12, and loss, $14, and we have a total of $155 paid per ton. The silver at $1.34 and the lead at 7 cents, amount together to $157.35, leaving a margin of $2.35.

A later sale of Emma ore, made in August, was even less favorable to the buyer. The amount was 100 tons, assaying 67 ounces silver per ton, and 48 per cent. lead. It was bought for Saint Louis at $85.50, leaving, according to the figures above given, only 48 cents margin per ton. Silver was probably worth, at that time, more than $1.34 gold per ounce; but this difference is not enough to render smelting at these figures an inviting business.

Such fierce competition was evidently unsound. It was a struggle among rival concerns to gain possession of the whole Utah market; and it was safe to prophesy that it would result either by the triumph of one party or the exhaustion of all, in a reaction of prices to a level more in agreement with business caution and permanent success. Meanwhile such a state of affairs furnished, of course, a rich harvest for the ore and bullion sellers of the Territory.

Big and *Little Cottonwood districts*, especially the latter, still hold the most prominent position among the Utah mining-camps. The Emma and Flagstaff mines, both now in English hands, have probably furnished more ore than any other two mines in Utah.

The Emma, in which a very large chamber had been excavated during the previous summer and during the earlier months of 1872, unfortunately experienced a complete caving in of the hanging-wall in the early spring, when the rapid melting of the heavy snow of the previous winter had filled the limestone with floods of water, loosening its texture and bringing an enormous weight on the timbers in the large chamber. It is always difficult to timber such large open spaces, and in this case the mistake had been made of putting in the timbers not at right angles to the strike of the walls, but so that the weight would fall obliquely on the points of junction of the uprights and caps.

After the cave, the large chamber was one inextricable mass of broken timbers and loose masses of rock, so that it was deemed best not to disturb this part of the mine any more, especially as nearly all the valuable ore had been taken out. Starting at a point in the main working-tunnel leading to the surface, a short distance from the caved portion of the mine, a drift was cut around the whole of the east side of the old chamber, which connects with the corresponding level of the new workings, northwest of the old ones. A shaft 136 feet deep had here been sunk, not far from the northwest end of the location, which struck a second body of ore connected with the older body, as plainly visible in several levels. Upon this connection of the two bodies turned the decision of the courts in the matter of the Emma Company against the Illinois Tunnel Company, (which had reached the second ore-body by a tunnel,) the first praying for an injunction against the latter, which was obtained. Immediately after this had been accomplished, the obstructions put into the connecting level between the old and new bodies by the Illinois Tunnel Company were removed, and further connections by means of lower levels were made. Most of the ore then mined was obtained from the new body and raised through the new shaft, from which levels started at depths of 40, 100, and 136 feet from the surface respectively. At that time, August, 1872, the new working-drift around the caved-in part of the mine was being timbered heavily, and no ore, or very little of it, could be brought through it. There were nineteen floors, (a little over 7 feet high each) above the level of the main tunnel, and sixteen floors below. The shaft sunk below the tunnel-floor was, however, not accessible, except for a short distance, the lower part being still filled with water from the spring-floods. From the bottom of this shaft the superintendent reported unusually rich ore had been taken before the disaster, and a great deal of the same kind was said to be still standing. The pump then in the shaft was a very small one, and not at all adequate to the requirements of the case. There was a very large amount of carbonate-ore standing in the mine, especially in the newly-developed ore-body, and some new ore had been met with in cutting the drift mentioned above, in what had formerly been supposed to be the hanging-wall of the old body. The superintendent thought that after the timbering was finished, 50 to 75 tons of ore could, without difficulty, be shipped from the mine. The Emma Company shipped to England, from January 1 to August 15, 4,000 tons of ore. From that time to January 1, 1873, they sold in open market, at Salt Lake City, 6,300 tons, thus making a total product of the mine of 10,300 tons.

At Salt Lake, an average price of $70 currency per ton was obtained; the ore assaying on an average 69 ounces of silver per ton, and 45 per cent. of lead. The ore sent to England was of somewhat higher grade.

The above figures were kindly furnished by Mr. George J. Johnson, of Salt Lake City, who obtained them from the company's books.

Concerning the notorious litigation between the Emma and the Illinois Tunnel Company, little need be said in this place. One legal point involved appears to have been the right of a patentee to follow his vein outside of the limits of the survey in course as well as in dip; and the decision of the court, asserting this right, seems to be contrary to the spirit and letter of the law. But the peculiarities of the Emma deposit, which is not a regular vein, and the other points in the case, make it a text unsuited to general comment. The doubtful character of the decision is shown by the confessed payment of a large sum by the Emma Company to the Illinois party, in consideration of which, it is said, the latter agreed not to appeal or further prosecute the case. The location of the Emma survey along an axis crossing the known axis of the ore-deposit, is a circumstance casting suspicion on the former but not the present owners. It is to be lamented that the English stockholders of this company have encountered so many foreseen and unforeseen difficulties.

The Flagstaff has been worked very energetically since it came into the hands of an English company, and much credit is due for his good management to the superintendent, Mr. N. M. Maxwell. The following extract from the London Mining World, based on the report of one of the directors, Mr. Frames, who was sent out from London to inspect the mines and furnaces in the summer of 1872, contains the principal facts of interest in regard to the condition of the property at the time mentioned:

The Flagstaff mine is situated at the head of Little Cottonwood Cañon; the road ascends 4,000 feet from the entrance of the cañon, where the Flagstaff furnaces are located. The ore-house is about 400 feet above Alta City, and receives the ore by tram-way from the present tunnel-entrance, about 1,000 feet above it. The vein of ore, inclosed by its walls of rock, is sharply marked to the most unpracticed observer, and from actual measurements of the ore in sight at the three lower levels, taken at the request and in the presence of Mr. Frames, there are 192,540 feet, averaging the width of the lode at 3 feet. The ore in weight is estimated at 9 cubic feet to the ton, which would show 21,383 tons; and on the same data, for the two upper levels of the old workings, where there are large quantities of good ore in sight, it does not seem excessive to regard them as making up the total to 30,000 tons.

The ore falls from the stopes above the present tunnel, and is lifted by a mule from below it into cars that convey it on a tram-way to the tunnel-mouth, where it is sackes and sent down the incline to the ore-house. At these two points there were about 60 tons ore, besides 400 tons at the furnaces. It is intended to have a stock of 6,000 ton at the ore-house before winter sets in, to provide for work being interrupted on the incline by snow. About 600 feet below the present tunnel a new one (called the Maxwell) has been started, and will be carried through the mountain into the adjoining cañon of Big Cottonwood, where there will be an eligible point of egress. If the lode continues in its present direction the tunnel is expected to strike it at 800 or 900 feet from its mouth, at a depth of about 450 feet from its intersection with the tunnel above. The prosecution of this important work will take some time—probably eighteen months—before meeting the lode, but success in its aim, or in making other discoveries on the way, would establish a multiplied value of the property.

The road in the cañon had been put in tolerable order just before Mr. Frames's arrival. A subscription of £3,000 had been raised for road-purposes from several of the larger interests, the Flagstaff contributing £300. One-fourth had been paid, and was in course of expenditure. The remainder is reserved for next spring. The transport-service is under contract with responsible men, at $7.50 per ton in summer, and $8 in winter, to haul, as required, 50 tons per day to June 1, 1873, from the mine to the furnaces. No difficulty is feared by the contractors or by Mr. Maxwell from the winter, as the sledge will be substituted for the wagon over the snow, and interruption is only looked for in May and June, when the snow melts. In the neighboring cañon of American Fork a line of rails has been laid down, and it is probable that before long engineers will be able to face the difficulties of Little Cottonwood. The daily freight of ore down the cañon is so great as to compel some solution. On the transport of 50 tons per day, that may be expected, at a tram-road rate of 10s. per ton for the ten miles, there would be a saving to this company of £15,000 per annum.

The mine is capable of sending down 50 tons of ore per day at a slight increase of cost, but the two furnaces, up to the date of Mr. Frames's arrival, had only consumed 20 tons of ore per day. Later returns show an increase, but the proper co-operation of the mine and furnaces must wait for the third furnace—hot-cylinder blast—the machinery of which has since arrived from Pittsburgh. It is expected to double the production of bullion, or to turn out reliably 18 to 20 tons per day in all, and also to treat low-grade ores of 20 per cent. profitably. For the three months ending September 15, 1,467 tons ore produced 619 tons bullion, or 2⅜ to 1, but, during Mr. Frames's presence, he understood that poorer ores from the older works were being sent down from the mine, and the returns for the next five weeks, ending October 13, show 1,167 tons of ore to produce 326 tons bullion, or 3⅝ to 1. These differing results suggest also an imperfect action of the furnaces, which the new furnace may be expected to remedy. Former difficulties in the supply of charcoal appear to have ceased. A good contract exists for 1,500 bushels per day, or more at option, at 30½ cents per bushel, deliverable at the furnaces, quality to be approved on arrival; purchases made of other burners at 24 to 26 cents, on the same terms, reduce the average cost to about 29 cents. Stock on hand 65,000 bushels, and the contractor states his reserve at a railway-station in the Territory to be 100,000 bushels, besides the same quantity in preparation; altogether an ample provision for the winter. It is expected that coke will be economically used instead of charcoal for the new furnace.

The smelting-works, the houses of Mr. Maxwell and the chief smelter, the boarding-house for the men, and the office are located on a tract of ground of about 16 acres belonging to the company. The water-power for the smelting-works is supplied to a ditch from the stream that runs down the cañon, which is ample and constant.

The distance of seven miles from the railway-station of Sandy is an element in the cost of the bullion before it reaches a market, and of charcoal and other supplies for the works. It is hoped that before long this charge will be reduced to a railway-rate. The granite for the Mormon Temple, building at Salt Lake City, is all obtained at the entrance of Little Cottonwood, and a railroad is being made to carry the granite blocks to Sandy. A branch of a few hundred yards will connect it with the smelting-works, and on the larger transport required for three furnaces, will lead to a saving of £4,000 to £5,000 per annum.

A railroad through Little Cottonwood Cañon has, since the publication of the above, been reported as feasible, and the work is said to be partly under contract.

Mr. Maxwell has kindly furnished me the following:

Reserves on December 31, 1872, 26,000 to 30,000 tons of gray and yellow carbonate ores, 3½ tons of which make 1 ton of base bullion. The metal being produced about that time assayed 157 ounces of silver and $50 gold per ton. Cost of smelting about $55 (?)* per ton.

The product of the Flagstaff furnaces during 1872 was 3,000 tons of metal, containing—

Silver	$390,000;	average per ton, $130.
Gold	120,000;	average per ton, 40.
Lead	240,000;	average per ton, 80.
Total	750,000	

The capital of the company is £300,000, on which 30 per cent. in dividends have been paid during the last three months, and 24 per cent. during those preceding; the total amount of dividends paid being £76,500.

Of other mines which have held a prominent place in Little Cotton-

*This estimate probably refers to the production of one ton of base bullion, and not the cost of smelting one ton of ore.

wood Cañon, the Davenport, Vallejo, Wellington, Savage, Montezuma and Hiawatha, have especially maintained their good reputations.

The Last Chance, Hiawatha, Montezuma, and Savage were consolidated in September, 1872, under the name of "The Winsor-Utah Silver Mines," and are now controlled by capital from New York, Michigan, and Utah. The property has since then been worked with energy, and 500 tons of ore, sold for $60 per ton, have been extracted. The shafts on the different lodes have the following depths: Montezuma, 375 feet; Last Chance, 366 feet; Savage and Hiawatha, 350 feet. Length of tunnels on the property, 550 feet. The outlets of the various mines are connected with the main tram-way, on which the ore is lowered to the valley below, by branch-tracks. All these ore-bodies are comparatively thin, the Montezuma, 3 feet thick, being the largest.

The Wellington mine lies on the mountain-side, opposite the Emma. It is opened by an incline 200 feet deep, and by levels from it about 800 feet long in the aggregate. The deposit is about 30 feet wide, has an ore-layer of about 4 feet in thickness on both walls, and a horse of the country-rock between. The ore-streaks are rather pockety, but the mine has yielded something over the expenses. There is now an ore-body uncovered at a depth of about 100 feet from the surface, in which 600 tons of ore are in sight.

The Davenport and a mine near it, the Matilda, have been sold to an English company, and smelting-works are in the course of construction near the mouth of the cañon, not far from the Flagstaff works. Both mines contain large bodies of rich ore. From the Vallejo the first wire-rope tram-way in the Territory has been built to the foot of Emma Hill, and, according to late accounts, it is a perfect success.

In Big Cottonwood district the Reed and Benson mine has furnished considerable ore, and several other mines have been worked with tolerable success.

In *American Fork district* the operations of the Miller Mining and Smelting Company have been carried out on a large scale. The Pittsburgh mine has also been worked to a limited degree.

The Miller mine is situated three and a quarter miles by wagon road, and two miles by the tram-way, from the Sultana smelting works, which belong to the Miller Company, and are located in the upper part of American Fork Cañon, about twelve miles from its mouth. The mine is not over two and one-half miles distant in an air-line from the Emma mine in Little Cottonwood Cañon. It was discovered in September, 1870, but was not worked on a large scale until the summer of 1871. Up to the middle of August, 1872, about 3,500 tons had been taken from the mine.

The deposit lies in limestone, near the contact with quartzite, and seems to follow the strike of the country-rock. It is, however, extremely irregular, and the mining-work done so far is not calculated to enlighten the visitor much in regard to the shape of the ore-body. The shafts and tunnels are situated about 1,500 feet above the bottom of the steep gorge, which sends its water down towards the East American Fork, on which the smelting-works have been built. There are several short tunnels driven to the deposit, but the upper works are all caved in, and at the time of my visit the ore was principally brought to grass by means of a tunnel, 20 feet lower than the old work. Another tunnel, about 80 feet lower, was in the course of construction, but this has, according to the latest accounts, not met the continuation in depth of the upper ore-mass, though, if the dip had been approximately regular, the ore ought to have been found at 460 to 500 feet from the surface. The ore-body is in some places quite thick, but in no case over 15 feet; and frequently it is much split up, and short arms branch from it, which do not again join the main channel, but are lost in the country-rock. The ore is a remarkably fine smelting material, being very ferruginous carbonate of lead, which contains much galena. Through the whole mass, and especially around the blocks and lumps of galena, there is found a multitude of small crystals of wulfenite, (molybdate of lead.) Crystals of carbonate of lead are also very frequent. Oxydized copper-ores are occasionally met with. The limestone immediately around the outside of the ore-mass is always very much broken, and similar to that found near the Emma, the large deposits on Ruby Hill, Eureka, and other lead deposits in limestone throughout the West. Near the surface in the upper works the ore assayed $30 to $40 per ton in gold and silver, and from 50 to 60 per cent. of lead. During the summer of 1872 the ore taken from the lower works contained, on an average, 56 per cent. of lead, 0.6 ounces of gold, and 40 ounces of silver per ton. The massive carbonate contains 76 per cent., the earthy ferruginous carbonates 25 per cent., and the galena from 63 to 80 per cent. of lead. Toward the end of the year it was reported that the body which had until then furnished the ore was entirely worked out.

The Sultana smelting-works and their operations are described in another part of this report under "Metallurgy." They were started on November 19, 1871, and run until February 5, 1872. The works were stopped until May 27, and from that time on until the time of my visit, in August, one furnace at least, and sometimes two, were kept running. Up to that time 750 tons of lead had been produced, containing about 90 ounces of silver and 1 ounce of gold per ton. These works use probably the cheapest charcoal of any lead-works in the western mining-districts, the total cost per bushel, delivered at the works, being only 13 cents. The coal is burned in kilns, twelve of which were standing on the bank of the creek, opposite the smelter-building, in August, while three more were soon to be built. These kilns are made of rock and brick. They have the shape of an old-fashioned bee-hive, a diameter of 23 feet at the base, and a height of 20 feet. There is a charge-door near the top in the back-side, and a discharging-door in front, level with the ground. A kiln holds 25 cords of wood, and the time of burning is twelve days; 38 to 48 bushels of good solid charcoal are produced per cord of wood, or from 950 to 1,200 bushels per day. Brands are returned into a subsequent fire. The above yield, it is seen, is far higher than can be attained in the common charcoal-pit.

The water-ditch supplying the wants of the smelting-works is 60 feet above the level of the slag-dump, and there is hose-connection to all parts of the building. The total product of the Miller mine and the smelting-works during 1872, was, according to the superintendent, Mr. E. Wilkes, 1,536 tons of lead, the average assay-value of which in gold and silver was $110.

Besides the Miller, the Pittsburgh mine was the only one being worked at the time of my visit to the district, and, so far as I am informed, no effective work has been done on any others during the rest of the year.

The Pittsburgh is situated one mile northeast of the Miller. It is owned by Pittsburgh parties. In August there was a shaft on the deposit 60 feet deep, from which about 300 tons of ore had been taken. The ore-body lies in limestone on the hanging-wall, and quartzite on the foot-wall, and is exposed by stripping the surface-soil 5 feet wide, and for a length of 40 feet. It stands very nearly perpendicular. The greater part of the ore is very ferruginous carbonate of lead, galena occurring, however, in nests. The average of the ore shows 55 per cent. of lead, but is poor in silver, assaying only $13 per ton. These figures are obtained from small lots of ore, which have been smelted at the Sultana Works. There is no sorting whatever necessary, the entire crevice being filled with ore of the above grade, which is so soft that it can all be shoveled out.

A tunnel was being driven at right angles to the course of the deposit, which was intended to strike the latter about 160 feet below the mouth of the shaft, and which, it was thought would be from 160 to 175 feet long. The ore sold to the Miller Company has brought $18 per ton, delivered at the smelting-works. It is thought that the mine can furnish 30 tons per day as soon as the tunnel is completed.

The Miller Company has, during the last summer constructed a narrow-gauge railroad from the Utah Southern road to a point in American Fork Cañon, sixteen miles distant. Another four miles will bring the end of the road to the Sultana Works. This road is remarkable as possessing the shortest curves and the steepest grades in the country, some of the latter being very nearly 300 feet to the mile.

Parley's Park district is situated in the Wasatch Range, north of Big Cottonwood, and about thirty-three miles from Salt Lake City. The district is comparatively new, having been formed in 1871. During that year the Flagstaff, Piñon, Walker and Webster, Wild Bill, Rocky Bar, and others were discovered. These are lead-mines in limestone, and contain principally carbonates.

The district has since been subdivided, or rather two more districts have been formed in the original one. They are Uintah and Blue Ledge districts. Of the mines in the former one, the Pioneer, Idaho, Gregory, and Porcupine have attracted most attention; of those in the latter, the discovery claim of the McHenry ledge has caused considerable excitement in 1872. I happened to arrive in Salt Lake City shortly after the discovery had been made, and visited Parley's Park. My impressions received at the time are expressed in the following:

The route to Parley's Park from Salt Lake City follows for a considerable way the old overland stage-road, passing Camp Douglas in the distance, and winding through the picturesque Parley's Cañon. The park itself is a small, nearly level plain, surrounded on all sides by the mountains, and the principal mines are near its southern end; on the west, near the summits in which head the famous Cottonwood Cañons over the range, are the Flagstaff, (not the Cottonwood Flagstaff, but an emulous namesake,) Walker and Webster, and Piñon, all in limestone. More nearly south of the park, on a mountain, which, being much covered with bowlders, soil, and pine timber, has heretofore been avoided by prospectors, is the McHenry, with its extension each way, and beyond these, on the northeast, the Bowlder, and on the southwest, a second extension, the Clara, the Wasatch, and the Red White and Blue, all of which are vehemently declared to be daughters in true lineal connection of the same mother-lode, to wit, the McHenry aforesaid. From the McHenry mine to Salt Lake it is twenty-nine miles; and the road near the mine is very steep and difficult. But to Echo City, on the Union Pacific Railroad, it is only twenty-four miles via the Provo Valley, and a new narrow-gauge railroad, said to be constructing from Echo to Heber City by the Mormons, would pass the foot of the mountain about three miles from the mine.

The mountain is quartzite and granite, mostly hidden from sight by the superincumbent earth and vegetation. Bowlders are plenty, and in the small steep cañon on the west they have been carried down for a considerable distance. It was in this cañon that the rich float-rock was found which led, after much laborious prospecting, to the discovery of the ledge. Not that it was so very hard to see. The discoverer sat on it a dozen times to wonder where it was, never suspecting that the large rock-mass beneath him was the outcrop of a vein.

This outcrop consists of a cliff, about 90 feet high, 250 feet long, and perhaps 15 feet wide on the top, from the edge to the line where it disappears under soil, roots, and bowlders. This cliff is believed to be, with the exception of a sheathing of quartzite, which adheres in places to the face, entirely composed of silver-bearing quartz. The evidence consists of numerous assays of samples chipped from all accessible points. The average of sixty-five assays is said to have been a little over \$200 per ton, the minimum being \$22. Some assays have yielded less; but these are declared to have been made upon samples of the quartzite outside of the vein. Perhaps fifty tons have been blasted from one corner of the mass, and form the beginning of a dump. So far as the excavation has gone, it shows the mass of quartz to be more or less charged with "mineral" in bluish and black spots, and ochreous or light yellow stains, as well as copper stains. It looks like a fair milling-ore, and an experiment tried with 75 pounds in San Francisco is said to have proved it to yield its silver readily by raw amalgamation.

It is impossible to say at present with positive certainty what is the form of the deposit. At first it was naturally believed to be an immense bowlder; but the discovery of more or less ore in the located extensions gives grounds for believing that it is really an outcrop in place; and the question then arises as to the true dip and real width of the deposit. Its course is northeast and southwest. If it dips southeast, that is, into the mountain, then the 90 feet of vertical exposure represents an oblique section across a vein of say 65 feet thickness. If it dips steeply northwest, that is, with the hillside, then the cliff is a portion of a vein, say 12 feet thick, and stripped on the hanging-wall. In the former case, the assays taken all over the surface might be presumed to represent the character of the vein throughout its whole sectional area. In the latter case the larger number of the assays would represent the character of a zone along the hanging-wall. There are both arguments and indications in favor of the supposition that the ledge is intercalated between layers of quartzite and dips into the mountain. A tunnel, now constructing, about 150 feet below the topmost outcrop, will probably decide the questions of form, thickness, and value. It has already, at 90 feet from the tunnel-mouth, struck hard bluish quartzite, dipping southeast about 30°, and it is expected within the next 90 feet to cut the vein.

The McHenry is owned by Messrs. Whitaker & Templeton. It is popularly reported that a large sum of money was paid for the property; but nobody really knows the terms of the purchase except the parties immediately concerned. At present they are engaged in developing the nature and value of the mine. If it sustains the high anticipations inspired by its superficial appearance, they will probably erect a stamp-mill of large capacity, and commence active operations.

Up to the date of writing this report I have not had any information in regard to the developments made by the tunnel.

From the lead-mines of the district, notably from the Piñon and Flagstaff, considerable ore has been shipped to the smelting-works at Ogden and others. The ore is a kindly smelting material.

West Mountain mining district, in Bingham Cañon, the only district in Utah, I believe, where placer-gold is found, is reported to have yielded about $100,000 of gold during the year.

Of lead mining and smelting operations those of the Winnamuck and Utah Silver Mining and Smelting Companies have been the most prominent before the public; the former on account of the success attending them, the latter on account of the utter and disastrous failure of the English Company, which, as I mentioned in my last report, was induced to enter into this enterprise in a rather remarkable manner.

The Winnamuck mine and smelting-works have been managed during the greater part of the year by Messrs. Bristol & Dagget, in the interest of a Rhode Island Company. Late in the year the whole establishment was transferred to an English company, for a consideration of $400,000. I visited the mine and smelting-works in August. The establishment is compactly built and arranged, mine, furnaces, and office being within hailing-distance, and the ore being lowered directly to the furnaces by an inclined tramway from the mouth of the windlass-drift in the side of the mountain. The mine comprises 2,000 feet on a vein running N. 76° W., and dipping northerly into the mountain. The course of the outcrop on the mountain side is nearly northwest. The general dip of both vein and country is about 45°. The hanging-wall is usually a belt of soft bluish rock (siliceous clay-slate?) but sometimes quartzite; the foot-wall, like the general country-rock, is quartzite. The ore is distributed in chimneys or bodies in the vein, and consists of carbonate of lead and galena, with subordinate associated minerals and siliceous gangue, carrying about 38 per cent. of lead and 56 ounces of silver per ton, as shown by the furnace-assays of nearly 1,300 tons.

The underground works consist chiefly of the discovery-shaft, 65 feet deep, a drift from it 30 feet long, an incline from this drift 130 feet deep, and a shaft 75 feet deep from the bottom of this incline. The windlass-drift above mentioned, through which the mine is worked at present, enters the face of the mountain on a level with the drift above mentioned. About 150 feet vertically or 200 feet inclined below the windlass-drift, a tunnel has been run in 600 feet on the contact-plane between the blue hanging-wall rock and the quartzite. This tunnel is not a part of the producing-mine at present. It is carried on to prospect the character of the vein in depth. Thus far it has developed no carbonate ore like that above, but a vein of mixed galena and iron pyrites is shown in it, which will be followed upward by winzes. The discovery indicates the continuance of the contact-vein in some form at greater depths than those now worked.

The average thickness of the vein is something over 4 feet—maximum 20. Two bodies of ore have furnished the amount hitherto extracted. The first was about 100 feet long by 250 feet in depth on the vein. The second, a small, rich body, was about 20 feet long by 60 feet deep and 2½ feet thick. Out of these bodies there have been extracted and reduced, from August 1, 1871, to June 30, 1872, about 2,200 tons of ore, yielding a net profit of $80,000. The mine cost is very small, as the vein-matter is thoroughly decomposed and can be removed without blasting, while at the same time the stopes and drifts do not require expensive timbering. The reserves of good ore still standing in the mine are considerable in amount.

Smelting in this locality is, of course, expensive. Charcoal costs (freight and waste included) something over 30 cents per bushel; iron-ore, (the pure red hematite brought from Rawlins, Wyoming Territory,) $22.50 to $25 per ton; limestone, $7 per ton. Fire bricks are brought from Golden City, Colorado, or even from Illinois. As the charge of the furnaces consists of about 13 parts ore, 4 parts iron ore, 5 parts limestone, and 6 parts charcoal, with two parts old slags, it will be seen that the *Beschickung* is highly expensive. In respect of completeness of extraction, the works are doing excellently for this region, the total losses in treatment being 6.4 per cent. of the lead and 5.8 per cent. of the silver contained, as per fire assay, in the ore.

The works comprise two Piltz furnaces, 14 feet in height from the tuyeres to the feed-hole, 3½ feet in diameter at the tuyeres, and 18 inches in thickness of walls. There are six tuyeres, with 2½-inch nozzles. The slag-discharge is 10 inches below the tuyeres—a point strangely overlooked in most of the Utah furnaces, where the blast is usually directed almost upon the lead. The automatic siphon-tap is employed. Blast is furnished from the Root blowers. They have been worked up to a pressure of 2 inches of mercury; but the usual pressure is 1½ inches.

The principal trouble in running the furnaces is the shortness of the campaigns, which are terminated either by the formation of "salamanders," or by the burning out of the walls. The latter is the most serious evil, and it is rendered more frequent by the employment of so much iron-ore, and the formation of a basic slag (probably a singulo-silicate at least) which attacks the fire-brick. It is said that the bricks made in 1872 at Golden City are unusually liable to be slagged away. This may be the case, but I fancy the constitution of the slags, and the high temperature and pressure sometimes employed to prevent or remove salamanders, are sufficient causes for the rapid consumption of the walls. Two weeks appear to be frequently the limit of a campaign.

The extra expense incurred by this method of running is partially balanced, at least, by the increased quantity smelted per diem. One furnace will reduce about 14 tons of ore daily, producing about 5 tons of bullion, worth in silver about $153 per ton.

A more detailed account of the operations of these furnaces will be found in the metallurgical part of the present report.

According to the superintendent, Mr. Ellsworth Dagget, there were smelted, during the year 1872, at the Winnamuck Works, dry ore, 54$\frac{913}{1000}$ tons, containing 1,383$\frac{712}{1000}$ tons of lead and 203,536$\frac{58}{100}$ ounces of silver, and producing 1,232$\frac{741}{1000}$ tons of lead and 191,661$\frac{4}{10}$ ounces of silver; total value of silver and lead produced, $353,551.26, assaying per ton, 34.98 per cent. of lead and 51.46 ounces of silver, and producing 31.16 per cent. of lead and 48.46 ounces of silver; losses in units, 3.82 per cent. of lead and 3.00 ounces of silver; losses on total contents, 11 per cent. of lead and 5.83 ounces of silver.

By total value in the above is meant the actual amount received for the products.

All of the ore handled, excepting a few tons, was from the Winnamuck mine.

The Utah Silver Mining and Smelting Company has during the year expended the total amount of money ($100,000) raised at the end of the previous year in addition to the original working-capital. Besides this, a debt of $35,000 was incurred. The condition of the enterprise at the end of the year will appear from the following abstract of a lengthy report to the directors, by Mr. J. R. Murphy, the superintendent:

Fully appreciating your disappointment in my not being able to bring the property to a paying condition as early as you have been from time to time led to expect, nor yet to do so with the amount of funds at first considered sufficient, I have entered more at length into an explanation of the difficulties which had to be surmounted, as well in the prospecting and opening of the mines as in the dressing and smelting of the ores, before the property could possibly be brought to a remunerative basis, that you might the more clearly comprehend the situation, and therefrom be able to estimate properly the magnitude of what the developments of the past season have proven the property to be possessed.

I have placed before you the work done on the mines in a detailed form, with the cost, from which you may judge its character, and the prospects exposed thereby in the different portions of the mines as explored. I also present to you a plan for the management of the property, treatment of the ores, &c., which is but a repetition of what I have already set forth in the course of the past spring and summer, as the only system under which it can be made to pay, but which, unfortunately, the means at command would not allow of being carried out to the present. To the latter I would most particularly beg to call your attention." * * "The cost of each ton of ore smelted is: in fluxes, $6.96; charcoal, $15.80; labor, $4.27; calcination, $5.30; mining and incidentals, $6.00; aggregating $38.33 per ton. While the amount produced from each ton of ore smelted was, gross, $43.85, leaving only $5.52 as net profit on each ton of ore. The causes which led to so unfavorable a result, as already explained, arose in having to smelt, in the absence of dressing-machinery, so much barren stuff of the most refractory kind, and in having to haul from railroad up a mountain-road all the material required, a distance of twenty miles, at $10 per ton; the waste on charcoal alone being fully 12 per cent, owing to its soft and friable character, the re-loading and hauling over a rough road breaking it to fine powder. * * * *

Total received from London, £19,300, equal	$101,913 20
Total received from bullion-product, net	8,311 00
Credit used, against which there is available stock on hand of $7,000, and stock in store to amount of $14,640	35,000 00

* * * This indebtedness was incurred since September last, believing that the capital would be forthcoming to remove smelting-furnaces and put up concentrators; stocks of fuel-wood, mining-timber, coal, iron, and other necessaries were laid in, in the expectation of being able to mine and smelt through the winter months, as might have been done had the means been furnished in September or October.

Much of this indebtedness was incurred in pressing forward developments on the mines before the approach of winter.

In addition to the foregoing encouraging prospects for the future of the Utah Company, there are some few others to be noticed. One is, that more cubed galena is found as greater depth is attained, and that, wherever found, it invariably carries from $5 to $40 per ton more silver than the short-grained galena, which predominates in the upper portions. Another great advantage is in the construction of the Bingham Cañon Railroad to within two and a half miles of the company's mine, and passing through the new furnace-site secured by me to the company in March last, in anticipation of my full plan being carried out to move furnaces, &c., to where the company have ten acres of a most eligible site, with water-right for water-power intended to be used in place of steam in driving air-fans, rock-breakers, and other machinery, as may be required. One great advantage to be gained in smelting at the railroad is the close proximity to the mines of the two Cottonwood districts, from whence ores can be obtained which would serve as a flux to the Utah Company's ores, owing to the presence of an unusual percentage of oxide of iron, which would obviate the necessity of using barren iron to any per cent. whatever. The distance from your mines to your new furnace-site is, from mines to railroad at Bingham Town, two and a half miles by teams; from Bingham Town to site by railroad fifteen and a half miles, where the proposed works will be in direct communication by railroad with the outside world for export or import, with an unlimited supply of water, and a climate in which nearly all kinds of out-door work can be carried on throughout the whole year.

I would beg again to remind you of the importance of developing the Belshazzar mine, which I am certain will prove equally, if not more, valuable than the Red Warrior has proved. Get your ore-dressing machinery to work as soon as possible, when you can ship the dressed ore to Liverpool for sale while the smelting-works are being built, keeping the mines running through the winter, raising ore, and I guarantee that within six months from this day the Utah will be paying satisfactory dividends.

The "guarantee" offered in the concluding paragraph of this extract is an extraordinary illustration of sanguine expectations based upon uniformly discouraging results. It is a pity that the resolution and perseverance displayed by the English stockholders of this company had not been applied to a more promising enterprise.

A large number of other mines have been worked more or less in this district during the year, but important results have been obtained so far from none of them.

In the main Bingham Cañon the West Jordan, Kenosh, Galena, Orphan Boy, Consolidation, Vespasian, Sultana, Elizabeth, Northern Light, and the mines of the two companies noticed at length heretofore, are situated;

also the Kelsey tunnel, which is intended to strike ten ore zones or deposits lying in front of it on the mountain-side. It is now over 350 feet long, and has passed two of the ore-deposits, said to be respectively 6 and 9 feet thick. On Silver Hill the Spanish, Queen, and Buckeye mines are located. They are reported to have been lately sold to New York capitalists.

On the hill dividing the main Bingham Cañon and Butterfield Cañon lie the Eagle Bird, Yosemite, and Telegraph; in Butterfield Cañon the Osceola, Lucky Boy, Bemis, and Hyatt; in Spring Gulch the Greeley, Royal, and Legal Tender; in Carr Fork the Nabob, White Pine, and Clipper; in Muddy Fork the Saturn, Last Chance, and Crœsus; in Markham Fork the Washington, Oro, &c.

The Saturn ore was, in the earlier part of the year, shipped to the Saturn smelting-works, on the Utah Southern Railroad, but it was of too low a grade to be profitably worked, and when I visited those works in August they were smelting ores from other sources.

The Last Chance has been sold to an English company, which has a nominal capital of $100,000. According to notes from Mr. N. M. Maxwell the mine was 300 feet deep at the end of the year, and over 1,000 feet of levels had been driven. The lode was on an average 4 feet wide, and is situated in granite containing porphyritic dikes (?). The pay-streak of the lode is 18 inches wide, and its value is $80 in silver and $15 in gold per ton. There is only 8 per cent. of lead in the ore. The mine is capable of producing 30 tons of ore per day, and the ends of the various levels, as well as the bottom of the shaft, are in good ore.

According to the account of a meeting of the directors, held on February 3, 1873, and published in the London Mining World of February 8, it was proposed to buy a lead-mine in addition to the Last Chance, for the purpose of using the lead-ores for the extraction of the precious metals in the Last Chance ore by means of smelting. There were also three furnaces to be erected. Locality not given.

From Rush Valley and Ophir districts I have not had any detailed reports this year. No news of important developments, with the exception of those at the Mono lode, have, however, appeared in public, and it is fair to presume that none have been made. Both districts were described at length in my last report. The Mono is situated on the Snow-Storm Hills, in Dry Cañon. The ore is very rich in gold. The smelting-works erected during the summer by Mr. Jacobs in Stockton, to work ores from Dry Cañon and do a custom business, appear to have stopped operations.

In Camp Floyd district the English company, which acquired during the early spring the Sparrow-Hawk, Last Chance, and Marion, has worked its mines actively, employing from forty to fifty miners. The same company have built a mill containing 20 stamps, and capable of reducing 30 tons of ore per day. A tram-way connects the mill with the mines. According to late accounts the company has not been financially successful. An abstract of an article furnished by Colonel Foriseth, of Salt Lake City, to the Mining and Scientific Press, of San Francisco, describes the developments of other mines in the district as follows:

The Mormon Chief and its extensions, the Grecian Bend and London, consist of 3,000 linear feet. The developments in tunnels, cuts, shafts, drifts, and inclines, will measure about 500 feet, showing a large body of free milling-ore. The Camp Douglas Consolidated has a shaft of 47 feet in depth, besides two open cuts, and the indication so far is not surpassed by any mine in the district equally developed. The Silver Cloud has a shaft 55 feet deep, and a level driven 180 feet from the bottom of the shaft on the course of the vein, showing 12 feet in width of rich ore. A tunnel has also been run 275 feet to cut the vein below. A mill-site has been located adjoining the mine, upon which is a fine spring of water. The Star of the West, owned and worked by a New York company, is developed by several open cuts and shafts. The Stafford mine has a well-defined vein of ore, and is being actively worked by open cuts and a tunnel now 60 feet long. The Carrie Steele adjoins this mine, and is promising well. The Silver Circle, Wandering Boy, Legal Tender, Comstock, Silver Star, America, Excelsior, and Lone Star, are all considerably developed and promise well. The General Morrow has a shaft 55 feet deep, and is very promising. The Antelope has now a shaft 7 by 7 and 12 feet deep; also an open cut 6 feet wide and 10 feet in. The ore from this mine is of good quality, and assays high. The Queen of the West, now owned by a Detroit party, is being actively worked, and a good quality of ore is produced therefrom. The Elkhorn is also considerably developed by shafts and a tunnel 60 feet. This is a very promising mine, and is in close proximity to the English company's mill, but work has for the present been suspended, owing to a want of means to continue the development.

The following mines have been surveyed for United States patents: Sparrow Hawk, Last Chance, Marion, Consolidated Camp Douglas, Silver Star, Wandering Boy, Silver Circle, Star of the West, Silver Cloud and mill-site, Red Eagle, Black Warrior, Gentile Belle, and American Flag consolidated mines.

A second stamp-mill has recently been completed at Fairfield by Messrs. Baxter & Hussey, which will be in running order in a short time, and is especially designed for custom-work.

East Tintic district.—For the information in regard to this district I am principally indebted to Mr. W. P. Ward, M. E., of Salt Lake City.

The principal mining-camps of this district, Eureka, Silver City, and Diamond City, are situated within seven miles of each other, and lie about ninety miles south of Salt Lake City. The most southern of these camps is Diamond City, three and one-half miles southeast of Silver City, and situated in a small gulch, opening into the Great Tintic Valley. The most important claims are located in a hill north of the town. Among them I may mention the Joe Bowers lode, running N. 7° 30′ W., and dipping 1 foot in 2½ feet, equal to about 25 degrees, west. Going over the hill to the north one first sees some small prospecting holes, showing but little ore, though all the ledge-rock is deeply stained with oxide of iron. Mr. James M. Wayne, the engineer in charge of the operations of the Wendigo Mining Company, of Marquette, Michigan, informed me that the croppings all along this portion of the lode assay about $15 per ton in silver. Over the brow of the first little hill small quantities of black sulphide of silver have been found, which run over $600 per ton. This prospect belongs to the Wendigo Company, whose principal shaft, 100 feet deep, lies higher up on the hill.

At the main shaft the ledge is 20 feet wide, and carries but little ore. A white, partially decomposed mineral, containing a considerable quantity of silicate of alumina, impregnated with small crystals of iron-pyrites, accompanies the vein. The Wendigo Company owns 1,300 feet on the lode south of the discovery-shaft. Two-thirds of the discovery claim belong to Mr. Tostavin. In this claim there is a shaft sunk 5[illegible] feet deep, and showing in the bottom a seam of ore 8 inches wide, and quartz-vein 4 feet wide, highly colored, and impregnated with decomposed pyrites. The ore on the dump at this shaft is said to average $70 per ton in silver.

East of the Bowers ledge and running diagonally to it, in a northwest direction, is the Shower ledge, 2,400 feet, under the control of the Tintic Mining and Smelting Company. At the principal shaft the ore streak is from 1 to 3 feet in width, and sometimes widens out to 5 feet. The ore consists of carbonate of lead, colored with hydrated oxide of iron, and containing some galena. This ore is said to average about 50 per cent. of lead and $80 in silver per ton. The same company own two furnaces, one of them very poorly constructed, and the other of a very singular pattern, known as Richards's patent. The bottom of this furnace is about 2½ feet above the floor of the works, and is constructed of iron, and hung on hinges, so that it can be opened, and allow the salamanders, which may have formed in the furnace, to drop out.

Three miles south of Diamond City are a number of prospects containing galena. The Alice has a shaft 100 feet deep, and shows a vein 2½ feet broad, running north and south. The galena averages about $50 in silver per ton. This belongs to the Wendigo Company.

The Rising Sun Tunnel Company has a tunnel about one-half mile south of Diamond, running under a number of galena-claims. The owners of the claims are friendly to the tunnel, and have deeded portions of their claims to the company when their ledges are reached. Monterey, Elephant, King Philip, Saratoga, and Jefferson are some of the claims which the tunnel is intended to cut.

The Morning Glory claim is situated on a parallel ledge to the Joe Bowers, and lies to the west of it. About 50 tons of copper-ore, averaging, from appearances, about 10 per cent. of copper, were upon the dump at the time of Mr. Ward's visit. The copper is in the form of blue and green carbonates. The claim includes 3,000 feet on the lode, and has lately been bonded for $25 per foot.

The Swansea is a mine located about a mile north of Silver City, and is being successfully worked under the management of Mr. Meade, of Salt Lake City. The ore runs well in both lead and silver, and works well in the furnace. Considerable quantities of ore have been shipped from this mine during the summer and fall of 1872.

By far the richest and most promising mines in the Tintic district are the Mammoth Copperopolis and the Crismon mines. They are situated close together on the range between Diamond and Silver Cities. In August, 1872, there were three large openings upon the property of the Mammoth Company, from each of which ore was being sacked up and shipped in large quantities to Liverpool.

At the time of Mr. Ward's visit a tunnel was being driven to cut the lode at a depth of 200 feet. There were still 150 feet to run to cut the lode. In an open cut in the hill south of that in which the first openings were made a vein of gold quartz lying by the side of a 12-foot vein of massive copper-ore had been opened. The quartz formed in fact the foot-wall of the copper ledge. The gold rock must run into the thousands per ton, for the yellow metal could be plainly seen in almost every piece broken from the vein. The copper-ore lying adjacent carried little or no gold, but the gold is reported to run over into the copper-ore farther in the hill. The deepest shaft on the property was 60 feet. The ores are blue and green carbonates, black oxide, red oxide of copper, and occasionally small quantities of copper-pyrites are found. The first-class ore from this mine runs 35 per cent. of copper, and about 50 ounces silver per ton. Second-class 22 per cent. of copper, and 20 ounces silver per ton.

North of the Mammoth, and separated from it by a gulch, lies the Crismon mine. The character of the ore is the same as in the Mammoth, but it runs much higher in silver, averaging about 150 ounces per ton.

The mines of the Mammoth Copperopolis Company of Utah (limited) have yielded during 1872 about 2,000 tons of copper-ore, 1,000 tons of which, valued at $150 per ton, were shipped to Swansea. The other 1,000 tons, said to contain 11 ounces in silver and $50 in gold per ton, were extracted from the south hill, and are on the dumps awaiting the erection of a mill.

At the end of the year the section of the mine lying on the south hill was opened by an open cut 50 feet long, 30 feet wide, and 30 feet deep. A shaft 50 feet deep was sunk from the bottom of the cut, and thence a drift was driven in a southerly direction, on the course of the vein 50 feet in length, also a drift north 45 feet in length. These developments had exposed to view a vein 20 feet in width, from which can be extracted 100 tons of ore per day. The tunnel was still being driven from the foot of the hill, and was in about 60 feet.

The north hill, which has yielded the greater portion of copper-ore, was developed by three shafts, the depths of which were respectively 71, 55, and 45 feet, besides drifting to the extent of 260 feet. In addition to the above there were several chambers below and above the levels, which had been excavated by stoping out the copper. The main tunnel was being driven from the foot of the hill, and was then in 275 feet. It will cut the vein 100 feet below the present workings. About eight tons of copper-ore were being extracted daily from this section of the mine. A force of forty-five men was employed on the works. The company had purchased a fine mill-site, and intended to erect on it a 30-stamp mill and furnace.

Eureka Hill.—The Eureka Mining Company of Utah now hold full possession of all the mines situated on this hill. There are four parallel ledges known as the Eureka, Deseret, Young Lion, and Montana, on each of which the Eureka Company owns 2,200 feet. The locations were made in 1870, since which time a large amount of work has been done upon them, and a survey for a United States patent made. At the time of Mr. Ward's visit the company were sinking a very large shaft and timbering it splendidly. This shaft is intended to cut all the veins at a considerable depth and to serve as a main working-shaft. The Eureka Company have been much troubled by jumpers on their claims, but they have the prior location; and, by the expenditure of a great deal of money, have traced out all jumpers and proved the continuity of their veins.

At the time above mentioned no ore was being raised, as the company had a large amount above ground, (enough, it was said, to keep a 20-stamp mill in operation for a year,) and their mill was not yet complete.

Since that time the Eureka Mill at Homansville has been completed and put in operation, and also the Wyoming Mill, at the same place.

The Eureka Mill, at Homansville, belonging to the Eureka Silver-Mining Company, of Utah, is located in Tintic district. This is a mill of the California pattern, but the machinery was all built at the Council Bluffs Iron-Works, Iowa, and the complete mill was erected by their agents, Messrs. Hendrie Brothers, of Salt Lake City. There are twelve revolving stamps, which have an improvement, not before introduced on the Pacific coast, of a cast-iron guide for each stem, on the same principle as the stuffing-box to a cylinder, which keeps the stem perpendicular, prevents the wear of the guides, and needs no renewal. They are claimed as a decided improvement on the usual wooden guides. There are also six 5-foot Varney pans, three 7-foot settlers, two agitators, all with iron rims, and one 9 by 15 large Blake crusher. These are all run by a highly finished engine of 18 by 30 cylinder, having two boilers 52 inches in diameter, and 16 feet long, with iron fire-front. This does not support the boilers, which rest upon the brick furnace erected upon a new plan, and claimed to economize fuel to a great extent.

The water to supply the mill is forced up from a pond 70 feet vertically below, and 300 feet distant from the tank, by one of the steam-pumps manufactured by the Council Bluffs Iron-Works. It supplies the mill abundantly.

The mill is adapted to wet crushing, and has a capacity of 25 to 35 tons per day, according to the nature of the ore worked. There is more machinery in this than in the Wyoming Mill, but it works smoothly, and does credit to the builders. The cost of the mill was $45,000.

The Wyoming Mill, belonging to the Wyoming Mining Company, of Cincinnati, Ohio, is also located in Tintic district. It contains ten revolving stamps, four 4-foot combination pans, (Wheeler & Varney pattern,) two 7-foot settlers, and one cleaning-up pan. The engine cylinder is 14 by 32 inches, the boiler (tubular) 50 inches in diameter and 14 feet long. The speed of stamps is 82 drops; of pans, 60 revolutions; and of settlers, 11 revolutions per minute. There is an 8 by 15 Blake crusher.

This is a dry-crushing mill; capacity, 10 tons per day. There is also attached to the mill a Stetefeldt furnace, with a capacity of 30 tons per day. The machinery was made at the Marysville foundery, California, and the mill was erected under the superintendence of D. J. Bell, of California. This is a good mill, and has cost $85,000 including the approaches to the mill, &c.

There are a number of other districts south of those already mentioned, such as *Ohio* or *Sevier*, *Lincoln*, *Star*, and *Beaver Lake*, none of which has so far contributed greatly to the product of the Territory Granite district, sixty miles west of Ophir district, and Mineral Point district, sixteen miles from Bingham City, are also new districts. The latter is reported to contain very valuable deposits of iron-ore.

In Lucien district the Tecoma mine and several other claims are reported to have lately been sold to an English company.

List of smelting-furnaces and amalgamation-works in Utah.

Name.	No. of smelting-furnaces.	No. of roasting-furnaces.	No. of stamps.
Warm Springs Smelting-Works, Salt Lake City	1	1	.....
Badger State Works, on State road	1	.....	.....
Wahsatch Smelting-Works, on Utah Southern Railroad	2	1	.....
Robbins's Smelting-Works, on State road	1	1	.....
Saturn Smelting-Works, Sandy Station	3	.....	.....
Flagstaff Smelting-Works, mouth of Little Cottonwood	3	.....	.....
Davenport Smelting-Works, (in course of construction)	.....	.....	.....
Wellington Smelting-Works, in Little Cottonwood	1	.....	.....
Monitor Smelting-Works, mouth of Little Cottonwood	1	.....	.....
Utah Company's Smelting-Works, Bingham Cañon	2	2	.....
Winamuck Smelting-Works, Bingham Cañon	2	.....	.....
Sultana Smelting-Works, American Fork	3	1	.....
Utah Smelting and Milling Company's Works, Homansville	2	.....	.....
Tintic Smelting Company's Works, Diamond City	2	.....	.....
Waterman Smelting-Works, Stockton	2	.....	.....
Ophir Upper Smelting-Works, East Cañon	2	.....	.....
Ophir Smelting-Works	1	.....	.....
Utah Mining and Smelting Company's Works, East Cañon	1	.....	.....
H. S. Jacobs & Co.'s Works, Stockton	3	.....	.....
Gilbertson & Barry's, Deep Creek	1	.....	.....
Register Smelting Company, Ogden	1	.....	.....
Alger Reduction-Works	1	1	.....
Pioneer Mill, East Cañon	.....	.....	15
Eureka Mining Company's mill, Tintic	.....	.....	12
Wyoming Mining Company's mill, Tintic	.....	.....	10
Camp Floyd Silver Mining Company's mill, Camp Floyd	.....	.....	20
Brevoort Mill, East Cañon, (steam-stamp)	.....	.....	2
Chicago Company's mill, Ohio district, on Sevier River, (steam-battery)	.....	.....	2
Total	36	7	61

Wahsatch Smelting-Works.—In regard to the Wahsatch Smelting-Works, seven miles south of Salt Lake City, which have been erected during the fore part of 1872, I have the following details, furnished by Alfred Wartenweiler, esq., the metallurgist of the establishment:

The works, as first constructed, contained only a Flintshire reverberatory and a small slag-hearth. Since Mr. Wartenweiler took charge, the old English process has been thrown overboard as unsuited to the ores and not economical. A shaft-furnace, which has so far given excellent satisfaction, has been built and put in operation. Its dimensions are about as follows: Section at the tuyeres, 2 feet 6 inches by 3 feet. From here upward the two side-walls start outward, so that at the charge-door the section is 4 feet 2 inches by 3 feet, the front and back walls being perpendicular. Height from the tuyeres to the charge-door, 7 feet 4 inches. There are three wrought-iron water-tuyeres with $2\frac{1}{2}$-inch nozzles. The inside lining is Colorado fire-brick, and campaigns of four weeks' duration have been made. Connected with the furnace is Arent's automatic tap, from which the lead is drawn off into a second pot. This is done because copper-matte finds its way into the basin of the automatic tap—why, does it not appear from Mr. Wartenweiler's letter—and, as this forms a hard coat on top of the lead, the latter cannot be continually ladled from this basin.

The ore, as delivered at the works, is first sifted through a coarse sieve. The part falling through goes to the reverberatory-furnace, where it is simply agglomerated, the object being to prevent losses in the shaft-furnace from fine ore being blown out of the top. The coarser part, remaining on the sieve, goes directly, without a previous roasting, to the shaft-furnace, the greater part of the ore being in an oxidized form, and the cost of roasting in reverberatories too high. Some sulphur is at any rate required to cause the copper in the ores to go into a matte, which, although it contains always considerable lead, can be roasted sufficiently in open heaps.

Of the ores, which so far have come to the works, those of the—

	Pb, per cent.	Fe_2O_3, per cent.	SiO_3, per cent.
Reed & Benson, Big Cottonwood Cañon, contains	28	22	
Wellington, Little Cottonwood Cañon, contains	27	......	16
Spanish Hill, Bingham Cañon, contains	48	......	31
Emma, Little Cottonwood Cañon, contains	45	......	27

Fuller and more exact analyses of the ores Mr. Wartenweiler has not been able yet to make. He has endeavored to mix them so as to obtain, without any other addition than that of old slags, a slag containing 47 per cent. Fe O and 38 per cent. SiO_3. Assays of the same show 3 per cent. of lead and 1 ounce silver in the ton. In making the above mixture Mr. Wartenweiler avoids the addition of the costly iron-ore from Rawlins as flux, and increases the capacity of the furnace considerably. Thus the furnace smelts now in twenty-four hours 20 tons of ore, while of any of the above siliceous ores alone, for instance of the Emma ore, not more than 10 tons can be smelted in twenty-four hours, and the Rawlins iron-ore, costing $15 per ton, must be added in large quantities. A charge of 300 pounds requires 30 pounds, or 10 per cent., of coke, which is now (end of the year 1872) almost universally used instead of the charcoal used before. Smelting with coke, at $30 per ton laid down at the works, is about $4 cheaper per ton of ore smelted than smelting with charcoal at 30 cents per bushel. The cost of slagging the fine ore in the reverberatory is about $4 for labor and fuel, (the latter being lignite.) Smelting in the shaft-furnace costs $13 per ton of ore. All the above values are currency. The old slag-hearth was intended to be used for smelting second-class copper-ores from the Mammoth Copperopolis in Tintic. A lot of these at the works assayed 24 per cent. of copper and 11 ounces of silver per ton.

Germania Separating and Refining Works.—These works have been lately built, and are the first of their kind erected near the western mining districts. A description of the same, by Mr. Bentham Fabian, appeared in the Salt Lake Tribune of January 4, 1873, which I reproduce here. The works were only commenced when I visited Utah in the summer of 1872, but were finished soon enough to commence working in December.

The object of these works is to separate from the impure lead-bullion the precious metals which it contains, as well as its impurities; and to effect this on the spot where the bullion is produced, and thus save the expense of shipping worthless matter at great cost to points far distant.

The works are situated on the west side of the Utah Southern Railroad, about eight miles from Salt Lake City. The buildings are extensive, substantial, and arranged with a view to economy of labor and convenience in manipulation. They consist of the main building or furnace-house, refining-house, assay-office, engine-house, and all necessary offices and out-houses, together with manager's and superintendent's dwellings. In the furnace-building are five large cast-iron pots, set in substantial brick-work, each one over its furnace or fire-place, two reverberatory softening-furnaces, two calciners, and two flowing-furnaces. Connected with this building is the engine-house, containing a fine 45-horse-power engine and a 55-horse-power boiler. A little to the north of this is an inclined shaft-furnace, while to the west of the works, at a distance of a few rods, is a substantial brick-stack, which is connected with the furnaces by means of underground flues of strong masonry. A side-track is laid from the main railroad track to the works, by means of which all the materials employed are brought to their respective destinations without transshipment.

The process which is used for separating the lead and silver is that known as Flach's process, with some additions and improvements made by Mr. Sieger, the superintendent of the establishment.

The following description will give some idea of the *modus operandi:*

About 23 or $23\frac{1}{2}$ tons of base bullion, as received from the different smelting-works are put into one of the largest of the pots, which are five in number, two of them having a capacity of 25 tons each, the other three being smaller; the whole number being set in the form of a wedge, the two largest forming the broad part, while the smallest pot forms the point. A sharp heat is kept up until the impure lead is thoroughly melted, and sufficiently hot to melt the zinc (which is the medium of separation) immediately on its addition, or at a temperature of about 411° Celsius, the melting-point of zinc. Zinc is employed for the separation of gold, silver, and copper from lead owing to its possessing a greater chemical affinity for these metals than that of lead. The zinc employed at this establishment is of two kinds, viz: commercial or good zinc, and dross zinc, (a refuse matter from galvanic batteries,) which contains about 30 per cent. of iron. The former is obtained from Illinois, at a cost of 9 cents per pound, and the latter from New York, at a cost of 5 cents per pound. When the base bullion is tolerably free from impurities and contains from 150 to 200 ounces of silver per ton, $2\frac{1}{4}$ to $2\frac{3}{4}$ per cent. of zinc, or 3 to $3\frac{1}{2}$ per cent. of dross zinc suffices for its complete desilverization.

As soon as the metal has attained the requisite heat, from $\frac{1}{2}$ to 1 per cent. of zinc, or from $\frac{3}{4}$ to $1\frac{1}{2}$ per cent. of zinc-dross is added to the molten mass, which is well stirred by two men for half an hour, and then allowed to remain still for three hours. Immediately after stirring, the fire is withdrawn from under the pot, and the metal allowed to cool to a dull red heat. The zinc being thoroughly mixed with the lead, takes up the gold and copper, with the greater portion of the silver, and rises to the surface forming a scum or cake, which gradually covers the whole of the lead.

The object of adding a portion and not the whole of the zinc at one time, is to avoid the caking of the zinc on the surface of the metallic bath, whereby it would not be in a state of division sufficiently fine to mix thoroughly with the lead.

At the expiration of three hours this scum is skimmed off and transferred to the pot next in advance. The whole operation, from the commencement to this point, occupies about four hours, but varies with the amount of the impurities in the lead. A second addition of zinc is now made, in the proportion of $\frac{1}{2}$ to $\frac{3}{4}$ per cent. of zinc, or 1 to $1\frac{1}{2}$ per cent. of zinc-dross.

The dross or scum in the second or advanced pot, after being melted, stirred, and allowed to cool, is skimmed, and the skimmings are transferred to the third or end pot of the series, the alloyed lead and zinc containing a little silver which has separated from the dross being moved back to No. 1. This is effected by means of an iron-gutter leading from the rim of one pot to that of the other, into which the lead is ladled. A similar process is then performed with pot No. 3, the dross being skimmed off and transferred to a receptacle called the "safe," and the separated alloy of lead and zinc carried back. The remainder of the zinc having been added to pot No. 1, it is again stirred and skimmed, the skimmings being put aside for a further operation.

The lead remaining in pot No. 1 is now practically free from gold, silver, and copper, but is rendered a little hard by a portion of the zinc remaining in it, together with a little antimony, of which, if there is much in the base bullion, a small percentage remains.

At the bottom of the large pot is a pipe connected with an iron gutter leading to the hearth of a reverberatory softening-furnace, which is placed at a lower level than that of the pots, to avoid the necessity of moving the lead by hand.

These furnaces, of which there are two, one for each large pot, are 15 feet 6 inches long and 9 feet 4 inches wide, internal dimensions, with a hearth or bed of sufficient depth to contain the contents of the large pot. The bed of this furnace is composed of a large iron pan cast in three pieces, and having the bottom flat and gradually curving to meet the upright sides and ends. This is covered with fire-clay, and above the clay with fire-brick set on end. When well put together these parts will last for years. The furnace has only one fire-grate, placed at the end. These furnaces are built upon arches, which serve to keep the bottom cool, and in order to more easily remove any lead which through bad setting may trickle through. The furnace having been raised to the requisite temperature, the lead-pot is tapped, and the metal allowed to flow into the furnace. The heat is then kept up, and a portion of the zinc and antimony is oxydized and escapes in the form of fume, while the remainder forms a scum which rises to the surface and covers the bath of lead. The lead is well rabbled from time to time with iron rakes, in order to expose a fresh surface to the air, and this is continued until the lead shows, by samples taken from the furnace, that it is pure and ready for tapping.

At a distance of a few feet from the end of the furnace is another pot, called the market-pot, the level of its rim being a little below that of the hearth of the furnace, and into this the lead, after being skimmed, is allowed to flow through an iron gutter.

The molds, which are on wheels, having been run under this pot, the lead is admitted into them by means of a tap.

These bars of lead are made to weigh about 140 pounds each; and, when cool, are taken out and ready for shipment. They are now wheeled up an incline, but it is intended to have a raised tramway over the tapping-place, on to which small wagons containing the bars will be hoisted, and run directly to the side-track. This lead is now pure, containing, on an average, not more than half a hundred-weight of silver to the ton, and being free from gold, copper, and all impurities, and fit for any of the purposes to which lead is applied, either for making white or red lead, sheet, or pipe.

The loss in this furnace is very trifling, not amounting to more than one-half per cent., because the molten lead is almost continually covered with the crust of zinc, &c.

The whole operation, from the loading of the first pot to the tapping of the market-lead, occupies twenty-four hours, and at the present time the capacity of these works is 40 tons per day. So that each twenty-four hours about 90 per cent. of the bullion operated upon is returned as pure marketable lead.

The dross obtained from the last skimming of No. 1 pot is transferred to a flat-bedded calcining or roasting furnace, of which there are two in the main building, one for treating the pot-skimmings, the other for the skimmings from the reverberatory furnace. It is here thoroughly roasted at a temperature insufficient to soften it so as to get rid of any remaining zinc or antimony, and, when sufficiently roasted, it is put in the flowing-furnace, where the lead is separated from the iron and other matters which form a slag which is worthless. The lead is tapped and returned to No. 1 pot, with a fresh charge of bullion, when the same routine is again gone through. The flowing-furnace is very similar to the reverberatory softening-furnace, differing only in the form and material of the furnace-bed. The calciners, before mentioned, have each two grates, with a flue rising from the center of the furnace. The object of the two grates is to obtain a high degree of heat, when necessary for the roasting of refractory or very impure skimmings.

The same process is gone through with the skimmings from the softening-furnace. The next point is the treatment of the rich alloy from pot No. 3, which was placed in the "safe." This is taken to the shaft-furnace before mentioned.

This is an inclined shaft-furnace, with the back slopping toward the front; at a little distance above the tuyeres the front recedes more abruptly from the back. The internal dimensions are, from breast to back, 2 feet 7 inches, and from side to side 2 feet 6 inches. It has three tuyeres, having a diameter of only 1¼ inches, and a pressure of blast equal to about 24 inches of water, or about one pound upon the square inch is used. This blast is produced by a blowing-cylinder, 24 inches in diameter, and having a 24-inch stroke. The blast passes into a chest or reservoir, and is thence conducted by pipes to the furnace.

The fuel used is coke, (that in all the other furnaces, with the exception of the crucible-furnace, being Vandyke coal,) which is obtained from Pittsburgh, and costs, delivered at the works, about $28 per ton.

The fluxes used are hematite iron-ore, which is obtained from Rawlins, and costs about $15 per ton, delivered, and a little lead-slag, of which plenty can be had in the neighborhood. The charge is composed as follows: Rich alloy, 250 pounds; iron-ore, [illegible] pounds; coke, 55 pounds; and a little lead-slag. After a good heat has been raised in the furnace the charging is commenced; the coke is first thrown in and spread evenly over the surface. The rich alloy is then charged, being all fed against the front of the furnace; the iron-ore and lead-slag are then thrown in, mixed together, and spread evenly over the furnace. Three of these charges are worked in one hour, so that about 16,000 pounds of alloy are passed through this furnace in twenty-four hours. The heat is maintained so low that the furnace at the feed-door is perfectly black and quite cool; the only flame visible being a small reducing flame running up the inside of the front of the furnace. Owing to the peculiar construction of the furnace, the charge gradually sinks and meets the sudden incline, whence the alloy passes down to the point of fusion, in the center of the furnace, without touching the walls, and is not melted until when within a few inches of the tuyeres. By this process the copper is obtained as matter, and the gold, silver, and lead in the form of a highly enriched lead. This rich alloy is tapped off about once in every hour and a quarter, and the slag about every five minutes. This slag is received in cast-iron pots, where it is allowed to solidify before being turned out. The slag is almost entirely free from lead, and contains only a trace of silver, so that practically it may be considered clean. The bars of silver are now taken to the cupelling furnace. This is in appearance not unlike a very short reverberatory furnace with a very large grate; but in place of the usual bed are a couple of bars, on which is supported the cupel, or, as it is usually called, the "test."

The test consists of an elliptical frame of wrought iron, filled in with bone-ash well beaten, and hollowed out to the requisite shape by means of special tools for that purpose. At the back of the furnace are two holes, one where the blast-pipe enters and the other for introducing the rich bars into the test. The test, which is placed with its long axis towards the blast, is left a little thicker at the opposite end where the litharge flows over. When the test has been raised to a good heat, a sufficient quantity of the rich lead is introduced; and the whole speedily melts, and the blast is now turned on. The oxygen of the air oxidizes the lead into litharge, and this takes up all foreign metals. A portion of the litharge is absorbed by the test, but much the larger quantity flows over the end of the test furthest from the blast, and is received in iron pots mounted on wheels, which are moved as fast as filled. The rich lead is continually added until all has been oxidized, and the silver is now pure, containing only the gold in the bullion. If, however, there should happen to have been more copper in the enriched alloy than could be carried off by the lead contained in it, (which is shown by the appearance of greenish spots floating on the silver,) this can be easily removed by the addition of a little more pure lead to the test.

Immediately on the termination of the cupellation a very beautiful phenomenon is seen, which is termed the "brightening." Just as the last trace of lead clears from the silver a peculiar bright and vivid flash seems to cover the whole bath of metallic silver, and for an instant every brick in the arch of the furnace is reflected as plainly as in a mirror.

A series of ingot-molds, set in a frame, are then run under the test, and through a hole bored in the bottom of the test all the silver runs into the molds.

These ingots are now taken to the crucible-house, and about 35 pounds put into a plumbago crucible and melted. A little charcoal is thrown into the crucible, and the whole stirred with a stick. After skimming off the coal and any little slag which may have formed, the metal is poured into ingot-molds of the requisite size, and the silver, which is now fine, is, after assay, stamped with its degree of fineness.

This finishes the whole operation, as the gold and silver are not separated at these works.

Owing to the fact that all these operations are not proceeding at one and the same time, the number of men employed is comparatively small (being only thirty-five) when the large amount of work done comes to be considered.

These works have been erected, not only with a view to convenience, but also to economy, the whole establishment, together with the purchase of the land, (twenty-five acres,) having cost not more than $58,000. It may be remarked here that the total loss of lead in all these operations does not amount to more than 2½ per cent.

Our thanks are due to Mr. Sieger, the able and efficient superintendent of the works, and also to Mr. Billing, the manager, for affording us every facility in their power to enable us to make a thorough investigation, and also giving us all the information we could desire to give a description commensurate with the importance of this new and inestimable enterprise.

I have inserted the foregoing article on the Germania works, as published in the Salt Lake Tribune. But I wish to add that the statements in the article, in regard to losses during the various manipulations, ought to be received with caution. The statement that in smelting the lead-zinc-silver alloy in the shaft-furnace, the copper which may be present is obtained in the shape of matte, is manifestly incorrect. There appears no sulphur in the charge, (unless it be assumed that there is sufficient for the purpose in the coke,) and the copper will therefore undoubtedly be found in the rich lead. Besides, there never could be a copper-matte formed in the shaft-furnace without taking up considerable lead and silver, which would be altogether undesirable.

CHAPTER VII.

COLORADO.

By the courtesy of Hon. George M. McCook, governor of the Territory, who has placed at my disposal the report of the territorial assayers; by the active co-operation of these gentlemen themselves, who, in view of this use to be made of their reports, exerted themselves to produce thorough and trustworthy discussions of the mining-industry in their respective districts; by the earnest and judicious assistance of Mr. J. F. L. Schirmer, superintendent of the Denver branch mint, Mr. J. H. Jones, agent of Wells, Fargo & Co. at Denver, and other citizens; and finally, by the observations which my deputy, Mr. Eilers, and myself were enabled to make during a somewhat extended though rapid tour in the Territory, I am enabled to present a very interesting and full account of the condition and progress of mining in Colorado.

The following comparative statement for the years 1870, 1871, and 1872 is compiled from the careful estimates made for me each year by Messrs. Schirmer and Jones, whose opportunities and qualifications for obtaining accurate results are unsurpassed. I give the items in detail, instead of comparing the totals only, that it may be clearly seen how the different elements of the total have varied:

Gold and silver, coin value.	1870.	1871.	1872.
Express shipments	$2,160,000	$2,820,000	$2,295,411
In private hands from Denver, estimated	120,000	140,000	50,000
Matte	884,000	923,000	1,019,498
Ore shipped	286,000	500,000	981,556
Southern mines, estimated	100,000	130,000	140,000
Northern mines, estimated	50,000	50,000	50,000
Used by manufacturers, estimated	75,000	100,000	125,000
Total	3,675,000	4,663,000	4,661,465

According to this exhibit the product of the Territory for 1872 is about the same as for 1871, the great falling off in express shipments, due to the depression of the industry of Gilpin County, being counterbalanced by the increase in the production of matte and shipping-ores, due to the increased prosperity of Clear Creek County.

The distribution of the product for 1872 among the respective counties and districts is partly shown by the detailed reports which follow. But the total obtained by adding all the exact sums reported would fall far short of that above given. It is impracticable to employ exclusively the method of calculating the bullion at the points of production or at the points of shipment. In the above statement the returns and estimates are based on the movements or destinations of metal and ores. The item of $1,019,498, classed as matte, represents really the reported purchases of the Boston and Colorado Smelting Company at Black Hawk, at the presumed actual value of the ores, not the price paid for them. The several items are:

Gilpin County	$419,850
Clear Creek County	406,648
Park County	118,000
Boulder County	75,000
Total	1,019,498

The actual shipment of matte from these works during the year was considerably less, (probably not in excess of $800,000,) and the difference represents the increase in the reserves of ore in their yard and roasting-heaps at the end of the year.

The following summary, classed as to counties, was published in January, in the Mining Review, of Georgetown, Colorado:

Clear Creek	$1,503,391
Gilpin	1,389,289
Boulder	346,540
Park	238,000
Lake	133,000
Summit	125,000
All other sources	50,000
Total	3,785,220

That this estimate is too low can be easily demonstrated by an analysis of some of its items. The amounts of *ores* shipped or sold to the Black Hawk works are the same as in my statement; but the aggregate of *bullion* estimated is below that of the actual shipments of bullion reported to me on the authority of Mr. Jones, agent of Wells, Fargo & Co. at Denver. Relying upon the accuracy of his report, and also the judiciousness of his estimates (supported by the opinion of Mr. Schirmer, superintendent of the mint) for gold not turned over to the express company, but either consumed in local manufactures or carried in private hands out of the Territory, and shipped, if at all, from points beyond its boundary, I present the following comparisons of the bullion-product in gold and silver, ores and furnace-products not reckoned:

THE MINING REVIEW.		MESSRS. JONES AND SCHIRMER.	
Clear Creek	$223,187	Express shipments	$2,295,411
Gilpin	959,439	In private hands:	
Boulder	271,540	From Denver	50,000
Summit	120,000	Southern mines	140,000
Lake	133,000	Northern mines	50,000
Park	30,000	Manufacturers	125,000
Total	1,737,166	Total	2,560,411

The difference of these totals, $823,245, is within $53,000 of the whole difference between the total production of the Territory, as given by the Mining Review, and the production as given by Messrs. Jones and Schirmer.

Mr. Valentine, of San Francisco, general superintendent of Wells, Fargo & Co., published in January a statement of the precious metals produced in 1872 west of the Missouri River, in which the following figures are given for Colorado:

Gold by express	$1,657,952
Silver by express	279,799
Ores and base bullion	1,064,000
Carried by private hands	None.
Total	3,001,751

The too early preparation of this statement perhaps explains the fact that no single item of it can be made to agree with later and more exact information. It is nearly three-quarters of a million below the estimate which I have just shown to be, by at least an equal amount, too small. Entertaining, as I do, a high respect for Mr. Valentine's great executive ability and general intelligence, I am compelled, nevertheless, to dissent widely from his conclusions regarding the bullion-product in almost every instance, except those of California and Nevada, where I substantially agree with him.

Returning, after these explanations, to the comparative statement first presented, it will be observed that, for the first time in the history of the Territory, Clear Creek County has surpassed, in the production of the precious metals, its earlier settled and exploited neighbor, Gilpin. The prospects for the future industry of both are set forth in the detailed reports which follow. I find in the exhibit for the year no cause to retract the favorable opinion heretofore expressed concerning the mineral resources and the facilities for mining possessed by Colorado. Of the criticisms contained in former reports, particularly with reference to the excessive and unjustifiable projection of exploring-tunnels, it is sufficient to remark that they have been fully justified by events, as is now generally admitted by all parties. The "tunnel clause" of the present United States mining-law, framed in the interest of such enterprises, has produced much dissatisfaction among prospectors, and will doubtless become practically a dead-letter, or be amended or repealed.

CLEAR CREEK COUNTY.

The able report on this county was prepared by Mr. Herman Stoelting, the territorial assayer at Georgetown, who wishes to acknowledge valuable assistance by Mr. B. F. Napheys. To the same gentleman I am indebted for a very full account of the mining operations in Summit County.

Georgetown.—Since the last report a great change has taken place in mining affairs in Clear Creek County. The "tunnel excitement" has subsided in a certain degree, and the year 1872 has witnessed more solid development and material progress in Griffith and Argentine districts than any other year since their organization. The eager desire to "sell out," characteristic perhaps of the early years of almost all mining-camps, has in a great measure been abandoned, and been replaced by the energy of actual work. New discoveries of veins of great size and richness, and the steady development of a largely increased number of the older lodes, have had their effect in increasing the ore and bullion production of the districts named.

The burning of the large mill of the Stewart Silver-Reducing Company in January, 1872, and the extraordinary severity of the winter, had a somewhat depressing influence on ore-production. After the burning of the mill none but the higher grades of ore could be disposed of, and these only at reduced prices as compared with rates previously paid. The consequence of the lack of mill capacity for the treatment of the second-class ores produced in the district, is quite as severely felt at the close of the year as at the commencement. The new Stewart Mill is kept fully employed in reducing but a portion of the second-class ores from the Pelican and Terrible lodes. The Brückner Cylinder Mill, leased by Palmer & Nichols, being run by water-power, has treated but a comparatively small amount of ore, and is in such a bad state of repair that but little can be expected from it until completely renovated.

The mill of Messrs. Crosby & Judd just commenced operations at the close of the year, and is undergoing a series of changes and consequent delays, seemingly inevitable in all new mills. The one other mill in this section of the county, that of Professor Dibbin, in East Argentine, is kept fully employed during the season of active operation in treating the ores from the mines in its immediate vicinity. These and the Swansea Smelting-Works, (noted under the head of Empire,) comprise the present reducing facilities of this part of Clear Creek County, and are entirely inadequate for the treatment of the ores produced. It is true that a large amount of ore has been shipped to Professor Hill's works in Black Hawk; but this has been ore of a grade sufficiently high to stand the freight ($15 to $20 per ton) to that point, or such ore of lower grades as could not be disposed of at Georgetown to either ore-buyers or metallurgical works. These works, then, while relieving somewhat the pressure in the ore-market, have served for the disposal of certain grades of ore only, and the many hundreds of tons of ore, of the value of 40 to 100 ounces, now produced here, are still comparatively valueless. That this condition of affairs operates to the great disadvantage of the miner, cannot be doubted, since this low grade of ore is now either left in the mines or else scattered through the dumps, and too often wasted.

The true prosperity of this mining-camp can only be realized when the lower grades of ore are utilized; and this will probably be done when Georgetown has railroad communication with the valley, which will be within from nine to twelve months.

Notwithstanding the drawbacks mentioned, the progress of the county has been highly satisfactory. The town of Georgetown has grown in wealth and population; and the other mining-camps in the county have participated in the general prosperity. The cost of living has been considerably reduced, while the price of labor has reached a point which, while remunerative to the laborer, still permits the development of the mines.

The Stewart Mill was at once rebuilt, and recommenced operations in July. Several important improvements were made in the mill, which increased both its capacity and the thoroughness of the work done. Prominent among these may be mentioned the employment of a large reverberatory furnace for the preliminary roasting of the heavy ores, (containing a large percentage of zinc-blende, iron-pyrites, and galena,), previous to their passage through the Airey furnace.* A system of saving the tailings, after a partial rough concentration, has been adopted; and the mill is now apparently giving full satisfaction to both its owners and its patrons.

Of the older mines, the Terrible, Brown, Coin, Cashier, Phœnix, Dives, Silver Plume, Snow-Drift, Clift, Magnet, Argentine, Gilpin, Compass and Square, Equator, Belmont, International, Steven, and others continue to be worked with satisfactory results.

The more recent discoveries and such of the older ones as have been developed only since last year, comprising the Violet, Curry, Saco, John Bull, Nirvot, Hidden Treasure, Polar Star, G. Rogers, Lucky, Matilda Fletcher, Hopewell, Pay Rock, Pelican, Eagle Bird, Antelope, Maine, (Cold Stream,) Eureka, Seven-Thirty, Hercules, Old Missouri, Atlantic, Shively, Killbride, Brick Pomeroy, New England, and many others are in active operation, and yielding large amounts of valuable ore.

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* The Stetefeldt furnace has been introduced in place of the Airey since this report was written. I presume the preliminary roasting will no longer be required.—R. W. R

Of the tunnels but little can be said. Work has been carried on in but very few of them, and this without any actual result, except, perhaps, in the case of the Marshall Tunnel, in which it is reported that a large vein of fair ore has been found. The short upper tunnel of the Marshall Company has been producing ore.

The glowing promises and expectations of the promoters of the enterprise have not yet been realized, and it is quite probable that very many of the tunnels, on which considerable work has been done, will never resume operations. Others, such as the Marshall and Burleigh Tunnels, may be pushed to completion, and be made, when the lodes, which they cut, are developed in depth, useful for drainage, ventilation, and the delivery of ore. But at present the results from prospecting by tunnels are in the highest degree unsatisfactory.

A large amount of money has been expended in the work already done, in addition to the other large amount paid for "tunnel-sites," on which to do this expensive and unproductive work. No dividends have been paid, except, perhaps, in one or two isolated cases, in which money received from sales of stock has been used for this purpose.

On the whole, the tunnel excitement in Clear Creek County has been productive of no good, but, on the contrary, has been of very considerable detriment to the true interests of the county. Aside from the numerous cross-cut tunnels, generally of short length, which have been driven to cut deposits of ore known to exist, there are about twenty tunnels in the county driven across the course of known belts of lodes, and it is a reasonable estimate to say that nearly or quite 10,000 feet of tunnels have been driven, at an average cost of about $30 per foot. To say that this has been an entirely useless expenditure of money would be hardly just; but it was certainly a premature and ill advised investment of money, which was needed in other and more legitimate mining enterprises.

A large proportion of these tunnel enterprises had nothing but the simple right to drive ahead in a certain given direction for a certain number of feet, and, necessarily, had to depend for hopes of profit either on ore from "blind lodes," struck in their course, or on ore from lodes already owned by other parties. In the one case, the hope of remunerative results was vague, uncertain, and, up to the present date, entirely and wholly illusory; in the other, nothing but a species of dishonest procedure could realize profit, since, in the event of the striking of a body of rich ore at a great depth from the surface in a vein owned by outside parties, much time would necessarily elapse before the continuity of the vein from the surface could be proved, during which time the parties driving the tunnel would be at liberty to extract all the ore within their reach on either side and below them. To properly realize what this would amount to, it is only necessary to consider the time which would be consumed in sinking a shaft, say, 500 feet, a depth less than the average distance below the surface at which the majority of the speculative tunnels would hope to cut veins of known value and richness. Only the fact that none of these tunnels have proven to be the highly profitable ventures they were once supposed by many to be, has prevented the actual prosecution of these *quasi* dishonest programmes.

The question as to the greater cheapness of mining through long and deep cross-cut tunnels alone, it is, perhaps, not necessary to discuss here, as in the event of work being actively commenced on any one of the lodes cut by any of these tunnels the question would settle itself, and it would at once be found just how far mining could be carried on from below upward without having communication with the surface other than by the tunnel which cut the vein. My opinion that such tunnels may be a valuable, and, indeed, a necessary auxiliary to shafts, is sufficiently well known.

As the character of the ore found in a mining-district determines the proper method of its treatment, a glance at the different combinations of the various valuable metals found in Clear Creek County may not be uninteresting.

In the eastern end of the county the lodes were formerly worked for the gold-ores which they contained at and near the surface; and the deeper ores are still found to contain varying amounts of gold; yet now the ore even of that section of the county may properly be called silver-ores, since the larger part of their value is in silver.

The ore is generally a mixture of two or more sulphides, such as iron and copper pyrites, galena, zinc-blende, gray copper, and occasionally the rarer true silver-ores. Coming westward, up South Clear Creek, a number of lodes of gold-ores, *i. e.*, auriferous copper and iron pyrites, are found; but since only a slight degree of development has been attained in them, and already the presence of galena is to be noted, the belief is suggested that at greater depth the gold-contents of the ore will be replaced by an equivalent or greater silver value. The occurrence in the vicinity of large veins of argentiferous galena strengthens this view. In Empire, however, the lodes are characteristically gold-bearing; yet the circumstance, that as greater depth is attained the silver-contents of the ore seems to be increasing, may not be without significance.

In Griffith district the ore may be described as argentiferous galena and zinc-blende, occasionally intermixed with iron and copper pyrites, and with the silver-ores proper, such as ruby and brittle silver, silver glance, &c.

At and near the surface the ores are more or less decomposed; but in depth the sulphides are found free from the products of decomposition. As the surface-ores are small in amount compared with the other ore produced from the mines, it is fair to say that the ores of the district are varying mixtures of galena, zinc-blende, and iron pyrites. The other minerals found with these, such as gray copper, ruby and brittle silver, stephanite, strohmeyerite, and argentite, although adding greatly to the silver-contents of the ores, are properly but accidental constituents.

The occurrence of a small amount of gold in the ores of some lodes of Griffith district may be mentioned as a curiosity rather than as of practical value, since the amount of such ore is insignificant. Such of the metallurgical works of the county (apart from the two smelting-works at Swansea and Spanish Bar) as treat the ores produced in Griffith district, employ a chloridizing roasting, followed by amalgamation in barrels or iron pans. The reverberatory furnaces employed for the roasting of the ores in the earlier years of this mining-district, have given place to the more improved and economical appliances of modern times, prominent among which are the Stetefeldt furnace and the Brückner revolving-cylinder, the former being in use at the Stewart Mill, and the latter at the Germania Reduction-Works, and at Professor Dibbin's mill in East Argentine.

Of the adaptability of the Stetefeldt furnace for the treatment of the heavy ores of Clear Creek County, nothing can yet be said, as the changing of Stewart's Airey furnace into a Stetefeldt furnace is just now going on. It is to be hoped, however, that this furnace will meet with the same degree of success in treating the ores of this county as it has achieved at other points where it is employed.

The merits of the Brückner cylinder have been mentioned in former reports. This furnace has advantages that are much to be commended. The ore is completely under control, both as regards the time of roasting and the degree of heat to which it is to be subjected, and is continually in motion during treatment, thereby more certainly undergoing complete desulphurization and chlorination. The results obtained are good; a high percentage of the silver is chloridized, and the bullion is fine. Only a small amount of wood is consumed per ton of ore treated; and with a mill of a capacity of 20 tons per day the amount of labor required is small. On the other hand, the amount of "scrapings" and "screenings" (lumps and masses of roasted ore from the sides of the cylinder) is large when compared with the weight of the charge treated. These lumps, however, are chiefly produced in the treatment of those ores only which contain a large percentage of lead. No trials have ever been made to ascertain whether these scrapings, &c., are not sufficiently well chloridized to be amalgamated. The probability is that they are quite as well fitted for amalgamation as the lumps from the Stetefeldt furnace. The practice in the cylinder-mills here has been to crush and reroast such lumps, with the addition of a very small percentage of salt.

The establishment of Messrs. Crosby & Judd, of which mention has been made above, is the last built of the Georgetown reduction-works, and is furnished with the Crosby furnace. This furnace consists of an inclined reverberatory through which the ore is passed by mechanical stirrers, and also a shaft-furnace, down which the ore is dropped after its passage through the reverberatory. The mechanical stirrers are attached to and moved by iron pipes passing through both walls of the furnace, through which pipes a stream of water is constantly passing. At the point where the ore falls through the shaft salt is added, being fed by a mechanical contrivance which both crushes the salt fine and also regulates the amount delivered. The mill is supplied with a ball-grinder, which prepares the ore for the furnace, and amalgamation is effected in iron pans. The mill is well arranged for economy of labor, being built in terraces, on the upper one of which the ore is delivered by wagons.

The power used is obtained from the west fork of South Clear Creek, and is ample for all the purposes of the mill. Concerning the metallurgical efficiency of the system here employed I prefer not to pronounce judgment at present.

The several mills in the vicinity of Georgetown, engaged in the treatment of silver ores, now receive only the second-class ores, that is, ores containing less than 200 ounces of silver and but a small percentage of lead. The remaining ores are either sold to ore-buyers in Georgetown, who ship them to Germany, England, or the East, (Chicago, Omaha, Saint Louis, New York, &c.,) or are sold to Professor Hill, at Black Hawk, or to the smelting-works at Swansea, Spanish Bar, or Golden City.

There are four works here engaged in crushing the ore and preparing it for shipping. The ore is crushed and rolled sufficiently fine to obtain a good average sample. The sampling is done either by the common way of quartering down the whole lot of ore until a quantity sufficient for a sample is obtained, or by forming a ring of the ore instead of a cone, and taking two opposite quarters of it, and by repeating this operation reducing the sample to the proper quantity. Still another method is in use. The crushed ore is shoveled over a kind of scoop, about $1\frac{1}{2}$ inches wide and 12 inches long, which will catch a small proportion of each shovelful.

Dr. J. G. Pohle, engaged in crushing ores, has been experimenting with a mechanical sampler of his own construction. The ore is elevated to a hopper, from which it falls on a sheet-iron cone 24 inches in diameter and 12 inches high. This is provided with four slots cut in the sheet-iron in such a way that lines drawn from their two corresponding courses will meet in the head of the cone, being about 1 inch wide at the head and 6 inches long. That portion of the crushed ore which in rolling over this cone will fall through the slats, (about 6½ per cent. of the whole bulk,) constitutes the sample, which is collected by a funnel under the cone, and is, if the amount should be too large, subjected to the same process again. The remainder of the ore falls into a hopper, from which it runs directly into ore-bags. The whole machine is cased in, and the sample is out of reach during the process. The machine answers its purpose apparently well, there being only slight differences in the assay of samples taken by the ordinary way and that of the machine.

The price paid during the year by ore-buyers averages about as follows:

Assay ounces per ton.	Paid per ounce (currency.)
250	$0 80 to $0 85
300	90 to 95
350	95 to 1 00
400	1 00 to 1 05
500	1 05 to 1 10
600	1 10 to 1 15

These prices were paid for average quantities of ores; in case much lead was present, the prices paid were better, averaging about 5 cents per ounce more, or $1 for every per cent. of lead above 30 per cent., and if the ores were very zincky, a corresponding deduction was made. The scale of deduction made by Professor Hill is as follows:

Zinc present.	Up to 100 ozs.	100 to 150 ozs.	150 to 200 ozs.	200 ozs. and more.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
2 to 5 per cent. deduct	3	2½	2	1½
5 to 10 per cent. deduct	6	5	4	3
10 to 15 per cent. deduct	9	7½	6	4½
15 to 20 per cent. deduct	12	10	8	6
20 to 25 per cent. deduct	14	12	10	8
25 to 30 per cent. deduct	16	14	12	10
30 to 35 per cent. deduct	18	16	14	12

With an average ore the difference between the silver value of the ore and the price paid for it, according to the above price-list, is as follows:

Ounces per ton.	Difference per ton.	Ounces per ton.	Difference per ton.
250	$155 to $142	400	$169 to $149
300	156 to 141	500	166 to 141
350	165 to 147	600	193 to 163

being a margin of about from $145 to $175 per ton in favor of the ore-buyers, the cost of crushing, sampling, assaying, sacking, and shipping to New York being about $50 to $55 per ton. That this is an exorbitant charge on the miner of the ore is very evident. The freight-item alone should be sufficient to pay all costs of reduction in properly-constructed reduction-works at home.

The mining-industry of the county demands the establishment of thorough metallurgical works, in which all the ores raised in the county could be thoroughly and economically treated, and in which not alone the silver, but also lead and other valuable metals could be saved. Such an establishment should be provided with an ample amount of capital, and be prepared to pay cash for any and all kinds of ore offered.

Regarding the rich silver-ore of the Georgetown districts the plan to be pursued might be: 1. Very careful hammer-dressing of the ores in order to separate as much as possible the galena from the zinc-blende, by which would result: *a*, galena-ores, *b*, dressing-ores. 2. Treatment in complete dressing and concentrating works, the products of which would be:

a. Smelting-ore:
  aa. Galena.
  bb. All other products of the dressing-machinery assaying over a certain amount, say 250 to 300 ounces per ton.
b. Amalgamating-ores:
  aa. All such products of concentration containing not enough silver or lead to be subjected to smelting, but consisting mainly of zinc-blende and iron pyrites.
  bb. All "tailings" and slimes too rich to be thrown away.
c. Tailings too poor to be subjected to further treatment.

The main principle upon which such concentrating-works should be managed would be not to subject any of the finer products of crushing to any dressing whatever, on account of the great loss of silver which would inevitably result, owing to the frequently very fine distribution of the silver-ores proper through the gangue, and their specific gravity. By such a process it would be possible with little more expense to save a great proportion of the lead contained in the second-class ores, now entirely wasted, and to have the amalgamating ore nearly free of galena, the great obstacle to chloridizing wasting.

Concerning the treatment of the amalgamating-ores, it would probably be found that leaching with a solution of hyposulphite of soda, after a thorough chloridizing roasting of the ores, would be found to be a cheaper and better method than amalgamation.

The smelting-works would consist of roasting-furnaces for the preparation of the ores for treatment in blast-furnaces for lead riches; and probably reverberatories of iron pyrites could be had cheaply to make a matte from such ores as did not contain enough lead to be smelted for lead riches.

Many of the ores, principally those extracted from the lower workings of the mines, contain a large percentage of zinc, in fact so much that it has become quite difficult to dispose of such ores. In such dressing-works, as above referred to, the second-class ore derived from the dressing-machinery would contain a high percentage of zinc. Proper works could treat this ore for zinc, and the remaining residue for silver.

Below is appended a brief notice of some of the more important mines of the districts around Georgetown. The Pelican lode, probably the richest in Griffith district, is situated on Showman Mountain, about 700 feet above the level of the creek. The vein was first opened in May, 1871, and since that time has been constantly under development. The crevice is very wide, increasing in places as much as 20 feet.

The ore-vein, varying in thickness, but always present, is from 6 inches to 4 feet of first-class ore, while the amount of second-class ore, *i. e.*, mineral mixed with gangue, is very great, some of the lower workings in the mine showing as much as 12 feet of this class of ore. The lode has been opened by a series of cross-cut tunnels, connected with shafts in the vein, and the length of drifts now open is nearly 2,000 feet. All the ore produced from the Pelican mine, and it amounts to over $500,000 in value, has been produced from these drifts and shafts, as no stoping has been done.

The ore produced is of the character usually found in the lodes around Georgetown, galena, zinc-blende, with stromeyerite, gray copper, and silver glance, specimens of which, weighing several pounds each, have been found. The first-class ore varies in value from 350 to 1,000 ounces; the second-class ore runs from 15 to 250 ounces, and a very large amount of third-class ore worth 50 ounces per ton can be readily mined whenever there is a market for ore of this grade. The peculiar state of affairs existing in Clear Creek County regarding the disposal of ore, has prevented the raising of any but high-grade ore from this mine. The first-class ore from the Pelican is now shipped to Europe, and a small amount of the second-class treated at the Stewart Mill, but, as before stated, no effort is being made to raise any amount of mineral, only such as is mined in the work of opening the lode being disposed of, and not all of this.

A very careful estimate of the value of the ore in sight is that it is worth $1,500,000, and recent developments in the shaft sunk from the lowest level increase this sum.

The ore found in the lowest working is of good quality, and in places is found in solid veins of 3 feet in thickness. All things considered, the Pelican is the most valuable lode of silver-bearing ore in the Territory, having the largest crevice and the greatest amount of rich ore. The owners, Messrs. Streeter & McCunniff, have confined their operations only to the opening up of reserves of ore, and of doing other work in the development of their property.

On the Brown lode, since its sale to Mr. S. B. Chaffee, the present owner, considerable work has been done, all operations being based on the necessity of placing the mine in good shape for future working, by sinking shafts, running drifts, &c. The ore-yield of the mine has, consequently, been small.

In the Terrible mine work has been constantly and vigorously prosecuted, and probably nearly one-half of the ore milled by Mr. Stewart was second and third class ore from this mine. The greater part of the improvements made on this lode has been on the west part of the vein, owned by the Terrible Silver-Mining Company, the yield of which has been 110 tons of the first-class ore, worth $500 coin per ton; 556 tons of the second-class ore, worth $135 coin per ton; 857 tons of the third-class ore, worth $45 coin per ton. This company has built a mill-tramway from the mouth of its tunnel to the ore-house at the foot of the mountain, and has adopted a rough system of concentration by hand-jigs, by which it has dressed 145 tons of second-class ore from the third-class ore, 8 tons of which was rated as first-class, and shipped with their other first-class ore to Europe.

In the eastern part of the lode the Clark Mining Company has been mining with success. The first-class ore, about 30 tons, was shipped to Europe. This mine has been much hindered in its development by the lack of proper facilities for the treatment of second and third-class ores. The Terrible lode alone could nearly keep the Stewart Mill fully employed. The Cold Stream lode, formerly the Maine, is being placed in a condition to yield a steady supply of ore, of which an abundance is to be found below the upper workings, which gave the Maine its prominence. It is proposed to sink two shafts and connect them at proper intervals by levels. This will be a work of time, and, inasmuch as nearly all the ore within reach was extracted before the mine was sold, the yield of the mine during the last half of 1872 was not as great as in former months.

The Hercules and Seven-Thirty lodes (two locations on one and the same vein) have been extensively worked during the year, although litigation between the owners of the two lodes has, undoubtedly, interfered with the yield of the vein. The ores from these mines are rich, and their total production has been about 175 tons of a value of over $50,000. It is to be hoped that the suits between these two mines will be settled during 1873, and that their development may proceed without any further disturbance.

The Cashier lode, on Sherman Mountain, has been but little worked by the company owning it, and its ore-production has been almost all from lessees' work.

The Iron-Drift and Silver Plume have been in constant and active operation during the year, and with remunerative results.

The Dives lode, and also the Laura Dale, in the same vicinity, have been worked during the year with highly satisfactory results.

On Brown Mountain, about one mile west of Brown Gulch, a belt of lodes has been discovered and opened during the summer, of which I may name the Atlantic, Pacific, Shively, Kilbride, and Brick Pomeroy, all of which carry regular seams of 2 to 6 inches of very high-grade ore, assaying from 425 to 650 ounces per ton on an average. On Brown Mountain the old Missouri, Coin, Silver lode, Mammoth, Glasgow, and others have been actively worked.

On Sherman Mountain several other lodes besides those mentioned above have been in active operation, namely, the Hopewell, Payrock, Eagle Bird, Antelope, Eureka, &c.

On Democrat Mountain a group of lodes, prominent among which are the Cliff, West Junction, Lucky, Gala, Polar Star, Providence, and Fred Rogers, have been opened and yielded a considerable quantity of good ore. These lodes have all been developed to a greater or less extent, and have most excellent prospects. A wagon-road up Broad Creek would greatly facilitate the development of these mines, and provide for the easier delivery of their ores, which, so far, are mainly those usually found on the surface of all the lodes in this vicinity. They are of a high grade. These lodes are all being actively worked.

The Saco lode, situated on Leavenworth Mountain, is one of the late rich discoveries that have stimulated mining affairs in this vicinity. The lode is opened by a series of drifts and shafts connected with a cross-cut tunnel. The ore from the lode is rich, and has assayed as high as 1,330 ounces per ton in mill lots. The total of ore mined during the last five months (since the discovery) has yielded the owners somewhat over $55,000.

Other lodes in the same locality, such as the John Bull and Ni-wot, near the Saco, have been worked with most satisfactory results, the ore furnished by these lodes being of remarkably high grade, containing as much as 1,500 ounces per ton by mill samples. The amount produced is difficult to estimate, but is large.

The Equator, once one of the leading mines of the district, has been leased to a number of miners, and from their workings, mainly in the surface-openings of the lode, much rich ore was taken. There seems to be no probability of the early resumption of work by the company owning the mine.

The Argentine, a large vein of argentiferous galena, late in the year furnished quite an amount of ore of a desirable grade and quality. The percentage of lead in the ores from the Argentine is large, and its silver contents are as high as 175 ounces per ton.

The Gilpin or McClellan, worked on a lease, has been productive, and has, without doubt, paid a good profit to those working it.

Of the other lodes located on Leavenworth Mountain, which have been worked during the year, may be mentioned the Ocean Wave, Colorado Central, Hidden Treasure, Compass and Square, Alabama, O. K., &c.

The Stephens lode, situated in West Argentine district, has been constantly and profitably worked during the year, yielding an average of 30 tons per month of good ore, averaging 150 ounces in silver per ton, with a high percentage of lead. This lode is owned by a company who are conducting their operations with economy and ability.

The International, Belmont, Owlet, Fortunatus, Corey, &c., have also been worked more or less, being somewhat dependent on climatical changes.

Even a short description of the many lodes that have been in operation during the year would take up too much space, and, therefore, the notice of those given above must suffice.

In general, it may be said that nearly all of the older mines that have been productive in former years have been in operation during the past year, and that the result of their workings is in the highest degree favorable. The later discoveries, nearly all of which yielded unusually rich ore, have had their share in increasing the ore-product to an amount very much greater than in any previous year.

The mines in the eastern end of the county have been worked to a greater extent than in any year since their surface-ores were treated for the gold they contained. The ores still contain more or less gold, but notwithstanding this fact, the lodes carry now mainly silver ores.

The principal mines are the Seaton, Crystal, Edgar, Whale, Kukill, Veto, Queen, and Franklin, and the ore obtained was almost entirely shipped to the works of Professor Hill, at Black Hawk. The establishment of smelting-works at the Whale Mill, at Spanish Bar, and the completion of the mill at Masonville, (Airey furnace,) will give a home-market for the ores of this section of the country. The yield from the mines mentioned above has been large during the past year, and bids fair to be still larger during 1873.

Attention has been again turned toward the placer-mines of South Clear Creek, and in the bars along that stream. The yield of gold from this source during 1872 has been about $24,000 coin, and it is very probable that this yield will be largely increased during the coming year. Mining on these bars will be carried on in future in a more systematic manner, and steam-power will be employed for drainage in such of the claims as need it. Drifting on the pay-streak in the heavier deposits of gravel will be done, and all the modern and more improved appliances of placer-mining will be used in such of the claims as will permit of hydraulicking or sluicing.

It is highly probable that work will be commenced in the mines in Cascade, Trail Run, and other districts that have been neglected during the past few years.

Cascade district contains a number of silver and gold bearing lodes, the ores of which are found in large quantity. Means of reduction are needed there, and when these are furnished there is no reason why this district should not furnish a valuable addition to the product of the county.

Trail Run and other neighboring districts contain a large number of gold-bearing lodes, prominent among which may be mentioned the Cayote, Kelly, and Freeland. Under proper management, and with a remunerative home-market for these ores, these districts will be again populated by busy and prosperous miners.

Between this section of the county and Georgetown is a scope of country which, although more or less worked in former years, has been for some time neglected. The ores contain both gold and silver, some of the veins being characterized by unusually heavy bodies of low-grade argentiferous galena. Under the stimulus of improvements in neighboring districts, and the advent of a railroad up the valley of South Clear Creek, these districts will again receive the attention which their veins warrant.

As we approach Georgetown the value of the ore found increases, and a short distance below the junction of the Empire Fork with South Clear Creek several lodes of proved value are now being worked. These lodes, prominent among which are the Oshkosh and New England, contain the same character of ore as is found around Georgetown, and the ore seems to be of high grade and in good quantity.

The prospect for the coming year is in the highest degree favorable. The Miners' Reduction Company, a home organization, under the superintendency of J. A. Stewart, propose to erect a large mill, with a Stetefeldt furnace, during the coming year; and it is probable that a mill with ten Brückner cylinders will replace the now worn-out mill of the German Reduction-Works.

The completion of railroad communication between Georgetown and the valley will have a great effect in increasing the amount of ore mined in the county. The awakening of new interest in the gold-mines of Empire and other auriferous districts assures a full supply of iron and copper pyrites for the matte smelting-works at Swansea and Spanish Bar, under the stimulus of which there is no doubt but that the more unknown and unworked districts, Daily, Cascade, Trail Run, &c., will receive their due share of attention.

The results of the mining operations in Clear Creek County during the past year have gone very far toward establishing a general degree of confidence in the mineral wealth of the county, and all legitimate mining enterprises, based on good property, will hereafter be very much more successful than in former years.

The amount of ore raised and disposed of in the county during the past year is not less than 5,860 tons, and the bullion product is as follows:

	Bullion product, coin.
Stewart S. R. Company worked 1,059 tons	$126,432 50
Putmer & Nichols worked 198 tons	32,911 98
Judd & Crosby worked 50 tons	3,842 95
Swansea and Whale (matte) worked 250 tons	35,000 00
[illegible], (mainly from Idaho)	25,000 00
[illegible]national Mill, (Professor Dibbin) worked 150 tons	42,000 00
Total of gold, silver, and matte, coin value	265,187 43

The following is the amount of ore bought and shipped to the East and Europe:

Name of buyer.	No. of tons.	Contents in ounces of silver.	Coin value
William Light	191	47,750	$61,741
J. P. Airey & Co	235	47,000	60,771
F. T. Marshall	385	146,272	189,130
William Bement	121	40,000	51,716
Terrible Lode Mining Company	110	44,000	56,892
Terrible Lode Mining Company, (East)	30	12,000	15,516
J. G. Pohle	140	58,520	75,666
J. Snider	154	59,293	76,665
G. C. H. Gray	244	98,128	126,880
Jay W. Smith, L. G. Colkins, Bagley & West, Snowdrift mine, Silver Plume mine, W. W. Glenn	416½	81,162	104,942
Various small lots	30	9,000	11,637
Total	2,056½	643,125	831,556

Average coin-value of all ore shipped to the East or Europe, $404.3[?]

In addition to this there was shipped to N. P. Hill's works, at Black Hawk, 2,125 tons, containing 314,500 ounces, worth $406,648 coin.

The total production of Clear Creek County is therefore as follows:

	Coin.
Bullion and matte	$265,187 43
Ore shipped East, &c	831,556 00
Ore sold to N. P. Hill	406,648 00
Total	1,503,391 43

The above does not include the value of any ore mined awaiting treatment, or in process of treatment, but represents the actual value of the ore worked or shipped during the year 1872.

Empire.—In Upper Union district, and about four miles from George-town by the wagon-road, is situated the town of Empire. Upper Union district was located in 1860 by a party of prospectors and placer-miners from the "Gregory Diggings," now known as the Central City Gold Region. The existence of gold below and on the slopes of Silver Mountain was soon an established fact, and the basis for extensive operations. Ditches were constructed, and the other preliminary work of a placer-mining camp done. The yield of the precious metal at once rose to a large sum, and the existence of Empire and Upper Empire was assured.

A comparatively small amount of skill and knowledge is necessary for success in any rich mining-camp, and fortunes were soon made in Empire, but too often quite as quickly lost.

The history of this district is by no means an uninteresting one. Rich placer and surface quartz from lodes were quickly discovered, and yielded their golden contents readily. The two towns soon assumed importance; stage-lines provided communication with the outside world, merchants established their stores, labor was abundant and well remunerated, and such rude and semi-barbarous luxury as the distance of the place from civilization would permit, was freely indulged in. Champagne suppers, celebrated "big runs," and whatever else money could procure in Colorado was to be had in the city of Empire. But, unfortunately, a very few years of such mining as was in vogue in Empire from 1861 to 1864, sufficed to exhaust the placer-grounds; and surface-quartz is only too apt to terminate in "cap" or in iron pyrites.

The rise of Empire was rapid, and its fall was nearly as rapid. With iron pyrites came a cessation of big runs; champagne suppers were soon too costly for the miners' or mill-men's pockets, and a migration of the floating population to some "pound diggings" in other more favored parts of the Territory began. Six stamp-mills, with 94 stamps, were soon idle, since with the knowledge of treating pyrites then extant in the county these mills could no longer be run with success.

The district had produced nearly $2,000,000 in gold, and had supported a population of about 1,000 men. A number of large and valuable lodes had been found and developed to a certain extent, that is, all the surface-quartz had been extracted, and "cap" or iron pyrites reached. About this time it was discovered that gold lodes had a marked value in New York, and soon the era of stock-companies and speculation set in. Greenbacks were plenty in Empire again; new mills were erected, and the "process mania" took entire possession of too many of the Eastern superintendents. The history of Colorado in this respect is the history of Empire. Everything, from superheated steam to tobacco-juice, was tried on Empire ores. Glowing promises of success made to Eastern stockholders were succeeded by disastrous failures, and confidence in the resources of the district was again shaken when assessments instead of dividends were the outcome of all endeavors and hopes.

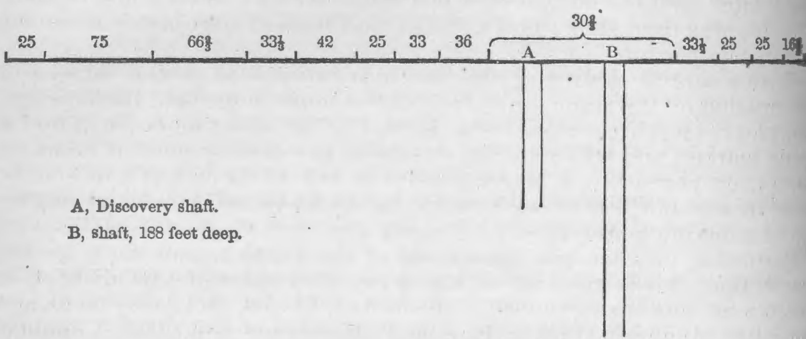
A year of such work sufficed, and as company after company suspended operations, often deeply in debt, work for the laborers of the community was not to be had. The population of the district rapidly melted away, and soon but a corporal's guard of men, too deeply interested or too confident of final success to leave the place, remained behind. The town, with its pretty houses, was nearly empty; the once constant fall of the stamp was heard no more; and a district filled with rich lodes and all desirable facilities for working them, was left in a Rip Van Winkle sleep to await the day of cheaper labor and the advent of a method of treating "rebellious" ores. Such, in brief, is the history of Empire, a district characterized by the great size of its veins and the abundance of auriferous iron and copper pyrites contained therein.

With the advent of railroads into Colorado came a better-educated class of men; the reckless superintendents of former "flush" times took their departure, and were succeeded by men interested in the successful working of the mines under their charge. The smaller stockholders in Eastern companies withdrew, and soon a few men of wealth controlled the operations of the largest companies. The establishment of the works of the Boston and Colorado Company, (Professor Hill's,) in Black Hawk, and its success in thoroughly treating the ores of that region, gave new energy to those interested in the mines of Empire. The building up of Georgetown, and the successful working of the silver-ores of that region, began to attract attention to the other mineral resources of Clear Creek County, and the patient, constant few who had stood by Empire once more took heart.

During the early part of 1872 the Swansea, Colorado, Smelting and Silver Mining Company "limited," an English corporation, commenced the erection of smelting-works at Swansea, a point at the junction of the Empire Fork of Clear Creek with South Clear Creek, and the mine-owners of Empire began to think of their long-deserted gold-mines on Silver Mountain. During the year Dr. George C. Munsen, agent for F. Schuchardt & Sons, of New York, now the owners of the property of the former Knickerbocker Gold-Mining Company, of the Tenth Legion, and other gold-bearing lodes in Empire, began operations on the Tenth Legion.

To resume operations on the property of a defunct company is often quite as difficult a task as to commence *de novo* on an untouched vein. Such at least was the case regarding the Tenth Legion, for in addition to the legacy of rickety shafts and poorly-timbered drifts, left by reckless miners and superintendents of former times, the excessive subdivision of the lode interfered with its thorough development.

The following sketch shows the condition of the lode in this respect; the figures attached to the different subdivisions represent each the length of the property of a separate owner:



A, Discovery shaft.
B, shaft, 188 feet deep.

That such a subdivision of the lode is injurious to its profitable working is evident, and we can but hope that the efforts for the consolidation of the smaller interests will be crowned with success.

The Tenth Legion is a large vein, the crevices between walls seldom being less than 9½ feet wide. In the bottom of the deeper shaft, 188 feet in depth, and the one through which future developments will be prosecuted, there are two veins of ore, one on the north side of the crevice of 3 feet, and one on the south side of 4 feet, separated by a "horse" of 2 feet 4 inches in thickness. In re-timbering this shaft, and at a depth of 96 feet from the surface, a vein of iron-pyrites of, at first, 4 inches in thickness was found, which afterwards increased to over 2 feet of solid ore. This new vein, of which no former record is to be had, differs in dip from the apparent dip of the main one, but is probably part of the vein separated by a "horse" from the larger part of the lode. The ore from this vein is rich in copper, carrying as high as 12½ per cent. of that metal, together with 7 ounces of gold and 20 ounces of silver per ton. In the bottom of the deep shaft the ore averages well, the results from thirteen samples, assayed by Dr. John Torrey, of New York, being $84 gold per ton. The mine, as at present opened, will furnish about 8 tons of ore per day, and, what is worthy of notice, only one-third of this is stamp-mill ore, the remaining two-thirds being pyrites so well concentrated as to be fit for the immediate use of the smelter. It is the intention of the present owners of this lode to reserve all smelting-ore, and sell the same to either or both of the two smelting-works now established in Clear Creek County. The remaining ore will be crushed in the stamp-mill belonging to the same parties that own the mine.

The mill is located about one and a quarter miles from the mine, and is connected therewith by a good wagon-road. It contains 20 stamps and three pans, and is furnished with power from an 18 foot wheel, (with 8 feet face,) the water being conveyed through a covered flume from a substantial dam. The stamps now drop not to exceed 24 drops per minute, and fall from 15 to 19 inches. It is proposed, however, to give them less fall and drop them at the rate of 40 drops per minute. The stamping-ore will be passed through the mill, and the tailings to a concentrator. The resulting dressed ore is to be treated in flat iron pans with the use of chemicals. The experience of Mr. Munson, gained in the former runnings of the mill and from experiments made on 500 and 1,000 pound lots within a year, has enabled him to treat iron-pyrites in the manner described, and at a cost for chemicals of not over $1 per ton, with a high degree of success. The results from the last series of experiments, and with check assays of both ore and tailings, show that he obtained from 65 to 92 per cent. of the coin value contained in the ore treated, and the bullion obtained was from $\frac{800}{1000}$ to $\frac{858}{1000}$ fine in gold. This too was from stamp-mill tailings, and from raw ore, assaying about $20 in coin per ton.

With a careful sorting of this ore into two grades at the mine, and the treating of the stamp-mill ore in the manner described, the management leaves but little more to be desired. The smelting-ore will find a ready market, and will materially assist in the development of home industry, by permitting a larger amount of the silver-ores of the county to be treated in Clear Creek County, the iron-pyrites being very desirable as a fluxing-material.

Particular mention has been made of the Tenth Legion lode, for the reason that this is the first of the many good lodes of this district in which work has been resumed. In addition to this, there may be named the Silver Mountain, Liebig, Humboldt, Rosecrans, Gold Dirt, Conqueror, Atlantic, Livingston County, and Great Equator lodes, all more or less developed by shafts or tunnels, and all capable of yielding a large amount of gold-bearing ore, carrying more or less copper.

It is highly probable that, during the coming year, nearly all the above-named lodes will be in active operation. The work of connecting the Silver Mountain lode with one of the tunnels of the Bay State Mining Company is now in progress, and, as but a short distance remains to be driven, it is probable that this valuable vein will be productive in a short time.

Mention has been made of the works of the Swansea Colorado Smelting and Silver-Mining Company, located a short distance below Empire. The method of treating ores in this establishment is identical with that of Professor Hill's in Black Hawk, *i. e.*, a smelting for matte, in which is concentrated the gold, silver, and copper contained in the ore treated. The company began operations in April last, and have had, owing to the difficulty in procuring a sufficient supply of iron-pyrites, only about one month of steady work.

The works have both steam and water power, and are provided with a large crusher and rolls. A number of kilns, of a capacity of 10 tons each, are used for the preliminary roasting of such of the ores as need it. A reverberatory roasting-furnace is also used for this purpose. A smelting-furnace (reverberatory) receives the roasted ore and fluxes, and the matte and slag are obtained in a manner similar to that of Professor Hill's. The works, which have at present a capacity of 8 tons in twenty-four hours, are under the management of Mr. Richard Pearce, and seem to be managed with the same degree of skill and business-tact that characterizes the investment of foreign capital in metallurgical works in this Territory. The workmen are nearly all English.

At present the matte is shipped to Swansea, Wales, for further treatment, but it is the intention of Mr. Pearce to shortly make the proper arrangements for the extraction of the silver from the matte produced by Ziervogel's process, the remainder of the valuable metals to be separated in Swansea, to which place the matte, after treatment, will continue to be sent.

With the certainty of a large and constant supply of iron-pyrites from the Empire mines, and which the recommencement of mining in that district seems to assure, the works will certainly be enlarged during the coming year. Almost any amount of silver-ores can be obtained from the mines of Griffith district, and the future of the establishment is a promising one. With plenty of ore of a good grade in both gold and silver, and with wood at $4.25 per cord, with a certainty of a railroad passing within a few hundred feet of the works within nine or twelve months, there can be no good reason why the ores, both of silver and gold, of the western part of Clear Creek County should not be thoroughly and economically treated at home. Owing to the difficulties mentioned above, the production of the works for the year 1872 aggregates but $20,000 coin.

SUMMIT COUNTY.

This county, the least populous, though not least prosperous in the Territory, is the extreme northwestern county in Colorado, and embraces the area west of the main range, and north of 39° 31′ north latitude, being about one hundred and fifty miles in an east and west and one hundred and fifteen miles in a north and south direction, and including, within these limits, about seventeen thousand square miles of surface.

A number of passes across the main range afford an entrance into Summit County, the principal one of which is the Tarryall Pass, from the head of Tarryall Creek (a tributary of the Platte) to Breckenridge. A wagon-road from Georgetown to Montezuma also exists, but, owing to its unfortunate location, and the steep grade on which it is built, it is but little used, except during the summer months, and then only as a trail for jack-trains, and for travel on horseback.

Aside from a partial development of a few of the mineral resources of the county, and this, too, in the small area around the head-waters of the Snake, Swan, and Blue Rivers, the county is, to-day, nearly as wild and unimproved as it was when first entered by white men. Dense bodies of timber cover the mountains, extending from the timber-line, which is, on an average, about 11,000 feet above sea-level, to the valleys of the stream.

These valleys are covered with heavy growths of nutritious native grasses, prominent among which are red-top, timothy, blue-grass, bunch-grass, white-clover, and wild oats. They are admirably adapted for grazing purposes, and probably for the raising of the more hardy of the small grains.

The principal towns of the county are Breckenridge, the county-seat, and headquarters of the placer-mining interest, situated on the Blue River, and Montezuma, a small mining-camp on the Snake, the post-office, and depot of supplies for the Snake River mines.

The principal business of the county is placer-mining, which has been steadily prosecuted since 1860, and which has been generally remunerative to those engaged therein.

Within the scope of country extending from the head of the Swan to the head of the Blue River, and down this latter stream for a distance of about twenty miles, are a number of tributary gulches emptying into the Swan and Blue Rivers, and it is in these gulches that most of the placer-mines of the county are to be found. Aside from the mineral resources of the county, the most prominent object of interest are the Hot Springs, situated on the Grand River, and reached by a good trail from Breckenridge. These springs are remarkable for their size, and for the temperature of their waters, which is 112° F. at the point where the water issues from the earth. The water has a decided sulphurous taste, and a not unpleasant sparkle. The springs are in good repute, and are much frequented by Indians as well as whites.

The population of Summit County is extremely variable, being greatest in summer when the mining is at its height, and dwindling down to a comparatively small number in the winter-months, a condition of affairs peculiar to a country that relies solely upon an industry which is dependent on the seasons for its successful prosecution.

There are four saw-mills in the county, and lumber is worth from $30 to $35 per 1,000 feet, the latter price being for sluice-lumber.

Labor, during the mining season, commands from $3 to $5 per day, averaging about $3.50 per day for the season. During the past year about two hundred and fifty men have been engaged in mining and accessory work, such as ditch-building, &c. The total product for the year, including the value of the ore and lead riches shipped from the Snake River mining-camps, will not exceed $125,000 coin value.

During the past season the process of "booming" has been inaugurated in Summit County. This consists in collecting water in a proper reservoir, of large capacity, and discharging a great volume of it at once, thereby removing an amount of gravel impracticable by any other means. Notwithstanding the great volume of water used, and the amount of gravel kept in motion in the flume in a state of thick mud, the results seem to be favorable as regards the collection of gold. Large areas of ground can be worked by this method, which cannot be mined profitably by other ways. Ground which, by the ordinary hydraulic process, pays $3 per day to the hand, can be made to yield $25 a day. The extensive application of "booming" to many of the gulches of Summit County cannot fail to raise the gold-yield of the county.

Commencing in the extreme southern part of the mining-districts of the county, and on the head of the Blue River, the first mining-camp is that of Bemrose & Co., in Hoosier gulch, a tributary of the Blue River. This company is working in an old side-channel in good pay-gravel, overlaid with cement. Four men are employed during an average season of only two and one-half months, caused by the early failure of water at the location worked, which is over 10,000 feet above sea-level. The ground pays about $12 per day to the hand employed.

In this immediate neighborhood is situated the Vanderbilt, a free-gold lode in quartzite. The crevice is irregular, varying from 6 to 12 inches in width. The ore averages well, and many exceedingly rich specimens have been found. The lode is not being actively worked.

On the hillside of the second gulch north of Hoosier gulch is situated the Hunter lode, a vein of silver-bearing ore, opened by a shaft of 30 feet in depth. The ore-vein varies from 3 to 8 inches in thickness. The ore consists of galena, gray copper, and blue and green carbonate of copper, and carries from 40 to 1,000 ounces in silver per ton. Several tons have been shipped to Newark, New Jersey, averaging about 300 ounces per ton.

On the Blue River, a short distance above, south of Breckenridge, Messrs. Crone & Fuller are sluicing on a side-bar, employing three men for an average season of four months, the ground paying about $5 per day to the man.

Below this claim Messrs. Sheppard & McNasser have ground opened preparatory to booming next season.

Immediately below Breckenridge, in what is known as "Klack's gulch," probably an old side-channel of the Blue River, Greenleaf & Co. (Springfield Mining Company) are employing twelve men. They are using a 3-foot flume, dumping into Blue River. The ground is paying finely.

Opposite Breckenridge, in Lomax gulch, the same firm is booming, employing three men, with fair results.

On Corkscrew patch the same firm is booming, employing two men. The ground is not yet fairly opened, but prospects well.

Jones & Hunter are mining in Yuba Dam patch, below Breckenridge, employing two men in booming; pay averages $7 per day to the hand.

In Iowa gulch Adams & Stahl are booming, employing six men. During the past season the gulch has produced about $6,000, the length of the season being about four months.

On the same hill, and south of Iowa gulch, Hopkins & Hoopes have opened ground preparatory to booming. The ground prospects well.

In Illinois gulch, a tributary of the Blue, and emptying into that stream just above Breckenridge, Colonel Fuller is mining. He is also booming in Mayo gulch, a tributary of Illinois. He employs four men. The ground pays about $10 per day to the man.

Above Mayo is Pacific gulch, also a tributary of Illinois. Messrs. Hopkins, Hoopes & Blair have here opened ground preparatory to booming. The ground prospects well.

In French gulch, emptying into the Blue a short distance below Breckenridge, a number of companies are mining. In the head of the gulch Messrs. Martin Day & Co. are sluicing in the gulch and booming on the hill-side, employing four men; pay good. Conners & Cobb, in Rich gulch, a tributary of French, are preparing to boom during the next season.

C. P. Clark is sluicing in French gulch and booming in Lillian Vail patch. He employs eight men with good results. McFarland & Todd are next below, in French gulch, employing two men; pay fair. The Badger Flume Company come next. The pay here is poor, the bed-rock not having been reached.

In Negro gulch, a tributary of French, T. H. Fuller is preparing to boom, with very favorable prospects.

Mower & Hangs, on Stilson's patch, in French gulch, are sluicing with three men, using a hydraulic; pay good.

Sisler & Co., below, use sluices, employing two men, with fair results.

The Blue River Mining Company come next in French gulch, using sluices and a hydraulic. They employ five men; pay fair.

The U. S. Grant Mining and Smelting Company is the lowest company in French gulch, employing seven men; pay fair.

North of French gulch is Gold Run, a somewhat noted gulch. In this locality D. Walker with three men, Moffat & Co. with four men, the Tiffin Gold-Mining Company with four men, L. Peabody with six men, and G. Mumford with ten men are sluicing with excellent results.

On Delaware Flats, east of Gold Run, A. Delaine with three men, and Canfield & Johnson with two men, are doing well.

On the side-hill, between Delaware Flats and Galena, the claims of Twibill & Stogsdale are located. The firm employ eight men, and have the best paying ground in the county, the gross yield of which for the past season has been nearly $25,000.

In Galena gulch the Galena Mining Company with eight men, and Kiland & Coatney with four men, are sluicing with good results.

On the Swan River, below the mouth of Georgia gulch, Clegg & Young are putting in a bed-rock flume, employing four men. The bed-rock has not yet been reached. The prospects of the enterprise are favorable.

In Georgia gulch George Twist is working three men; pay good.

In Humbug gulch P. Iversen employs two men; pay fair.

In American Gulch Hitchcock & Stomes are employing three men in sluicing; pay good.

Messrs. Greenleaf & Co. are building a large ditch to carry the water of the three forks of Swan River to the head of Humbug gulch. The ditch, when fully completed, will be about thirteen miles in length; it is 4 feet wide and 4 feet high, flumed for the entire distance, and will carry 1,500 miners' inches of water. The ditch has throughout a grade of a quarter of an inch to carry 12 feet. This ditch will command the largest extent of ground left unworked in the county, and will doubtless prove a remunerative enterprise.

Twelve miles below Breckenridge Salt Lick gulch is being workd by four men. Water is brought from Ten Mile Creek. The pay is good.

Comparatively little lode-mining was done in the county during the past season. In Snake River district considerable prospecting was done and with favorable results. In Montezuma the Saint Lawrence Company worked the Silver Wing lode, and succeeded in developing a fair-sized vein of pay-ore, specimens from which were remarkable for the amount of ruby silver contained therein. The mill of the company is a substantial structure, containing ten stamps and an Airey furnace, which, however, has not been tested yet. The mill is not quite in running order. On Bear Creek, a tributary of the Snake, and about one and one-half miles above Montezuma, is located Saint John, the seat of operations of the Boston Silver-Mining Association, W. L. Caudler, superintendent. This organization, although owning much other valuable property, are developing only the Comstock lode, a large vein, the ore of which carries much galena. The development of the mine has been described in former reports, since which time, excepting stoping ore and the commencement of another tunnel, designed to cut the vein at a depth of 700 feet from the surface, but little has been done in the mine. Since the last report a large mill has been built, finished late in 1872, and a few tons of ore treated before the severity of the winter suspended operations.

The mill is built so as to receive the ore from the ore-house, where it is dumped from the tram-way conveying it from the mine. On its entrance into the mill it is dumped by the side of a large Blake crusher, and then either fed into the stamp-battery of ten stamps or passed through the crusher and rollers and then elevated to screens preparatory to dressing. If the ore is suited for amalgamation it is passed from the crusher to the ball-grinder, and from this machine to the proper bins, from which it is conveyed to the roasting-furnace.

Such of the ore as consists of galena associated with baryta and quartz, and carrying but little gray copper or other brittle ore of silver, is passed through the sizing and dressing machinery. The latter consists of, first, two continuously-working jiggers on the same floor with the stamps. These jiggers are designed for stuff of from $\frac{1}{4}$ to $1\frac{1}{4}$ inches diameter, and pass their tailings, if worthy of further treatment, directly to the stamps. From the stamps the now finely-crushed stuff passes, secondly, three "spitz-cutters" which size it, the coarsest going, thirdly, to two other continuously-acting jiggers, designed for stuff of from ½ mm. to 1 mm. in size; and the finest, fourthly, to two of Rittenger's continuously-working shaking-tables, which treat the slimes. The ore now being prepared for smelting is dried and passed to the roasting-furnaces, two in number. These furnaces have three floors, and are designed to each treat eight tons in twenty-four hours. Passing from one floor to the other the ore is desulphurized, and in the lowest hearth is converted into silicate of lead. The charge is drawn in a liquid condition into a sand-bed on the ground-floor of the furnace-house, and, when cold, is broken up and taken to the shaft-furnace, which is about 10 feet in height, and having three common tuyeres. This furnace is built of fire-bricks made of material found near the works, which have stood perfectly the test imposed upon them. The furnace-walls are one brick thick, and are bound with hoop and flat iron. The blast is supplied by a McKenzie blower, driven by a small steam-engine. What lime is necessary for a flux is obtained in the Snake River Valley, a few miles below the works. The working results of this method of beneficiating the ores of the Comstock lode are most excellent. The slag from the shaft-furnace is clear of silver or lead, and the lead produced is soft and of a good quality. At this point the operations of the company cease; and the pigs of lead riches are shipped to the East for separation.

The amalgamation-ore, after being subjected to a chloridizing roasting, is further treated in two of Wheeler & Randall's pans, furnished with proper settlers, &c. The amalgam, after retorting, is smelted into bars, assayed and stamped, and in this state shipped East.

Among the prominent discoveries of the year may be mentioned the veins found in what is known as Geneva district, a section of country embracing the main range between Peru district and one of the numerous heads of the Platte River. The district, geographically, is partly in Park and partly in Summit County, but owing to its distance from the settled portion of Park County, is practically a Summit County mining-camp. A number of promising veins have been located, prominent among which are the Revenue, Starr, Overland, and Loraine lodes. The Revenue has two shafts of about 20 feet in depth, and carries a vein of pay-ore of about 1 foot in thickness. The ore consists of gray copper and galena, and is rich in silver, assays varying from 100 to 800 ounces of silver per ton. The returns from a lot of about 8 tons shipped to Georgetown and there crushed, show that the first-class ore yields nearly 500 ounces per ton. The lode is remarkable for the large amount of gray copper contained in it, and for the presence of beautiful specimens of native sulphate of copper. The other lodes of this district have been but little developed, but all show more or less of the same characteristics as the Revenue. The Overland carries 6 feet of mixed galena and gangue, and assays nearly 1,000 ounces to the ton.

There is scarcely any doubt but that this district will prove to be one of the best located during the year.

GILPIN COUNTY.

Mr. A. von Schulz, territorial assayer at Central City, has furnished the report on this county.

The mining-industry of Gilpin County has not made that progress during the last year which the richness of the gold-mines promised. The monthly production has, in comparison with former years, fallen off during the past summer and winter, but has at present (end of the year) reached again about $80,000; this amount not including the shipments of auriferous and argentiferous copper matte of the Boston and Colorado Smelting-Works, which may be safely put down at $60,000 per month more.

The rather stagnant condition of mining in the gold-region may be attributed to several causes, on account of which many, or rather the largest part, of the Gilpin County mines are idle.

Everybody has been waiting for facilities for cheaper and more profitable working of the mines than were heretofore in existence. The great cry has been for a railroad; and if a railroad will really benefit this part of the country so much as is generally believed, the fact ought now to become apparent, a narrow-gauge road being finished to Black Hawk. This privilege of having connection by rail with the East and West has been obtained at a considerable cost, the voting of $250,000 in bonds to the Central City Railroad Company, whereby the tax on the whole taxable property of Gilpin County is raised to nearly 2 per cent., and it is therefore the more to be hoped that the completion of the road will really give new impulse to the mining-industry of the county, as has been expected. The rates of freight will be reduced; fuel and labor will command lower prices; capitalists, who heretofore have been kept away on account of the tedious trip up to Central City and vicinity, and the poor accommodations which existed at that place before the new hotel was finished, will now investigate the resources of the gold-region more thoroughly, and invest, perhaps, convinced of the mineral wealth of the district, more judiciously than has been done up to this time. As mentioned before, most of those lodes which formerly added considerably to the bullion-production, are now, and have been, lying idle for the past two years.

The numerous companies on the well-known Bobtail, Gregory, Bates, Burroughs, and other lodes have been prevented from working, partly by internal troubles in the companies and partly by the drowning of their properties. It would lead too far to give reasons for this, to strangers and the uninitiated, seemingly causeless idleness of the best claims which were formerly paying so well; suffice it to say, that internal troubles in some of the companies, which had it in their power to drain pretty nearly the whole extent of two of the above-named lodes, caused them to stop work, and the consequence was a suspension of operations on all these lodes on account of water. It is hoped, however, that as the drainage of one mine has been successfully undertaken by the enterprising owners thereof, (the Briggs Brothers,) and as this drainage will materially benefit some of the other claims, a general revival will take place on the whole line, which would give employment to over one thousand men. The Bobtail tunnel, started over a year ago, approaches its completion very rapidly, and will drain nearly the whole extent of the Bobtail lode, promising therefore a renewal of activity on the claims lying along it.

Another reason for the comparative inactivity of the mining-camp is found in the system of leasing claims, owned generally by companies, to single miners. This system does not tend to the perfection of a continuous and steady prosperity of the mining-industry. For a certain share of the net profits, payable to the company, these miners go to work, not always in the most approved manner, and take out the ore as long as it will pay them, caring little for a proper development of the property, and still less for the state and shape in which they leave the mine should they not "make it pay." They are certain to quit work the moment they run behind in the least degree. Should the company owning the mine afterwards have the intention of starting up work on their own account, it finds the mine stripped and in such a shape that it would cause a large expenditure of money to put it into working order again.

The opening of newly-discovered districts and the higher wages in the neighboring silver-region about Georgetown have induced many prospectors and miners to leave this camp.

The most effective means, however, for bringing about a prosperous state of mining-affairs in Gilpin County would be a consolidation of the many small claims, taken up under the old mining-laws, in lengths varying from a few feet to several hundred.

To give an instance of this subdivision, the 800 feet at present located and partly developed in the original Bobtail lode are cut up into claims of respectively 433⅓, 66⅔, 72, 33⅓, 66⅔, and 128 feet; the 1,750 feet on the Gregory lode are owned by five separate companies, while the 2,347 feet on the Burroughs lode are divided into seventeen distinct claims; and so it is with nearly all the more prominent mines.

Mining, of course, becomes more and more expensive the deeper it is carried on, and it is a matter of no great calculation to see the necessity of a consolidation of these different claims in the near future.

Nobody who has followed the development of the resources of this gold-region in past years will have any doubt as to its future prosperity. The opening and working of the innumerable lodes have nowhere shown a giving out of the precious metals, and when it has temporarily appeared so it must be attributed to only a local deterioration in the quality of the gold-bearing material, which will occur, more or less, in every mine and in every country.

The total production of Gilpin County for the year 1872 amounts to $1,389,289. Of this amount $959,439 were produced in bullion, purchased and shipped by the banks; $419,850 represents the value of first-class ore from Gilpin County treated by the Boston and Colorado Smelting-Works, and $10,000 worth of ore and tailings were purchased by the chlorination-works of Cash & Rockwell.

The shipments of the banks, as given in detail by the express office, are as follows:

Rocky Mountain National Bank.

	Currency.		Currency.
January	$20,767	August	$39,247
February	28,933	September	32,442
March	27,048	October	35,606
April	22,760	November	39,292
May	18,350	December	43,535
June	29,231		
July	35,646	Total	372,857

Thatcher, Stanley & Co.'s Bank.

	Currency.		Currency.
January	$30,600	August	$25,500
February	20,550	September	31,000
March	21,500	October	38,000
April	29,400	November	25,800
May	23,500	December	31,850
June	32,000		
July	49,500	Total	359,200

Nath. Youngs & Co.'s Bank.

	Currency.		Currency.
January	$42,056	June	$27,000
February	39,300	July	21,000
March	10,800		
April	24,796	Total	177,752
May	12,800		

Black Hawk Savings Bank.

	Currency.		Currency.
April	$4,300	September	$4,270
May	4,000	October	300
June	13,930		
July	14,250	Total	49,630
August	8,500		

The amount of milling and smelting ore raised, during the past year, is estimated at 90,000 tons, of which between 3 to 4 per cent. is smelting-ore, although the percentage of first-class ore can safely be placed at 10 per cent. Not more than 3 to 4 per cent., however, is sorted out as smelting-ore, the balance being sent to the stamp-mills.

The mill or second-class ore yields, on an average, from $10 to $12.50 per ton, while the value of the smelting-ore may be estimated between $80 and $100 per ton of 2,000 pounds.

Out of seventy stamp-mills, with 1,300 stamps, only fourteen, with 360 stamps, have been in operation during the past year. They are:

	Stamps.		Stamps.
Potter's mill	15	New York Mill	55
Clayton's mill	30	Kimber & Fullerton's mill	18
Whitcomb's mill	20	Polar Star Mill	32
Sullivan's mill	25	Berhaus & Miller's mill	20
Black Hawk Mill	50	Arrighi Mills	10
Lake Mills	20	Briggs Mills	25
Meade Mills	20		
Mensenderffer Mill	20	Total number of stamps	360

The Boston and Colorado Smelting-Works have purchased, according to Professor Hill's statement, during the year 1872, 9,650 tons of ore. Of this amount 6,950 tons were produced in Gilpin County, for which $178,000 were paid at the works; 21,000 tons came from Clear Creek County, and realized $320,000, while Park County furnished 600 tons of the above total, with $88,000 valuation.

The 6,950 tons of ore furnished by Gilpin County include, however, about 3,000 tons of tailings, which, with a margin of the smelting-works of $24 per ton, have a value of $72,000. Taking, further, the average margin on ores at $43 per ton, the remaining 3,950 tons of ore are worth $169,850. If to these two amounts the above $178,000, which the works actually paid, are added, we have the actual value of the product of first-class ore and tailings from Gilpin County, and bought by the Boston and Colorado Smelting-Works, amounting to $419,850.

The works have enlarged their capacity by the addition of one reverberatory, of which there are now three in all, and one blast-furnace for the reworking of slags obtained by the treatment of zinciferous silver-ores. The blast-furnace has only been running for a short time, but it is the intention of the managers to start it up again as soon as the coke, which will be used instead of charcoal, arrives.

The Cash & Rockwell Chlorination-Works will be soon started up again, for which purpose they have already commenced buying ores, (first-class and tailings.) They will increase their capacity if they should see a necessity for it.

Of the principal mines in Gilpin County the following have been worked, more or less, during the past year:

	Claim.		Claim.
California	1	Missouri	1
Forks	1	Sparks	1
Alps	1	Prize	1
Roderick Dhu	1	Jones	2
Kansas	4	Senderburg	2
Kent County	1	Mertu County	1
American Flag	1	Gould and Curry	1
Gardner	1	Fisk	3
Grinnell	5	Foot and Simmons	1
Casto	1	Bobtail	1
Union Pacific Railway	1	Briggs	1
Leavitt	1	Wood	1

The Bobtail tunnel, started for the purpose of draining the Bobtail and adjoining lodes and working them, has at present reached a length of 1,100 feet, and is only a few feet distant from the above-named lode. It crosses the Fisk 588 feet from its mouth, and will intersect the Bobtail between the Sensenderffer and Trust Company's claims at a depth of 500 feet below the surface. The dimensions of the tunnel are 6 by 7 feet, with a fall of 6 inches in 100 feet.

The minimum number of feet driven per month was 36, the maximum number 78, costing on an average $22 per foot, exclusive of timbering, tram-ways, flumes, &c. The total cost of the tunnel will be between $35,000 and $40,000.

The Wood lode, in Leavenworth Gulch, is at present principally worked for the pitch-blende (ü ü) it contains. The first lot of ore, amounting to 200 pounds, was sent to England, and sold for $300, or $1.50 per pound, assaying 67 per cent. of oxide of uranium.

From the last lot of 1,200 pounds no returns have as yet been received; and about four tons more are on the dump, not yet closely enough sorted. The mine is worked at a depth of 70 feet, this being the only instance where pitch-blende is found so close to the surface, the occurrence in Saxony, Bohemia, and Redruth, Cornwall, being found at much greater depth.

BOULDER COUNTY.

Mr. Lawrence Thompson, territorial assayer for this county, has furnished the following report:

Most of the mines of this county are worked by the original prospectors, or discoverers, and the want of reduction-works or an easily accessible market has operated in most cases to prevent production of ores beyond that incidental to exploration. Some few lots of ore have been occasionally sold, but there are no systematic accounts from which totals and values could be taken. The unusually heavy snows of last winter and spring have much delayed work, and limited it to the few summer months. The gold and silver mining districts of Boulder County commence about five miles from the foot of the mountains, on the east side of Gold Hill, and extend west some twelve miles in a direct line to the summit of the Snowy Range. They reach on the north and south the limits of the county, embracing an area of about two hundred and eighty-eight square miles.

The principal districts are Grand Island, Gold Hill, Sugar-Loaf, James Creek, and Ward.

Grand Island district.—The Caribou mine is located on Caribou Mountain, four miles east of the Middle Boulder or Dartt Pass, and is 9,800 feet above tide-water. This lode extends 1,400 feet on the surface, and its course is N. 82½° W. The owner, Mr. A. D. Breed, has obtained a United States patent for the property.

There are in this mine eleven shafts, aggregating 1,248 feet in depth. The main or working shaft is 329 feet deep; another is 229; a third is 129, and eight others are from 20 to 100 feet deep. There are, also, four tunnels, aggregating 1,678 feet in length. The walls are not well defined, there being no regular selvages. The crevice may, however, be stated to be from 6 to 8 feet in width, and the paying part of the vein is from 6 inches to 4 feet wide. The ores of this mine are sulphurets of silver, argentiferous galena, brittle and native silver, with but little zinc-blende. They are easily reduced by chloridizing, roasting, and amalgamation.

Mr. Breed has kindly furnished from his books the following statements of the product from the time of his purchase, September 21, 1870, to October 1, 1872. Number of tons of ore mined and milled, 3,650¾; net profit per ton, $90 currency. The present developments in the mine expose 34,082 tons of ore. In the bottom of the deep shaft, as well as in the 260-foot level, is a fine vein of first-class ore, 44 inches wide. Mr. Breed also owns and operates a mill at the village of Middle Boulder, four miles east of the mines, of which the following is a brief description:

The mill building measures 100 by 165 feet, and has five terraces or floors. The motive-power is steam, and the method of treatment is chloridizing-roasting in Brückner cylinders, and amalgamation in pans. Twenty men are required to run the works day and night, and 3,500 pounds of salt are used during the twenty-four hours. The bullion produced is from .850 to .950 fine, and the capacity of the works is from 18 to 20 tons per day.

Idaho. This mine is about one mile east of the Caribou lode, on what is known as Idaho Hill. The following facts in relation to it were furnished by Mr. J. D. Westover, one of the owners:

The main shaft has been sunk to a depth of 100 feet, at a cost of $300, including timbering, shaft house, &c. Amount received for ores sold, [illegible]985. Width of crevice 3 feet; width of ore-vein 12 to 24 inches.

The Perigo mine, one of the first discoveries in this district, contains gold on the surface, but it has had comparatively little development. During the past season the 4-foot vein has produced $25 per ton in the stamp-mill. In the shaft, which is 40 feet deep, silver-ore of fine grade replaces the gold at a depth of 25 feet from the top.

Isabel. This is a recent discovery, lying about 300 feet south of the Caribou mine, and has a shaft of 35 feet in depth, with a crevice 5 feet wide, and an ore-streak of 10 inches. The first-class ore has been sold to the Boston and Colorado Smelting Company, of Black Hawk, for $858 per ton; second class for $229 per ton. Amount not stated. The third-class ore assays $100 per ton.

Boulder County lode. This vein lies about two miles east of Caribou. There are eight shafts on it, aggregating 250 feet in depth; also 225 feet of levels and tunnels. It has produced during the past season 600 tons of ore, worth, by assay, from $20 to $150 per ton in gold and silver. Part of the ore was sold to the Boston and Colorado Smelting Company, and another part was worked by stamp-mill. That portion stamped yielded $3,850 gold. The width of the crevice is 5 feet, and the width of ore-streak 2 feet. I am indebted to Mr. Charles Sherman, one of the owners, for the above statements.

Sherman. This mine has two shafts, one 90 and one 40 feet deep. Width of crevice, 5 feet; width of ore, 25 inches. The Boston and Colorado Smelting Company have paid for the first-class ore from this mine $376, and for the second-class, $128 per ton. Cost of mining and marketing ore, $50 per ton. Statement furnished by lessees.

Seven-Thirty. This mine is located immediately north of the Caribou mine, running parallel with it, and the claim is 3,000 feet in length. Mr. E. A. Hupper, one of the owners, and manager of the mine, furnished the following statement:

The main shaft is 75 feet deep, and 175 feet of levels have been run; average width of crevice 3½ feet; average width of ore 12 inches. The entire expenditure in and about the mine, including shaft-house, building road to mine, &c., is $3,922.24. The receipts from sales were $5,837.60.

Grand View, on Caribou Mountain, has a main shaft 80 feet deep, and two other shafts aggregating 47 feet in depth. Width of crevice 3 to 4 feet, containing an ore-vein from 8 to 12 inches wide. Twelve tons of ore have been sold, for which $216.50 per ton have been realized. About 25 tons of second-class ore are at the mine, the estimated value of which is $50 per ton. The owners have expended in and about the mine $2,320.25.

Bullion, near the village of Cardinal. One shaft has been sunk 30 feet deep. Width of crevice 4 feet. The rock yields in stamp-mill $25 per ton in gold. Cost of mining, hauling, and milling, $10 per ton.

The No-Name lode is owned by William Donnel & Company. One shaft has been sunk 55 feet deep. In sinking this shaft $478 have been realized from sales of first-class ore, and $140 for second-class. Width of crevice 4 feet; width of ore-vein 8 inches.

The Trojan lode lies near Cardinal. The main shaft is 130 feet deep, the east shaft 60 feet, and there are 100 feet of levels. This mine has produced 600 tons of ore, yielding in stamp-mill $10 per ton in gold. Considerable ore from this mine has been sold for from $120 to $208 per per ton. Width of crevice 4 feet; width of ore-vein 18 inches.

Sovereign People. This mine has three shafts aggregating 150 feet, the main shaft being 70 feet deep. First-class ore sells for $175, and second-class for $100, per ton. Width of crevice 4 feet; width of ore-vein 16 inches.

Arlington. The main shaft is 50 feet deep. The ore contains both gold and silver, yielding in stamp-mill $13 per ton in gold; assay-value $60 per ton.

Hetzer & McKenzie's stamp-mill is located at the town of Middle Boulder. It contains fifteen 500-pound stamps, and is run by water-power. Its capacity is seven tons per day. During the summer of 1872 it was run three months, producing $5,643 65, gold. Cost of mill, $3,000; cost of operating mill twelve hours, $3;* cost of quicksilver, &c., per day, 50 cents. Wear of shoes and dies per month, $125.

The Washington Avenue is situated on the divide between North Boulder and Four-Mile Creeks, and three miles west of Sugar-Loaf Mountain. This lode is a recent discovery, and is producing ores of high grade. The first-class ore yields by assay $399 per ton, and consists of argentiferous galena with sulphurets of silver. The width of the crevice is 6 feet; that of the ore-vein, 20 inches.

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* I give these figures as reported by Mr. Thompson; but they seem to me inexplicably low.—R. W. R.

Ward district.—The ores of Ward district are generally refractory, and but a comparatively small per cent. of the value can be saved by stamp-mills, owing to the failure to complete and run successfully the reduction-works at the Ni-Wot mine on the Columbia lode. Comparatively little mining has been done in the district during the year. Still the district is known to contain some of the most valuable lodes in Colorado, among which are the Columbia, (which has been opened by different shafts at short intervals for a distance of one and a half miles,) the Stoughton, Celestial, and others. The Columbia shows a strong vein for the whole distance explored. The average value of the first-class ore is about $100 per ton. It is principally sulphurets of iron and copper, carrying a small amount of silver.

The Stoughton has a pay-vein of about 3 feet, the ore being sulphurets of iron and copper, first-class ore being worth $175 per ton.

The Celestial has a pay-vein of about 12 inches, and has been worked during the past season to a limited extent, the ore yielding $250 per cord, of about seven tons in the stamp-mill process. The first-class ore of this mine assays over $200 per ton.

Gold Hill district.—The Red Cloud lode was discovered in May, 1872. Mr. John Evans, one of the owners and manager of the mine, furnishes the following statement: Depth of shaft, 75 feet; length of levels, 60 feet; width of crevice, 3 feet and 6 inches; product of mine from August 1 to December 31, 40 tons of first-class ore, with an average value of $900 per ton, and 250 tons of second-class ore, worth $100 per ton. This mine contains both gold and silver, and is remarkable on account of containing these metals in combination with tellurium, the mineral found being petzite. There have also been promising discoveries made during the season on the east flank of Gold Hill, which are now being developed. Among these may be mentioned the Phœnix lode, which has a shaft 35 feet deep, with a crevice of 4½ feet. Value of first-class ore, $200 per ton.

The Blue Jay is also a recent discovery of some promise. There are several other valuable lodes on Gold Hill, which have been worked during the season to a limited extent, viz, the White Rock, Seven-Thirty, Twins, and Horse-Fall. The ores from these mines have been worked by stamp-mill.

A company has been organized by some of the most prominent business men of Boulder City, for driving a tunnel under Gold Hill from Left-Hand Creek, and work on the same is now being vigorously prosecuted. It is a work of some magnitude, and promises large results, as it will cross lodes of known value at a great depth.

Central district, or Jamestown.—This district is situated on James Creek, a tributary of Left Hand. The ores found here contain both gold and silver. Some of the mines produce large quantities of sulphurets of iron and copper, also much argentiferous galena, and some arsenical and antimonial silver-ores.

The crevices and ore-streaks are generally large, and would produce large quantities of low-grade ores; but owing to the want of adequate means for reduction, no mining has been done the past season. A number of new discoveries have been made and are being developed in different parts of the county. At the head of Four-Mile Creek, at Garden Gulch and at Williamsburgh, lodes have been opened, showing argentiferous galena in such quantities as to induce preparations for vigorous work during the winter.

Gulch-mining has been prosecuted to some extent on Four-Mile Creek, about eight miles west of Boulder City, during the past summer, and about $6,000 in gold was received at the Boulder Bank from this source.

PARK COUNTY.

For the following reports on Park and Lake Counties I am indebted to Edward D. Peters, M. E., late territorial assayer at Fair Play, who wishes to acknowledge the valuable assistance of Messrs. Mills, Stansell, McGraw, and Dudley.

Geology of the principal mining-districts of Park County.—From Fair Play to the base of Lincoln, Bross, and Buckskin Mountains, and following the whole course of the Mosquito range, there exist extensive gravel and drift deposits entirely covering the surface of the country. These deposits are all more or less auriferous, and include some of the best paying placers in the county. The bed-rock is a micaceous sandstone, containing much lime and alumina. The wash-boulders are mostly quartzite from the higher formations, plentiful but not large. From Horseshoe district, and probably still farther south, to Ute or Hoosier Pass, the primitive rocks are overlaid by three distinct formations, two of which might be subdivided into an immense number of strata: first, sandstone; second, limestone; third, porphyritic trap.

In many of the deeper gulches, and on several of the lower mountains, one or all of these formations have been scoured away. On Mount Bross the geological formations can be plainly seen. On the primitive schistose rocks rests a layer of metamorphic sandstone 1,500 feet thick. This is overlaid by limestone 1,800 feet thick, and this again is capped by porphyritic trap 800 feet thick. These figures are not absolutely accurate, but are correct enough to show the enormous thickness of the stratified silver and gold bearing rocks. The chemical and physical properties of the sandstone and limestone vary very considerably at different depths. I am not aware that any analyses have been made of these rocks, and can therefore give only one, which I made from the limestone directly below the Moose mine, elevation about 13,000 feet above sea-level:

	Per cent.
Carbonate of lime	84.3
Carbonate of magnesia	3.0
Silica	9.6
Moisture	1.4
	98.3

The principal gold-lodes are found in the lower strata of sandstone; the higher strata are traversed by numerous and extensive silver-bearing veins, carrying gray copper, zincblende, and galena, with quartz gangue, while in the higher limestones are found the enormously rich silver deposits which have rendered the Mount Lincoln district so famous. These deposits are characterized by the presence of galena, silver-glance, and gray copper, and have almost invariably a heavy spar gangue. I cannot learn that any paying mineral has been discovered in the trap.

Mineralogy of Park County.—The following list of the minerals of this county includes only those which I have myself examined and tested. I do not claim it to be full or perfect, simply correct:

Park County minerals.

Name.	Locality.	Description.
Native gold	Placer and lead mines	Crystals very rare and imperfect. In laminæ, flattened grains and shot.
Native silver	Placer-mines; also lead-mine on Chalk Creek.	In nuggets and wires. In thin scales.
Graphite	In limestone on Silver Heels Mountain	Very impure; containing oxide of iron and earthy matter.
Molybdenite	Silver Heels Mountain	In threadlike veins.
Argentite	In Silver Star, Moose, and other mines	Amorphous and laminated.
Galenite	In all the mines in both sand and limestone. Assays from $3 to $12 per ton, and as high as $120 per ton in gold.	In simple and modified cubes, also in twins; also coarse and fine granular, the coarse being always the richer.
Alabandite (?) (Manganese blende, M. S.)	In some of the old gold-mines near Quartzville.	Massive.
Zincblende	In large quantities in the Mosquito gold-mines. Also in some silver-mines. Carries from $10 to $150 per ton in silver. Several specimens tested. Yielded cadmium.	Mostly massive. Highly ferruginous.
Pyrite	In all the gold-mines and in the silver-mines of Buckskin. Invariably auriferous, but seldom rich enough to be of value.	In simple cubes, pyritohedral, and massive. In the Phillips mine perfect cubes are found of enormous size.
Chalcopyrite	Found in all the gold and most of the silver mines. The richest matrix for gold, often assaying as high as $150 per ton; also, $300 per ton in silver.	Crystallized and massive. Often iridescent. Beautiful variegated specimens are found in the Mosquito mines.
Marcasite	Phillips mine	Cellular.
Arsenopyrite	Priest mine on Silver Heels Mountain	Massive.
Zinkenite	Sweet Home mine	In minute crystals.
Jamesonite	do	Capillary. So-called feather-ore.
Tetrahedrite	Principal silver-ore of Buckskin district; assays from $50 to $300 per ton. Select specimen from Moose mine assayed $5,200.	In complicated crystalline forms and massive.
Tennantite	Buckskin district	Crystallized,
Stephanite	In Moose and other silver-mines	Massive and crystalline.
Common salt	At the salt-works and several mineral springs.	Massive and crystallized.
Horn silver	In small quantities in Wade Hampton mine. The Moose and other mines in the limestone formation carry from 5 to 20 per cent. of their silver contents in the shape of a chloride, but invisible to the eye.	Massive.
Carnallite	Salt works	Crystalline.
Fluorite	Sweet Home mine	Crystallized, massive; pink and violet.
Cuprite	Sacramento Gulch, Sweet Home mine	Minute crystals and massive.
Melaconite	Unknown mine at Montgomery	Massive and earthy.
Hematite	In many places in the park	Argillaceous.
	Phillips mine Hamilton, Silver Heels	Specular.
	Hamilton, Silver Heels	Fibrous.
Chromite	Silver Heels Mountain	Massive.
Rutile	On Ute Pass in veins of quartz traversing limestone	Crystallized.
Pyrolusite	Buckskin and Silver Heel Mountains	Massive.
Limonite	Extensive beds in the South Park	Earthy.
Quartz	In nearly every mine and in veins traversing the limestone strata.	Crystallized and massive.
Wollastonite	In veins traversing the lower limestones.	
Pyroxene	In limestones and dolomite	In endless forms and varieties.
Amphibole	In schistose rocks at Montgomery.	
Garnet	do	Crystallized.
Epidote	In trap rock on summit of Mount Bross.	
Mica	Very abundant and in many varieties, especially near the junction of the sandstone and schistose rocks. I have noticed biotite, phlogopite, and muscovite.	
Feldspar	In many varieties in the schistose rocks. Have observed fine crystals of Labrador in trap.	
Tourmaline	In schist above Montgomery	Large black crystals. Both ends perfect.
Prehnite	In trap rock	In clusters of small crystals.
Apatite	In schist	Massive.
Barite	Principal gangue rock of the limestone silver-mines.	Crystallized and massive. Very abundant.
Anhydrite	Salt-works	Crystallized.
Gypsum	Various mineral springs	Crystallized and in sheets.
Melanterite	Sweet Home mine	In concretions.
Anglesite	Horseshoe lead-mine	Crystallized.
Chalcanthite	Sweet Home mine	In concretions.
Calcite	Very abundant in all of the mining districts.	Crystallized and massive. Some of the crystals are double-refracting.
Dolomite	In limestone	Massive.
Siderite	Sweet Home mine and many places in Park	Crystallized.
Cerussite	In Horseshoe mines in immense masses, usually containing a kernel of galena. Assays from $10 to $200 in silver. No gold.	Massive. Very abundant.
Malachite	Sweet Home mine	In very minute crystals and concretions.

Peru district, in this county, has furnished some magnificent specimens of ruby silver, in large and translucent crystals. I cannot give the precise locality.

Previous condition of mining affairs in Park County.—From 1859 to the present time, placer and lode mining have been conducted in Park County with greater or less success. It is impossible to form any correct estimate of the total production in gold for that time, but it will probably fall short of $2,750,000.

The placers have been mined principally by the slow and expensive method of rocking and ground sluicing. Within the last two years more economical processes have been introduced, and gravel which a few years ago would not pay over $2 a day to the man, will now yield $5 to $10, and even $20.

This increase in production and corresponding diminution in expense has been effected by substituting water-power for manual labor. During the past summer several parties have introduced the system of booming. This consists in collecting water in a reservoir until a strong head is obtained, and then letting it over the bank to be washed, in a body. The powerful current carries down trees, boulders, and all other impediments, and moves more dirt in a single hour than could formerly be excavated in a day.

The history of the gold-lodes of this district is exactly the same as that of Central, Gold Dirt, Empire, and many other mining camps in this Territory. The top quartz, decomposed and prepared by nature for amalgamation, was easily mined and readily treated. Large companies were formed, extensive mills built, and much money expended. As soon as the sulphurets were reached, the mills were closed and operations on the mines suspended, as it was found impossible to treat the pyritous ores successfully by amalgamation. There are a large number of gold-leads at Hamilton, Montgomery, and Mosquito, which only require proper treatment to render them profitable. Concentration and smelting would appear to be the most effectual and economical method of handling these ores.

Present condition of mining affairs.—Mining has received a powerful impulse during the past year from the rich silver discoveries on Lincoln and Bross Mountains. Although no great amount of money has as yet been taken out, the discoveries have caused an influx of prospectors and capitalists, and called attention to the wonderful riches of the whole Mosquito range from Ute Pass to Buffalo Peaks. The summer of 1872 was unusually cold and stormy, but in the face of these drawbacks, and in spite of the fact that nine men out of ten were prospecting and not mining, the South Park mines have produced about 1,500 tons of ore, which has been sold for about $150,000. I estimate the cost of mining and transporting this ore at $70,000, leaving a net profit of $80,000 for the working season of four months. This ore has been principally purchased by a branch of the Boston and Colorado Smelting Company, and by the Mount Lincoln Smelting-Works. The latter works have been in successful operation since December 1 of this year, are purchasing for cash all ores offered, and smelting daily about 10 tons. They use a blast furnace 3 by $3\frac{1}{2}$ feet in size and 12 feet high. The furnace has three tuyeres, and the blast is furnished by a Sturtevant's, No. 7, pressure blower. The products are lead riches and copper matte, all of which are shipped to Germany for further treatment. The prices paid for ore are liberal, being from $20 to $50 higher than can be realized by shipping to St. Louis or Swansea.

The silver discoveries on Lincoln and Bross this summer have been very numerous. They are without doubt superficial deposits in limestone, but appear remarkably regular and well-defined and very extensive. I cannot learn that any deposits *in situ* have "played out," although there are reports to that effect from discouraged miners. Many prospectors have discovered and recorded little stray bunches of mineral which occur frequently in the slide, and, of course, have dug them out. These little pockets can almost invariably be traced to the main deposit above, and there is no doubt that they have simply been broken off and moved down the hill by some convulsion of nature.

A very large number of silver-mines have been discovered on the south slope of Buckskin Mountain. I append a list of the names, owners, size, amount of development, and assays of some of the most promising of these leads, in order to call attention to the value of this hitherto neglected district. Besides those mentioned there are a multitude of lower grade, and from the surface-indications I judge that hundreds more will yet be discovered. The material that they contain is of such a nature as to admit of easy concentration, and I am satisfied that dressing-works would find steady and profitable employment in this district.

Future prospect of mining affairs.—The year 1873 will show an enormous increase in the production of the South Park mines. Most of the men who were prospecting last summer will commence developing their property and become producers. The time that was spent the past season in building houses, grading trails and roads, and opening mines, will be employed in taking out ore.

The Park Pool Company are working the Hiawatha and Beeger this winter, and will employ a large force of men on their various mines as soon as the spring opens. Messrs. J. H. Dudley & Co. have nine men on the Moose, and next season will employ some fifty or sixty more on their other mines. Many other operators have announced their intention of mining on Lincoln and Bross, and also extending their operations to Hamilton, Montgomery, Buckskin, Mosquito, and Horseshoe. It is also probable that large smelting-works will be erected in the latter district, to reduce the argentiferous lead-ores that are found there in great abundance. It is probable that the production of 1873 will exceed $1,000,000. It is confidently expected that a railroad will be built into the park during the coming year. This would give an additional impulse to mining. It would not only greatly lessen the cost of mining supplies, and afford cheap transportation for the rich ores and products of the smelting-works, but it would put the mines in direct communication with the coal-fields and beds of iron-ore near the base of the mountains. This would give cheap fuel and cheap flux for the smelters, and by lessening the cost of reduction would greatly increase the value of the ore. The coal-bed now worked near Hamilton, Park County, although large and regular, furnishes a quality of coal entirely unsuited for smelting. It is a middling good quality of lignite, will not coke, and is unable to bear the burden which it would be obliged to carry in a high furnace.

The owners are of the opinion that the coal will improve greatly in quality as depth is gained. I sincerely hope that such may be the case.

The Phillips mine.—This mine, being one of the most important and valuable gold lodes of this district, I insert a short sketch of its discovery, production, extent, &c. I do this to show the characteristics of the gold lodes found here in the lower strata of sandstone. The mine was discovered in Buckskin Gulch in 1860, by Joseph Higginbotham, alias "Buckskin Joe." In June, 1861, twelve persons were working on it. In September of the same year the town of Buckskin contained 1,000 inhabitants. From June 18 to October 19, Stansell, Bond & Harris, who owned 200 feet of this lead, took out $50,000. The process they employed was very simple. The top quartz and dirt was run through sluices, and the headings were re-worked in arrastras, yielding $350 per cord. The retorted gold sold for $16 per ounce, coin. During the same season about $25,000 was taken out by other parties. The lode was worked until 1863, when sulphurets were reached, which could not be treated by ordinary mill process. The total yield of the lode has been about $250,000, although many claim it to have been much greater. The average width of the Phillips is 30 feet, and it has been worked for a length of 2,000 feet. It traverses a quartzite formation, has a gangue of quartz and heavy spar, and carries immense masses of iron pyrites traversed by small and irregular veins of copper pyrites and zincblende.

The lode descends perpendicularly for 25 feet, and then splits up and pitches east almost horizontally in a multitude of seams varying from 1 inch to 10 feet in thickness. Thousands of tons of auriferous sulphurets are still exposed to view, and will doubtless be utilized at some future day.

The Moose.—This representative silver-mine of the newly-discovered limestone district was discovered in July, 1871, by Captain Plummer. The "Dwight," probably an extension of the same, was discovered in June, 1869, by Plummer & Myers. In 1871 this property was sold to Dudley & Co., who took out the same season from the Moose 30 tons, yielding 300 ounces per ton; from the Dwight, 15 tons, yielding 275 ounces per ton. As this material was shipped to Swansea exactly as it was taken from the mine, without any sorting or other preparation, the yield is very remarkable. The Moose has been traced for 800 feet and opened for nearly 400 feet. The crevice varies in width from 8 inches to 6½ feet, and pitches into the mountain at an angle of 35°. The country rock is black limestone, and the gangue of the vein is principally heavy spar. The principal silver-bearing minerals are galena and various decompositions of copper pyrites; much carbonate of lead is also found. The ore requires no sorting and is easily smelted. During the summer of 1872, 300 tons of this ore were sold to the Mount Lincoln Smelting-Works, yielding $350 per ton. A very small force of men has been employed upon the mine, and all the ore from it has been packed to timber line upon jacks. The elevation of the mine above sea-level is something over 13,000 feet.

Placer-mines.—There is an immense area of gravel-deposits in the South Park, which, owing to the high price of labor and imperfect methods of working, has never yet been touched. From personal observation and careful compilation of the statements of our most experienced gulch-miners, I estimate that there are no less than fifteen square miles of placer-ground which will yield $8 per day to the man by an extensive and economical method of working.

In the immediate vicinity of Fair Play, and since the founding of that town, about $1,000,000 worth of gulch-gold has been taken out, at an expense of $500,000. This gold is worth on an average $18.50 per ounce, coin. The following analysis, made by myself, will show the nature of the alloy:

Gold	89.42
Silver	9.92
Copper	Trace.
	99.34
Specific gravity	15.11

In the neighborhood of Hamilton and Tarryall, placer mining has been prosecuted since August, 1859, and has yielded about $1,000,000. There are still some 2,000 acres of gravel left, which will yield from $5 to $12 per day to the man. This gold comes principally from the lodes above Hamilton, which are numerous and large, but cannot be worked profitably by ordinary mill process.

The Bank mine of Messrs. Mills and Hodges, on the Platte, about four miles above Fair Play, has been worked for three years. In that time 2,000 days' labor have been expended upon the mine at an expense of $3 per day. Forty-five thousand cubic yards of gravel have been washed, yielding $19,350, or 43 cents per cubic yard. Average work per day per man has been 22½ yards, producing $9.67½. Their ditch is three miles long, 6 feet wide at the top and 4 feet at the bottom, with a quarter of an inch fall to the rod. It carries about 900 inches of water. The mine is only run during the day, and the proprietors have sold sufficient water at night to meet all incidental expenses of the mine. They use a hydraulic pipe with a 70-foot head and an inch and a quarter nozzle, and have a 2 foot flume, 220 feet long, paved with block ripples. They intend next summer to construct a 5-foot flume and use the booming method. Their average depth of gravel is 21 feet, and is increasing rapidly. The ground pays more or less from the grass-roots, but the principal money is found on a stratum of "hard-pan" 5 feet above bed-rock. The gold is mostly in the shape of shot, and sells for $18 per ounce.

Messrs. *Pease and Freeman have been working a gulch-mine on Beaver Creek, about one mile from Fair Play, for eight years. The first* year they worked five men and took out 58 cents. Since then they have expended $20,000 in running a flume 2 feet wide and three-fourths of a mile long, and have opened up an inexhaustible area of half ounce diggings. Their supply of water is small, but sufficient to carry all bowlders through their flume.

Messrs. J. W. Smith and Fred. Clarke have purchased nearly all the claims on the Platte River about two miles above and below the town of Fair Play. They have bought out some thirty-six men, and are running a flume 6 feet high and 6 feet wide, with a grade of 2 inches to 12 feet. The season of 1872 was spent in preliminaries, but there is no doubt that in future the enterprise will be self-sustaining until bed-rock is reached, when very large pay is expected, as the dirt has yielded as high as $41 a day to the man, by shoveling into sluices. The owners will have to flume for about one mile before striking bed-rock.

LAKE COUNTY.

The placer and lode mines of California Gulch have been worked vigorously this summer. The Printer Boy, owned by the Boston and Philadelphia Gold-Mining Company, J. Marshall Paul, agent, and by Captain Breese, has a crevice from 12 to 17 feet in width. I am informed that the whole of this enormous vein yields under stamps at the rate of 17 ounces per cord, or $45 per ton. The mine is, however, very pockety, and sometimes incredibly rich bunches of mineral occur. I am informed by one of the proprietors that a panful of dirt has been taken from one of these pockets which yielded 132 ounces in gold. The mine has a shaft on it 140 feet in depth, with levels run at regular intervals, and a large amount of backs yet untouched.

The Beery Tunnel, owned by Captain Breese, has a large crevice, and assays well in gold, silver, and copper, but the ore cannot be treated advantageously by the common mill process.

The "Five-Twenty" has a 7-foot crevice, with a pay-streak 14 inches wide, which yields $20 per ton.

There are a great number more of these gold-lodes, which only require development and means of reduction to make them valuable. They are all situated in quartzite, dipping west.

The total yield of the placers in this gulch has been estimated at $3,000,000, and there are still some five square miles of gravel-deposit which will pay $5 per day.

The Homestake mine, near Tennessee Pass, has been extensively worked this summer by Mr. McFadden. This vein has been traced for about 3,000 feet, and has an average width of 16 inches. The mineral is principally galena, with some copper and iron pyrites. About 50 tons have been sold this summer, yielding $125 per ton.

In Iowa Gulch, Breese, Paul & Co. are constructing a ditch, fourteen miles in length and 6 feet wide, to convey water to these very rich diggings.

The gulch is four miles long and 40 to 150 feet wide, with an average grade of 3½ inches to 12 feet. The depth to bed-rock is about 12 feet, and the whole gulch is rated as twelve-ounce diggings.

LODES RECORDED IN PARK COUNTY IN 1872.

Consolidated Montgomery mining-district.—Our Fritz, Red Bird, Black Bird, Tar Heels, Pioneer Silver Lode, Summit County, Terrible, Como, Sheridan, Eyrie, Ohio, Bellvue, Pack Saddle, Belmont, Legal Tender, Moreno, Cricket, Queen, Wolverine, Highlander, Alma, Booth, Jupiter, Oro Cash, Dolly Varden, Arctic, Ajax, Old Abe, Hoosier Boy, Caribou, Ocean Wave, Crown Point, Mammoth, Von Bismarck, Silver Wave, Cayuga, Confidential, Cora, White Fawn, Alma Extension, Blue Jay, Peacock, Reindeer, Rough and Ready, Olive, Denver City, Combination, Gertrude, Park County, Montezuma, Swansea, Terror, De Soto, North Star, Ledge, C. S., Dolly Varden, Kansas, Collins, Red Rock, American Flag, Cavern, Hamilton, Newton, Australia, Baltic, Miners' Delight, Mascou No. 1, Mascou No. 2, Russia, Seven-Thirty, Waterloo, Hidden Treasure, Bullion, Revenue, Fortune, Esta Buena, Colorado, Prolific, Buckeye, Autocrat, Castello, Concordia, Phœnix, Glancoria, Longfellow, Eclipse, Chicago, Milwaukee, Marco, Phil Sheridan, Minnehaha, Ferguson, Kohinoor, Leonora, Big Emma, Peacock, Queen of the May, Horace Greeley, Isabella, General D. H. Hill, Big Sunflower, Zeb. Vance, Buckeye No. 1, Buckeye No. 2, Juniata, Maggie, Cosmopolitan, McNab, Park County, Elgin, Grant, Monday, Hughes, Wheat Cate.

Buckskin Joe district.—Queen, Globe, Rising Sun, Three Men, Big Horn, Dolly Varden, School Marm, Guinea, D.D., Rocky Point, Bunker Hill, Framingham, P. D., Snow Bird, Johnny D., Whopper, Sneezeweed, Grant, Aztec, Pawnee, Stranger, Antelope, Home State, Fourth of July, Buckeye, Buffalo Head, Emma, Buckskin Joe, Flood Tide, Mattie Mullen, Taylor, Overseer, Homestead, Knox, Little Ettie, Pioneer, Jackson, Uncle Charley, Red Cloud, Park County, Tiger, Indian Boy, Ruby, Ipswich, Augustine, Compton, Monte Christo, Narrow Gauge, Sailor Boy, Potosi, Emma Louisa, Uncle Sam, Mountain Gem, C. H. Rodgers, Manganese, Condor, Thanksgiving, Lead, High Grade, Absecome, State of Maine, Kenduskey, T. D. Hume, Dick Lord, Bull Dog, Red Cloud, Wade Hampton, McGraw, Confidence, Columbia, Hanging, Rubicon,

Rubicon Extension, Angola, Raven, Lofty, Greenback, Security, Bagdad, Liberal, Idaho, Mahone, Ground Hog, St. Elmo, Quaker, Trail, New Discovery, Red Mountain, Norumbega, Black Bird, Rheinlander, Green Bird, Careless Boy, New Castle, C. D., A. B.

Mosquito district.—Whale, White Horse, State of Maine, Champion, Unknown, Black Bear, Humboldt, Colorado, Great Western, Morning Star, Porphyry, Clinton, Topeka, Hard to Beat, Elephant, Larke, J. B. Chaffer, Ballarat, Cora.

Hall's Gulch.—Wallace, Densmore, Nichols, Athens, Brownell, Liftwick, Comet, Ulster County, Cold Spring, Marietta, Dolly Varden, Baby, Cliff, Alice Cary, Olive Hoyle, Elizabeth, Columbus, Elliot, Colorado, Bison, Jasper.

Gibson Gulch.—Fat Boy, Orphan Boy, Hubbard, Yankee Boy, Yankee Nation.

Pennsylvania Gulch.—Julia.

Swan Gulch.—Summit.

Putnam Gulch.—Old North State, Barney.

Horseshoe district.—Buckeye State, Brownlow, Maria De Los Rayes, Blue Jacket, Elizabeth, Fair Play, Spar, Treasury, Galena, Brownlow Extension, Spotted Hornet, Sedgewick, Crystal Fountain.

Geneva district.—Starr, Perry, Hunt, Snow Storm, Dolly Varden, Black Dan.

Tarryall district.—O K, Silver Mist, Republic.

Outside of districts.—Santa Fé, Colorado, Tender Foot, Patebuma, Lion, Sunny Side, Tiger, Bonnie Doon, Millionaire, Metz, Orphan Boy, Tempest, Sherman Nos. 1, 2, 3, and 4, Manhattan, Chase.

List of principal mines in Buckskin district.

Name.	Owner.	Depth.	Width of crevice.	Assay value per ton.
Narrow Gauge	Mullen & Jordan	10-foot shaft	6 inches	$450 00
Monte Christo	do	12-foot shaft	3 feet	82 60
Careless Boy	do	30-foot tunnel	15 inches	700 00
Sailor Boy	do	30-foot tunnel	1 foot	390 00
Buckskin	do	15-foot shaft	3 feet	175 00
Great West	do	2 25-foot shafts	4 feet	*60 60
Capital	do	8-foot shaft	10 inches	100 00
Union No. 4	A. Bergh	120-foot shaft	18 inches	117 17
Surprise	T. Jordan	10-foot shaft	3 feet	101 01
[illegible] Money Bags	do	14-foot shaft	3 feet	190 90
Homestead	Mr. Simms	10-foot shaft	2 feet	112 00
Winnebago	do	10-foot shaft	1 foot	200 00
Mineral Bluff	do	14-foot shaft	6 inches	90 00
Knox	Dunbar & Rische	10-foot shaft	8 inches	360 00
Little Ettie	do	12 foot shaft	10 inches	340 00
Von Moltke	do	10-foot shaft	8 inches	117 00
Taylor	Mr. Taylor	12 foot shaft	6 inches	384 00
Raven	do	20-foot shaft	30 inches	130 00
Filthy Lucre	do	8-foot shaft	1 foot	75 00
High Grade	Dick Lord	10-foot shaft	3 feet	112 00
Plumbago	do	20-foot tunnel	10 inches	98 00
Summit Lake	Fritts & Harriden	15-foot shaft	18 inches	642 00
Confidence	McGraw & Hartwell	20-foot shaft	1 foot	725 00
McGraw	do	2 tunnels	9 feet	812 00
Stella Hartwell	do	10-foot shaft	5 inches	170 00
Sunday	do	12-foot shaft	6 inches	219 00
Silver Star	do	12-foot shaft	2 feet	125 00
Hope	do	8-foot shaft	2 feet	90 00
E. D. Peters	do	12-foot shaft	30 inches	302 00
Delavan	do	14-foot shaft	1 foot	211 00
Arctic	do	12-foot shaft	3 feet	128 00
Tom Thumb	do	10 foot shaft	4 inches	137 00
Irving A. Owens	do	10-foot shaft	3 inches	127 00
Little All Right	do	10-foot shaft	8 inches	95 00
Em. Brayton	do	10-foot shaft	3 feet	80 00
Green	do	8-foot shaft	5 feet	100 00

List of principal mines in Buckskin district—Continued.

Name.	Owner.	Depth.	Width of crevice.	Assay value per ton.
Victor	McGraw & Hartwell	10-foot shaft	3 feet	$60 00
Sweet Home	Morgan & Henderson	80-foot tunnel	18 inches	90 00
Red Mountain	Mills & Hoges	40-foot tunnel	18 inches	80 00
Overseer	Jerry Newell	10-foot shaft	12 inches	200 00
Potosi	George Wells	30-foot tunnel	15 inches	400 00
D. D	Douglass & Clarke	18 foot shaft	30 inches	150 00
Uncle Sam	Seymour & Peters	8-foot shaft	20 inches	150 00
Mountain Gem	do	10-foot shaft	18 inches	200 00
Wade Hampton	Burroughs, Heldo & Co	25-foot shaft	6 inches	1,200 00
Fourth July	do	10-foot shaft	20 inches	175 00
Johnny Dee	do	10-foot shaft	10 inches	75 00
Whopper	Mahany & Co	8-foot shaft	30 inches	110 00
Legal Tender	Dudley & Co	60-foot tunnel	18 inches	50 00
Hamburg	Mr. Simms	10-foot shaft	10 inches	130 00
Pelican	Mr. Walker	12-foot shaft	2 inches	700 00

* Gold.

THE CAÑON CITY COAL-BEDS.

The following account of these beds constitutes a paper by R. Neilson Clark, M. E., read at the Pittsburgh meeting of the American Institute of Mining Engineers, and courteously placed at my disposal by the author. Mr. Clark is the engineer in charge of the mines, and has thoroughly examined the whole field.

The coal-beds of Cañon City are situated six miles below the town upon the Arkansas River.

At this point the Rocky Mountains have thrown out from their main ridge two spurs. The one to the north, containing Pike's Peak and Cheyenne Mountain, is known as part of the "Rim Range;" the one to the west and south is known as the "Greenhorn Range."

Against these syenitic mountains the later rocks, from the silurian to the tertiary, are piled and uplifted; at right angles to the direction of this main uplift is the axis of a lesser plication.

On the north, west, and south the pitch is steep, gradually flattening as it approaches the center of the basin and rising again to the east at a pitch of about 5°, thus forming a perfect basin, the center of which is only two miles east of the base of the Greenhorn Range.

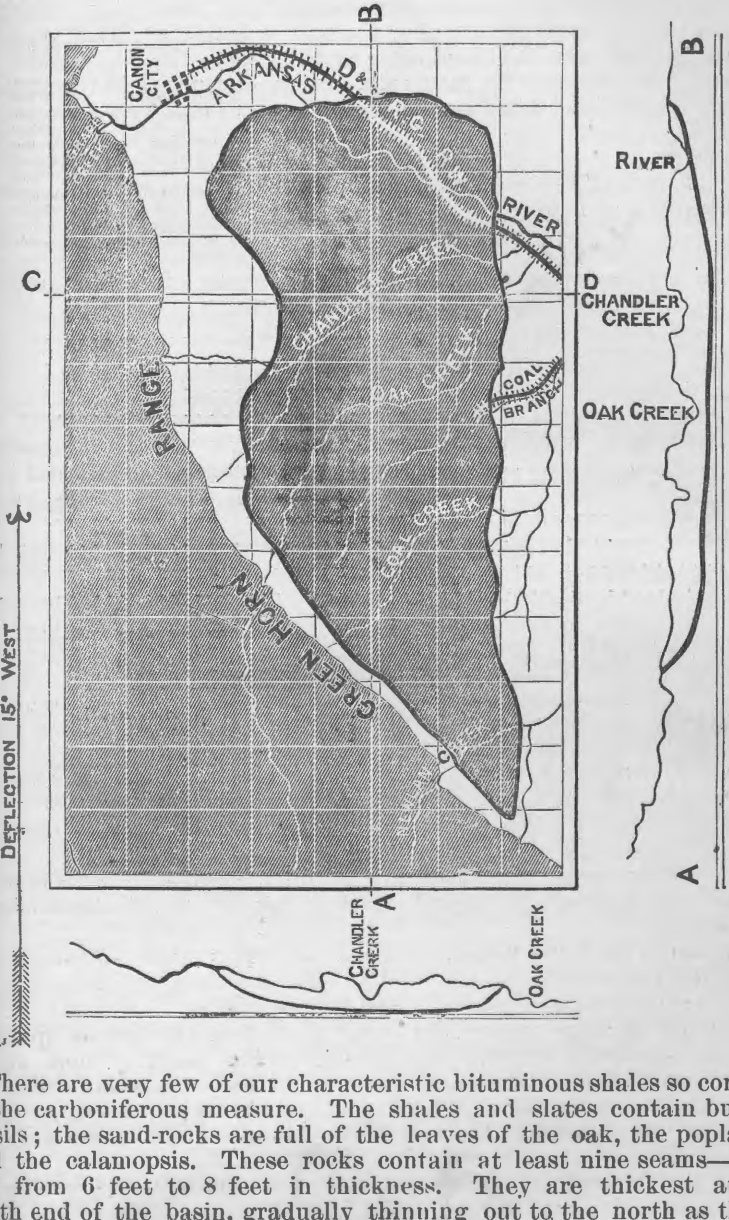
Over the center of this basin, and against the Greenhorn Range are situated the highest geological rocks of this region—the coal-bearing sandstones.

The bed is ten miles long at its greatest extent north and south, and five miles across at its greatest extent east and west; it contains in all about forty-four square miles of coal-bearing rocks.

A section through these rocks would give, from the bottom upwards, first, the sand-rock known for a hundred miles north of here as the "Hog-back"—probably eocene; on top of this a limestone; then the black shales; then the clay-bed—perhaps 200 feet in thickness; then the sand-rock—perhaps 150 feet thick—immediately underlying the coal.

To the north and east these seams are very thick, but they thin out to the west and south, the limestone and all intermediate strata disappearing, until at the south the bottom sand-rock lies upon the Greenhorn Range. The pitch at this point is not more than 15°, while but three miles to the north and west it is 60° to 80°, and stands apart from the range. Still further to the northwest, the other strata begin to appear; the clay-bed, however, I have never found on the western edge.

The coal-yielding rocks are about 600 feet in thickness—they are sand-rocks, with some black, yellow, and red shales.



THE CAÑON CITY COAL-FIELD, COLORADO TERRITORY.

There are very few of our characteristic bituminous shales so common in the carboniferous measure. The shales and slates contain but few fossils; the sand-rocks are full of the leaves of the oak, the poplar, (?) and the calamopsis. These rocks contain at least nine seams—varying from 6 feet to 8 feet in thickness. They are thickest at the south end of the basin, gradually thinning out to the north as the intermediate rocks thicken, thus two seams at the south, close to the range, are respectively 6 and 7 feet thick, and but 50 feet apart; at the north, on the river, they are but 2 and 4 feet thick and at least 150 feet apart.

The lowest of all of these seams is known as the Cañon City coal. Its section gives, from the bottom up, first, sand-rock; secondly, shale; thirdly, coal 8 feet; fourthly, shale and clay 24 feet; fifthly, coal 51 feet; sixthly, brown shale 8 feet; seventhly, coal 13 feet.

Twelve feet above is another thin seam of coal, and above this is a thin stratum of iron-ore, sample of which I had the pleasure of forwarding to Professor Raymond some months ago.

The coal is block-like in structure, not so distinct as in the Indiana coal-fields, but the cleavage is distinct enough to make excellent working for the miners. The underlying clay is too tough to afford undermining.

It yields by analysis made from samples taken from within ten yards of the surface, as follows:

By Professor E. T. Cox:*

Brown coal, color jet black, contains no seams of calcite; specific gravity 1.279; 1 cubic foot weighs 79.63 pounds.

Coke	61. 30	Ash, ocher yellow	4. 50
		Fixed carbon	56. 80
Volatile matter	38. 70	Water	4. 50
		Gas	34. 20

Coke—slightly swollen, unchanged, semi-lustrous.

By Dr. Thomas M. Drown:

Volatile matter	40. 65
Fixed carbon	53. 69
Ash	5. 66
Sulphur	0. 59

These analyses are taken from a letter of Mr. Robert H. Lamborn to Mr. George P. Hall, published in the Engineering and Mining Journal, of August 20, 1872.

Concerning its quality as a working-coal, I am happy to be able to place some figures before your notice.

The Denver and Rio Grande Railway have, up to this summer, always been forced to use the coal from near Erie. Some months ago I forwarded them a wagon-load of this coal for trial. I give an extract from the report of Colonel Greenwood, general manager D. & R. G. R. W., on the subject: "This report shows an average of one hundred and fifty-four miles run with a ton of coal, and, great as the distance is, there were one hundred and two miles of it up a heavy grade averaging nearly 40 feet per mile, and having two planes, of nearly eight miles each, where the grade was 75 feet per mile."

The engine was a four-driver passenger-engine; the train consisted of one eight-wheel baggage-car, and two of the standard passenger-coaches, capable of seating sixty-four passengers.

In the stove it burns very rapidly, with but very little smoke and no smut.

I forwarded specimens of this seam and the 4-foot overlying one, known as the "river-seam" to the Denver gas-works.

Mr. Fay, the superintendent, has been kind enough to send me the result of their experiments. I copy *verbatim :*

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* Concerning the analyses of these western coals, see a subsequent chapter on "The Calorific Value of Western Lignites."—R. W. R.

Result of tests (for gas alone) of coal from the Arkansas River and other districts, August 12, 1872.

Locality.	Weight in ounces.	Time in retort.	Coke.	Residue in retort.	Cubic feet crude gas.	Cubic feet washed gas.	Illuminating power.
River seam	32	25	None..	18 oz. S. P..	18	8.6	Fair.
Cañon coal	32	25	...do...	18 oz. S P..	17	7.6	Poor.
Trinidad	32	25	...do...	17 oz. L. P..	19	9.2	Good.
Rock Spring, Wyoming T.	32	26	...do...	18 oz. L. P..	15.6	7.2	Very good.

The letters S. P. (small pieces) denote that the residue is of no further use; L. P. (large pieces) that the greater portion of the residue will burn in our furnaces.

Carbonic acid and carbonic oxide in considerable force in each kind of coal. Sulphur present in each, but in very small quantity, the least in River seam; have no means of determining the proportions of either of the above obnoxious gases.

Each kind of coal was tested three times.

Respectfully,

WM. J. FAY,
Superintendent Denver Gas-Works.

Openings are now being made of the eastern outcrop, in preparation for the shipment of 150 tons per diem during the winter months.

Experiments are soon to be commenced for testing the coal in the blast furnace, as large deposits of iron-ore are found in the neighborhood. The demand for iron hereabouts is already good, and rapidly increasing, and it is hoped that the blast furnace and rolling mill will be lucrative investments. The amount of rails to be rolled is enormous; the nearest mills are at Saint Louis.

As it may be of interest, I add an analysis of the iron ore:

"Grape Creek iron-ore," Fremont County.

Silica	2.75	Oxide of magnesia	trace.
Mag. ox. of iron	67.76	Magnesia	3.20
Titanic iron	18.98	Sulphuric acid	trace.
Alumina	9.70	Phosphoric acid	faint trace.

The deposit is very large, and only twelve miles distant large deposits of iron-stones abound; limestone is in great plenty.

CHAPTER VIII.

WYOMING.

No new mining-districts have acquired prominence in this Territory during the year, and there is little to report of the old ones.

Mr. R. K. Morrison, of Miners' Delight, has kindly furnished data in regard to the gold mines of the Sweet-water region. From his report I estimate that, although not many quartz-mines have been in steady operation, the vigorous working of the placer-mines during the summer has fully made up the loss in production from the former source, and $100,000 coin may be safely accepted as the gold product of the region for 1872.

The close proximity of Utah, with its numerous deposits of rich silver ore, together with the universal habit of miners to stampede to every newly-discovered district of note, have almost depopulated the gold regions of Wyoming.

South Pass City is nearly deserted, all of the numerous ledges surrounding it now lying idle. The celebrated Cariso mine, from which so much bullion was taken in 1869 and 1870, was disposed of by Mr. Roberts in the fall of 1870. The English company, owners of the Irishman ledge, became the purchaser, paying $15,000 down, and agreeing to pay $115,000 more in monthly installments. After being put in possession of the mine, it was ascertained that they were not only unable to pay for the mine, but also to work it. They had evidently bought it on speculation, hoping their stock could be sold on the record of the Cariso. Since that time nothing has been done on the mine.

The Young America is also idle, the company having become disheartened by the loss of their valuable mill. The mine is well opened, exhibits a vein averaging 2 feet in width, and yields, by ordinary stamp process, about $15 per ton.

The other mines in this vicinity are similarly situated. They are all idle, and their locators are absent in Utah, prospecting for silver and lead mines.

Atlantic City presents a more prosperous appearance than South Pass, although but two mines are in operation there.

The Cariboo mine, formerly owned by Messrs. Cutler & Houghtaling, of Chicago, and operated by them one short season only, was subsequently abandoned. But upon the passage of the new United States mining law, regarding relocations of abandoned mines, it was relocated by a party of miners, who, since that time, have taken out a large quantity of ore, which yields from $10 to $30 per ton. There is no machinery upon this mine, the ore having to be hoisted by windlass. The relocators are well satisfied with their venture, and are still hard at work.

The Buckeye mine has been in continual operation ever since its location in 1868; and although started without machinery, capital, or credit, it has steadily progressed through misfortunes, cap-rock, non-paying quartz, &c., until it has accumulated enough to procure good hoisting works, a 10-stamp mill, a 6-inch double-acting pump, and a good credit. Finding the pump insufficient to drain the mine, they were forced to sink a new shaft, started at a less elevation than the old one. At the bottom of this new shaft they have a 10-feet vein of quartz, yielding on an average $9 per ton. Cost of mining and milling about $6.

Miners' Delight, or Hamilton City, is in a more prosperous condition than either of the two last-mentioned camps. In fact, no diminution of its population is discernable.

The old Miners' Delight mill has been idle during the past year for most of the time, but at present a force of men are taking quartz from the mine, which, it is estimated, will yield $20 per ton.

The Hartley mine, the west extension of the Miners' Delight, has been improved during the past year by the erection of a fine 20-stamp mill and hoisting works. A test run was made before the erection of the mill of 30 tons, yielding $30 per ton.

The East End Miners' Delight, consisting of 800 feet, owned by R. W. Shawhan, of Tiffin, Ohio, has also been improved by the erection of a fine 20-stamp mill and hoisting works, with 6-inch cornish pump, all run by one 40-horse-power engine. This mine is now in full operation, and shows a quartz vein of from 2 to 5 feet in width. The rock yields from $8 to $15 per ton. Cost of mining and milling, superintendent's salary included, $6 per ton.

The gulch mines were vigorously worked during 1872, giving employment to about one hundred men, and yielding upon an average $8 per day to the man. Cost of wood, delivered, $3.50 per cord; miners' wages, $4 per day; mechanics, $5 per day.

The above shows that the amount of development so far is not large, yet it must be remembered that this region has had no benefit of working capital, each mine being dependent upon its yield for its subsequent development.

THE COAL-MINES.

Of the two principal coal-mining companies of Wyoming, I submit the following statement, kindly furnished by the respective superintendents, Messrs. Charles J. Denel and Thomas Wardell:

Statement of mining operations of the Rocky Mountain Coal and Iron Company for 1872.

Coal mined in:	
January	8,481
February	7,597
March	8,857
April	8,106
May	7,351
June	7,204
July	8,657
August	9,066
September	8,420
October	8,237
November	9,228
December	13,856
Total for 1872	105,060

This company would have mined much more in September, October, and November, 1872, if they could have had cars enough. The railroad companies were both short of transportation. The company mined in January, 1873, 13,300 tons.

At the end of the year No. 1 slope was 563 feet long; No. 2 slope 630 feet long; No. 3 slope 472 feet long. No. 1 mine was working 3 levels; No. 2 mine was working 5 levels; No. 3 mine was working 6 levels. There are worked at No. 1 mine 2 dumps; at No. 2 mine 2 dumps; at No. 3 mine 1 dump.

Three sets of hoisting-works, employing double engines at two and single engine at one mine, are in use. There are, furthermore, 3 engine-houses, 3 blacksmith-shops, 3 weigh-houses, 3 sets of scales, snow-sheds, &c.; 64 dwelling-houses, 1 manufacturing-shop, 1 carpenter-shop, 1 school and meeting-house, 1 store, 1 hotel, 1 butcher-shop and market, 1 office, 1 car-shop, 1 stable, corral, wagon-house, ice-house, &c.

The company's track is four miles long from the main line of Union Pacific Railroad to the mine, including side-tracks, spurs, and switches.

Three furnaces are used for ventilation. There are also 3 wooden chimneys used for the same purpose.

The company employs 225 Chinese miners and laborers; 40 white miners; 25 white foremen and laborers; 15 white engineers and mechanics—total, 305.

Statement of coal shipped by Wyoming Coal and Mining Company during the year 1872.

Months.	Where shipped from.					
	Carbon.		Rock Spring.		Evanston.	
	Tons.	*Lbs.*	*Tons.*	*Lbs.*	*Tons.*	*Lbs.*
January	2,778	700	3,387	1,500	2,069	200
February	1,507	1,900	1,495	100	1,724	1,900
March	2,172	200	2,464	400	2,222	1,600
April	4,565	1,500	1,777	1,900	2,290	100
May	6,371	1,400	1,451	900	3,270	1,950
June	6,114	1,300	2,206	1,700	1,858	1,200
July	6,414	1,200	2,814	400	754	400
August	6,453	1,900	2,839	1,600	1,726	450
September	4,840	1,900	2,742	500	1,385	1,400
October	5,783	......	3,779	700	3,065	1,400
November	5,946	1,800	3,737	......	1,198	400
December	6,307	1,300	5,941	1,600	1,206	1,800
Total	59,257	1,100	34,637	1,300	22,773	800

CHAPTER IX.

NEW MEXICO.

This Territory has maintained the production of former years, but there is no material improvement to be reported.

At the Moreno mines the enterprise of the Moreno Valley and Gold-Mining Company, mentioned in my last report by Mr. Bloomfield, *i. e.*, the use of steam machinery for the raising and washing of auriferous gravel, has been carried out. The necessary arrangements were concluded in June, and a trial of a week's duration is reported to have given general satisfaction, the clean-up having been about $800 of gold, 881 fine. It is worth nearly $20 per ounce.

The works are placed opposite Spanish Bar, and consist principally of a tramway about 200 feet long and 35 feet high, carrying a track 3 feet wide. The upper end of the tram-way terminates in a platform which can be overrun by a stream of water, and which slopes gently down into a set of sluices. Cars, holding about 40 cubic feet, after being filled in the pit, are pulled up this track by a stationary engine placed on the ground, and are then emptied on the platform. There are also a number of flumes from different directions, conducting water at the proper heights to fill the sluices and work the pumps.

Mr. M. Bloomfield, the originator and manager of the enterprise, furnishes the following particulars of the trial-run: The number of men employed to fill each car was four; number of yards of dirt shoveled by each man per day averaged 15½; number of trips made with two cars, 142 in ten hours. Work was carried on twenty hours out of twenty-four. Two men were required to dump the cars on the platform and to regulate the flow of the dirt into the sluices. The engine, a 12-horse-power, worked with 20 pounds of steam, apparently with ease. The weight of the load, including the weight of the car, is about 6,000 pounds. The height of the car is 42 inches from top of track to top of bed. One car was used from Saturday to noon on Tuesday. Another car was then added, but broke down twice during the week, causing a stoppage of eighteen hours. Excepting the breakage of a car, everything worked smoothly and regularly. The result of the run was a trifle over 50 cents for every cubic yard of dirt worked; judging from the number of men employed during the time, the expenses must have been considerably under the amount produced. After this trial, the company had three cars running day and night. They were in good ground, and though annoyed by imperfect drainage of their claim, they expected to reap a substantial benefit from their undertaking.

I have no later news from the mines than July, with the exception of the general estimate of the production of the district, which is given by my correspondent, together with the amount produced by the placers near Santa Fé, as about $100,000.

Despite the many obstacles against it, the progress of Grant County has been quite rapid; mining-camps are springing up in every direction, and population is gradually increasing. Silver City, the county-seat, is the center of present mining operations. The town is beautifully situated in a charming little valley, flanked on both sides by rolling hills filled with precious metals and covered with timber and grass. It has a population of about one thousand, consisting chiefly of miners and their families, although most of the trades and professions are well represented. Some of the buildings of Silver City will compare favorably with those of large towns in the East. Brick is being extensively manufactured, and that material will be used almost exclusively for building purposes in the future.

The great advantage which Grant County possesses over every other mining country is its superb climate. No extremes of heat and cold are known here throughout the year.

A correspondent wrote to me from the district in June, 1872:

There are but four small mills in this district at the present time and two more are on the road. Three of the mills have been running to their utmost capacity almost constantly, but have not been able to meet the requirements of the district by one-fifth. As a consequence tons upon tons of rich ore are lying in all directions awaiting reduction, and the prosperity of the country is greatly retarded for the lack of sufficient means to develop its immense resources. The shipment of silver bullion from this point alone now averages about 5,000 ounces per week.

It has been satisfactorily proved that the whole country for a radius of two hundred miles is literally filled with mineral. Gold, silver, copper, iron, and lead abound in the greatest profusion, all awaiting capital and industry to bring to light the hidden treasure buried in this vast area of country. Below will be found a brief statement of the product of each of the mills at this place for the week ending June 22.

From this can be formed some idea of the richness of the ore in this locality, which is not surpassed in many other mining-districts on the continent.

Statement showing number of tons of ore worked and value of silver extracted during the week ending the 22d day of June, 1872, at Silver City, Grant County, New Mexico.

	Number of tons.	Mine.	How worked.					Remarks.	Refined silver.
			Arrastras.	Stamps.	Pans.	Barrels, wooden.	Ball pulverizer.		
W. H. Brennan	21	Seneca.	....	5	....	8	...	Engine from Pinos Altos	$2,422 00
Wilson, Wells & Co	5¼	Dexter	2	....	....	3	....		532 60
Wisconsin Mining Co	17	2 Ikes	...	....	2	....	1	Pans, Hepburn & Peterson.	1,050 00
J. U. Stevens	9	2 Ikes	3	....	....	2	....	Engine from Pinos Altos	786 00
By amalgamation									4,790 60
Extracted by furnaces—blast from blacksmith-bellows									2,200 00
Result of week									6,990 60

At Silver City there have been in operation during most of the time two 5-stamp mills, and a Ball crusher of the same capacity. A Howland rotary battery is now running, and two 10-stamp mills are nearly completed.

At Lone Mountain a 5-stamp mill has been running since November, 1872. No roasting-furnaces have as yet been erected in the county, and as most of the ore mined comes under the head either of smelting or base milling ore, the yield has been far less than could have been the case if chloridizing-furnaces had been employed. Smelting on a small scale has been carried on by Mexicans, great numbers of whom are coming from Sonora and Chihuahua. The effect of this immigration has been to cheapen labor very much, the best class of Mexican labor commanding only $1.50 per day; corresponding American labor costs $3—both without board.

A bowlder was recently found on the surface in Lone Mountain district, which weighs 220 pounds, and is estimated to be worth between $1,000 and $2,000. A similar one was found in the same locality about two years ago, which weighed 11 pounds 4 ounces, and produced $177.30 in silver. The average yield of Lone Mountain ore by arrastra process is $150 per ton. Worked by stamps without wasting, its yield has been $35 per ton only.

An extensive deposit of slate has been found in Chloride district, which contains silver in the form of chloride and in metallic leaves. The rock averages from $25 to $79 per ton. It is worked with profit. There are other rich deposits in the district, but they are all very irregular, the country-rock being an unstratified limestone.

At Pinos Altos, during a portion of the past year, the Pacific gold-mine and a few others have been worked with profit, though on a small scale. The placers have not been very productive on account of the drought.

The title to the famous Santa Rita copper-mines is still in dispute. Several notices of relocation have been placed on them during the past year, and there now appears little likelihood of a patent being granted soon to any of the present claimants.

After a careful comparison of the figures of the mill-men, and purchasers and shippers of bullion, Mr. M. J. Ryan, to whom I am indebted for facts in regard to Grant County, estimates the yield of gold and silver of that county during 1872 at $350,000.

The Socorro silver-mines, situated in the Magdalena Mountains, about twenty-four miles from the town of Socorro and twenty from Limitar, have been worked to some extent, and a few experiments have been made to reduce the ores. The district, so far as it has been prospected, extends about twenty miles from north to south, and is about twelve miles in width, the ores being carbonate of lead, bearing silver at the rate of from $30 to $600 per ton, and sulphuret of copper, also rich in silver.

The most prominent carbonate-leads are the Poor Man's, Little Fanny, Grand Tower, Pony, Alpine, Washoe, Sucker, Wolverine, and Sterling.

Messrs. George Way & Co. have tried to reduce some ore from the Little Fanny in a small reverberatory. The result was 1,839½ pounds of lead, containing 66.7 ounces of silver. Much of the lead was lost in the slag. Another reverberatory furnace was erected by Messrs. J. D. Baker & Bro., but it could not be worked to advantage, and the same gentlemen built then a small cupola furnace, the blast of which was supplied from a bellows worked by hand. The result was satisfactory, in so far as more lead was extracted than in the reverberatory. Still, the capacity of the furnace being so small, and no machinery on hand, the furnace cannot be run to an advantage.

Some of the deposits above enumerated, and notably the Poor Man's and Little Fanny, are very extensive, measuring from 30 to 60 feet in width. They are rich in lead, but carry not much over $30 per ton in silver.

The ores of the sub-district of Corona del Pueblo contain little lead, but they are richer in silver than those of the carbonate series of mines above spoken of. Assays so far made vary from $25 to high up into the thousands per ton, and all ores carry some copper. The mines are as yet little developed.

CHAPTER X.

ARIZONA.

Mining interests generally look more hopeful in this Territory than at any time for the last ten years; and if the Apache question can be finally settled in favor of the miner, as it bids fair to be soon, the country will, by the time of the advent of the Southern Pacific Railroad, be in a forward state for a large and permanent production of the precious metals.

During the last year the yield of the Territory has fallen off considerably, principally on account of the troubles of the Vulture mine, but the activity in several new silver-districts promises to make up for this, as soon as the preparatory developments of the mines have progressed sufficiently. I estimate last year's product as follows:

Gold from Vulture mine	$150,000
Gold from placer-mines and arrastras	300,000
Silver in bullion and ore-shipments	175,000
	625,000

I have again to thank Mr. John Wasson, surveyor-general of Arizona, for notes in regard to the mining industry of the Territory; and Messrs. T. J. Bidwell, of Yuma Country, W. F. Henning and W. H. Hardy, of Mojave County, have kindly furnished information in regard to their several districts.

The Planet mine, on Williams Fork, owned by the Planet Mining Company, and operated by the same, keeps about twenty men at work continually, and has shipped from 100 to 150 tons each month to San Francisco. The mine pays now, and has always paid. It carries copper-ore of a high grade.

The Constancia mine, about fifteen miles from Ehrenberg is owned and operated by the Constancia Mining Company, Charles Borger, superintendent. During the past year they erected a 10-stamp mill. They have three shafts in the mine, over 150 feet deep each, in which a ledge of about 4 feet in width is developed, paying from $15 to $25 per ton; at latest accounts about $18 in gold. Cost of mining and milling, from $6 to $8 per ton. Work is going on now.

In Castle Dome district, Captain Polhamus & Co. are sinking on the Flora Temple mine. They are now down about 200 feet, and shipping about 50 tons of ore per month. They are mainly laboring to develop the actual worth of the mine, although the receipts from sales of ore defray expenses. The ore is argentiferous galena.

William P. Miller & Co. are operating on a mine near the Flora Temple on same kind of ore. They ship about 150 tons per month, and are making money, and work is going on now.

The Vulture mine, near Wickenburg, has been idle for over six months. Endeavors are being made to procure capital to take water to the mine, with what success I do not know. The product of the mine is about half that of former years, or about $150,000. William P. Smith & Co. are putting up a 10-stamp mill on the Hassayampa, about fifteen miles below Wickenburg, and will soon commence crushing ore from their claims, which adjoin the Vulture Company's ground. They express great confidence of success. Mr. Peter Taylor, formerly mine-superintendent of the Vulture, is an interested party with Smith & Co.

in the present operations, and is convinced that their ground, as well as the Vulture, will pay well under proper management.

In Yavapai County no mills were put up in 1872, and I believe none but the Vulture ran at any time. Several arrastras have been kept going in Bradshaw district, and patents for eight mines therein, mainly on the Tiger lode, have been applied for. The placer-mines in Yavapai have been worked with average success in most of this district, and their yield is not less than in the previous year. In the extreme southeastern portion of Yavapai County a copper-district of great value has been discovered, and four surveys for patents to as many mines, and also one mill-site, have recently been made. A Detroit company stand ready to pay a large price for them and to commence work as soon as patents issue therefor.

In Pima County much prospecting has been done, and some new discoveries have been made. The necessary work is now being done to procure patents. Two mines have been patented, and more applications will soon be made. Returns have just been received of the working results of a lot of ore sent to San Francisco some months ago by Samuel Hughes, of Tucson; the ore coming from a mine located about thirty-five miles southwest of that town. The ore contains mainly copper, and purchasers offer for such ore $200 per ton, laid down on the San Francisco wharf.

The Mowry mine is now being worked by some men who have put an engine thereon, and I understand with good results. The parties, being "jumpers," keep very still, waiting for the time to expire which is given by law of Congress to owners of mines to do the necessary work on their claims or forfeit them.

Ore from Pinal district, near Florence, (about 5 tons,) was sent to San Francisco last summer, and yielded about $200 per ton, The parties were, however, driven away from the mines by Indians. They intended to commence work again soon, as they were certain of profits, judging from the 5 tons worked in San Francisco.

Wallapai or Hualpai district.—During the year 1871 little else was done by miners of this district than running over the hills and locating mines, and doing what work on each claim was necessary to hold it in accordance with the local laws of the district. Early in 1872 a 5-stamp mill (wet crushing) was completed; there were also two furnaces completed, Both mill and furnaces were owned and managed by men of but little experience in this matter; the mill would save only from 30 to 50 per cent. of the gold and silver, and the furnaces were a total failure.

In December, 1872, a third furnace was completed, and managed by an expert. This furnace has been a success; yet there is a question now about good smelting ores, as experience proves the ores of this district to be base milling ores, which require chloridizing, roasting, and amalgamation.

Within the past year there have been shipped to San Francisco about 120 tons of ore, averaging in value $600 per ton. Of gold and silver bullion there have been shipped about $35,000, and of base bullion about 10 tons. As the greater part of this is now in transit, the value is not yet known, but it is estimated at $600 per ton, or worth $6,000 in gold and silver. During the years 1871 and 1872 work was generally done on the surface, and until July of the last year but few shafts were down lower than 30 feet. It was found that in sinking from 20 to 40 feet most of the gold, silver, and lead ores gave out, and the ledges turned to iron sulphurets or arsenides. At water-level but little ore was found of value. Miners became discouraged, and many left the district in disgust. During the latter part of the year 1872 some of the more sanguine miners commenced sinking below the water-level. Silver-ores soon came in, and there is not a single instance reported where a valuable mine was not found within 10 feet of the former stoppage. The ores are generally antimonial or ruby silver, with sulphurets and the native metal.

At the present time miners are laboring under a greater disadvantage than ever before, although they are certain that they have valuable mines. It will require machinery to handle the water, and this requires capital. Some companies have been incorporated in San Francisco, and help is expected from that city. Until that is forthcoming, rapid progress will certainly be impossible.

There have already been located in this district 2,700 claims for companies, and about 1,000 of them are on separate ledges, the rest being on extensions. Several other new districts have been located within the past year. The Maynard district, located about ten miles south of the Wallapai district, is one of them. The Cedar district, about sixty miles south of the Wallapai, is another. Both districts are promising well. Preparations are being made for shipping ore from them at an early day. Preparations are also being made for putting up a mill and roasting-furnaces in the Wallapai district. When this is done, the district will have a better chance. The most valuable mines are located ten miles north of the original discoveries in the southern part of the range. The locations are scattered within a distance of fifteen miles. There are at the present time about twenty-five shafts, on as many different ledges, below the water-level, and the prospects, so far as richness of the mines is concerned, are truly flattering. But most of these mines will be compelled to suspend operations soon, on account of too much water. Mr. Hardy, at the end of the year, was prospecting the Fairfield, and three shifts of three men each, besides two men to assist outside, or eleven men at $4 per day, were employed. The shaft was down 150 feet, 20 feet below water-level, and 200 gallons of water per hour had to be drawn up by hand. It is seen from this that under such circumstances profitable mining is difficult, even on veins carrying as rich ores as those of Wallapai.

The following data in regard to individual claims are furnished by Mr. W. F. Henning, a member of the legislature of Arizona Territory:

Little Tiger, situated at Stockton, shaft over 100 feet deep. At bottom, vein 2½ feet wide. Very rich in native silver, ruby silver, and black sulphurets.

Cupel, near the former mine; about the same amount of work is done here as on the Little Tiger. The vein exhibits about the same quality and quantity of ore. Work has been recently suspended on account of over-abundance of water.

Empire, situated in Empire Cañon, near Chloride, has two shafts of 100 feet each, and some drifting has been done; ledge-matter is several feet wide; exhibits a large body of rich sulphuret-ore. Work was recently suspended on account of too much water. These mines all belong to the Cirbat Consolidated Company, of San Francisco, and the work has been done chiefly during the past summer. Hoisting-works for each of them are expected from San Francisco in the course of one or two months, and work will then be resumed.

Sixty-two, situated near Stockton, and owned by an unincorporated company. During the past summer several shipments of ore have been made to San Francisco, at a cost of nearly $100 per ton, including mining, transportation, sampling, &c. The returns left a handsome profit for the owners.

Lone Star, situated at Mineral Park. During the past year about 150 tons have been worked in a 5-stamp mill. They yielded about $7,000. Recently, work was resumed in an old shaft, and at a depth of 50 or 60 feet a body of ore, carrying large quantities of native silver and black sulphurets, was uncovered. The mine is owned by a company incorporated under the laws of Arizona. Work is still progressing; water plenty in the mine.

The Keystone has two shafts, about 60 feet deep each. It is situated at Mineral Park; two feet ledge, chloride of silver on top. Just below water-level, a heavy body of ore, carrying black sulphurets, native and ruby silver, has been uncovered in each shaft. The top ore, worked in the 5-stamp mill at Mineral Park, yielded $200 per ton, and not more than 50 per cent. was saved in the process. Several tons, shipped to San Francisco, yielded $600 per ton. Ore from the bottom of the shafts assays as high as $4,800 per ton. The mine was recently sold in San Francisco. Hoisting-works are to be put up about March, 1873, and work will then be resumed.

Besides the mines above mentioned, there are probably one hundred other locations, nearly as well developed, and giving promise of permanency and great value. Among them are the Todd mine, the Washington, the Independence, the Dexter, the Vanderbilt, the New Era, the Washington No. 2, the Donahue, the Treasure Hill, the Valley View, the Ida, the Bobtail, &c.

PART II.

METALLURGICAL PROCESSES.

[illegible] IN CALIFORNIA

[illegible] The ore [illegible] the glory-hole [illegible] stopes. [illegible]

The rock is generally [illegible]

The present [illegible]

[illegible]

3. [illegible]

operation.

The [illegible]

[illegible]

[illegible]

CHAPTER XI.

TREATMENT OF GOLD-BEARING ORES IN CALIFORNIA.

The gold-bearing ores of California* consist chiefly of quartz—in but a few instances of slates. The gold is usually disseminated through the rock in small metallic particles, sometimes scarcely visible to the naked eye. Sulphides of iron, lead, copper, and zinc, and arseniurets, are frequently associated with the gold; but these rarely constitute more than 6 per cent. of the rock, and average, perhaps, only 1 per cent. Galena is considered the most favorable indication of the presence of gold in the quartz. Most of the gold contained in the sulphides appears to be in the metallic state, as the greater part can be separated by a grinding operation in a porcelain mortar, combined with a careful washing off of the slimes. To extract the gold from these ores, they are subjected at present to a mill process, which, with necessary machinery and apparatus, will be described in these pages.

The rock is generally delivered at the mill free from any large amount of waste. The small quantity left by the miner is thrown aside at the mill. It consists, according to the mineralogical character of the walls of the vein, chiefly of talcose, chloritic and clay slates, serpentine, diorite, and granitic rocks in general.

The treatment of the quartz comprises the following operations:

1. Crushing it by means of rock-breaker and stamps, and amalgamating the freed gold, outside of the battery, by various contrivances.
2. Concentrating the freed gold lost by the above methods, with the auriferous sulphurets.
3. Extracting the gold contained therein by chlorination or pan-amalgamation.

The process of amalgamation in battery on copper plates is also practiced in California, but is gradually displaced by the above mill operations. It is described in the Mining Commissioner's Report of 1870, on the treatment of Colorado ores, and will be omitted here.

I.—CRUSHING AND FIRST AMALGAMATION.

Previous to a final pulverization in stamp-mills, the quartz is broken to a small and somewhat uniform size by rock-breakers. (For a description of Blake's rock-breaker see Mining Commissioner's Report of 1870, page 648.) The jaws are usually set from 1 to 1¼ inches apart, opening out to 1½ to 2 inches. The shoes are of white iron, cast in sand and slowly cooled. The rock-breaker discharges upon a platform in front of the feed side of the battery.

(*a.*) *Arrangement of the battery of a stamp-mill.*—For the purpose of erecting a battery a pit is sunk to the solid bed-rock, the bottom of which is nicely leveled off for the reception of the mortar block, *a*, *a*, (Plate I,) having a section of 3 by 5 feet, and rarely exceeding 10 feet

*This chapter is the work of Mr. G. F. Deetken, of Grass Valley, a leading metallurgist of California, the introducer into the State of the Plattner chlorination, and a very acute and trustworthy observer. His analysis is based upon practice at the Grass Valley Mills, considered, as a whole, the best system in use in California.—R. W. R.

in length. It is set on end, and consists of two logs 36 by 30 inches each, firmly bolted together with 1¼-inch bolts, and also connected with dowels 18 inches long, and of a section of 8 by 8 inches, introduced 2 feet from each end. The horizontal section of the pit leaves usually a space, *m*, *m*, of 24 inches all around the mortar-block, which is filled with hydraulic concrete up to the level of the floor of the mud-sills, from 4 to 5 feet below the top of the mortar-block.

After carefully leveling and planing the top of the block, it is ready for the reception of the iron mortar, which is fastened to the block by means of six 1¾-inch key-bolts, *k*, *k*, Fig. 1, passing through the bottom flanges of the mortar.

The wooden battery frame which carries the cam-shaft is independent of the mortar-block. The wood-work is usually of sugar-pine. The mud-sills, *l*, *l*, 24 by 24 inches, usually 3 or 4 in number, are laid parallel with the cam-shaft. The sills on each side of the mortar-block are secured by iron bolts passing through the hydraulic concrete, with an iron anchor-plate underneath. Cross-sills, *p*, *p*, 18 inches wide by 24 inches deep, and 18 feet long, at right angles to the mud-sills, carry the main posts, 12 by 24 inches in section, to which the cam-shaft is attached. They are let and keyed into the posts in the manner represented in Fig. 1.

The mortar, Plate II, Fig. 1, consists of a single casting 3 feet 9 inches high. The bottom is usually 3 inches thick, and sometimes more. The walls are vertical outside, 1½ to 1¾ inches thick on the bottom, tapering to ½ inch on the top. The bottom flanges for fastening the mortar to the block are 2½ inches thick and 4 inches wide. In order to prevent the premature destruction of the mortar near the dies, cast-iron plates, *j*, *j*, 1 inch thick and about 24 inches high, are placed all around the inside as a lining, which can be replaced when worn out. Being wedge-shaped at the lines of contact with each other, they do not need any additional fastening.

On one of the long sides of the mortar, opposite the discharge opening, *d*, the feed slit, *n*, is situated. It is from 6 to 12 inches below the top of the mortar, and 3 inches wide, extending across the whole width of the mortar. A rim of 3 inches around the discharge opening, *d*, is planed off for the purpose of receiving the sieve frame, Plate II, Fig. 3, and the splash-box, Fig. 2, both of cast iron, which are bolted to it. The horizontal mortar-bed receives the dies, *t*, the bottom or foot-plates of which fit almost close to the sides of the mortar, lined with the plates *j*, *j*.

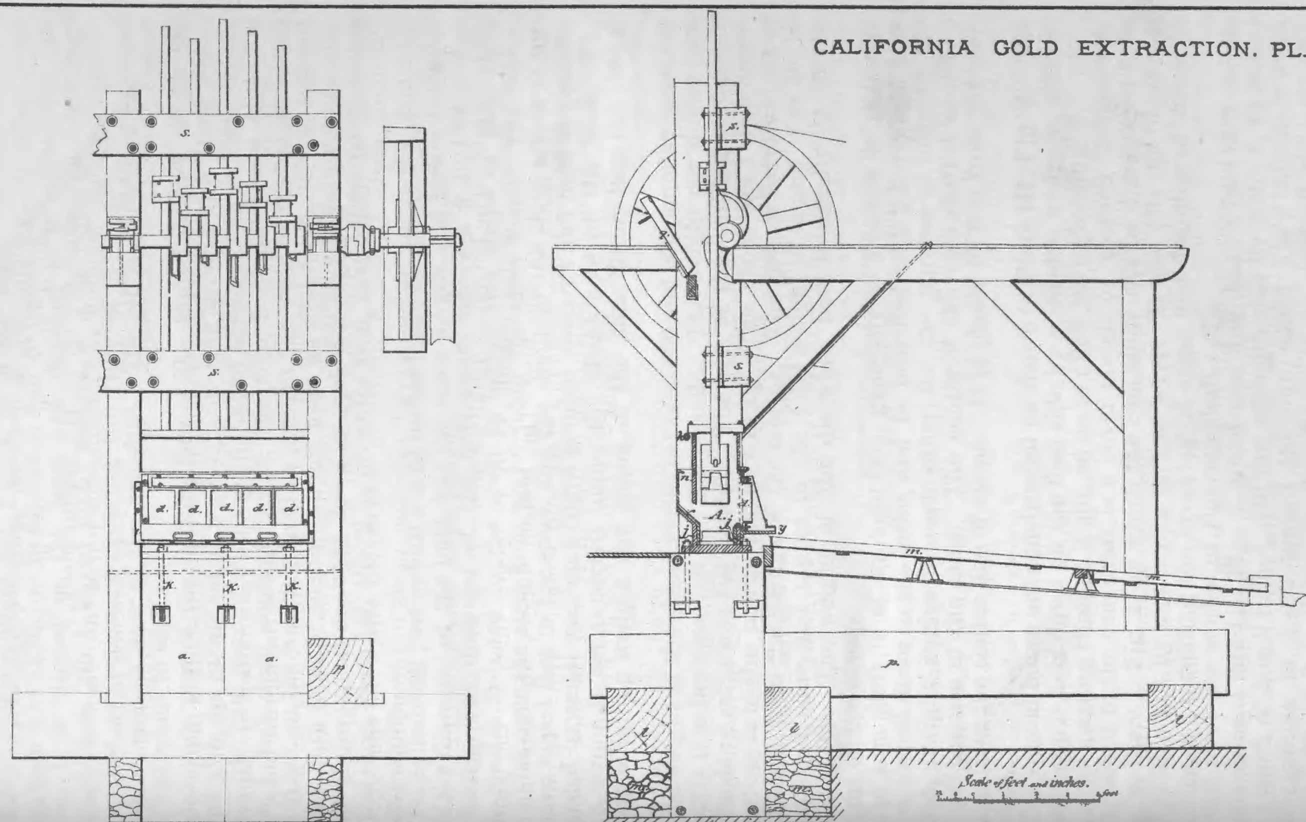
The foot-plate, *a*, of the die, Plate III, Fig. 1, has a rectangular form, the corners of which are cut off for the purpose of facilitating its removal in cleaning up the battery. It is 1½ inches thick, and carries a cylindrical part, *b*, 3½ inches high, the diameter of which is usually 10 inches. When worn down to the foot-plate it is replaced with a new die. Each battery consists of 4 or 5 stamps of uniform weight when new. The stamp consists of four cylindrical parts, the head or boss, stem, tappet, and shoe.

The head, Plate III, Fig. 3, of the same diameter as the shoe, is from 15 to 20 inches long. On its lower face it is provided with a conical recess, *f*, 6 inches deep, for the reception of the shank of the shoe, and a tapering core, *d*, for the foot of the stem.

For the purpose of facilitating the detachment of the shoe and stem in case of breakage, channels, *m*, *m*, *o*, *o*, are provided for the introduction of wedges below the same, passing radially through the boss.

The stem, *a*, Plate III, Fig. 4, is of wrought iron, and varies in length

CALIFORNIA GOLD EXTRACTION. PL. 1.



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from 13 to 15 feet, and in thickness from 3 to $3\frac{1}{4}$ inches. It is turned true upon the lathe. Six inches of both ends are turned off somewhat tapering, so that either end can serve as the foot.

The tappet *r r*, Plate III, Fig. 4, is in the main a cylinder of cast-iron, from 9 to 11 inches in diameter, and 10 inches long, with a central bore. It is slipped on the stem and fastened to it by means of a wrought-iron gib, *b*, keyed up by wedges, *n n*, at right angles to the gib. The projection *o o* prevents the slipping of the gib, which would cause an uneven wear of the cam-face. The gib is introduced into the mold previous to casting.

As every part of the working-face of the tappet is worn off by the cams with the exception of a concentric ring around the stem, $\frac{1}{2}$ inch wide, (the cam passing within $\frac{1}{2}$ an inch of the stem,) an annular recess, *m m*, 1 inch deep, concentric with the stem-bore, but 1 inch larger, is bored out on the working-faces to prevent the wear of the edges of the cam. Both faces of the tappet are used as working-faces. When the faces of the tappet are worn down an inch it is replaced with a new one.

The shoe, Plate III, Fig. 2, is of white iron, cast wholly in sand and slowly cooled.

The cylindrical part or butt *a* is $5\frac{1}{2}$ inches long; the shank *b*, having one-half the diameter of the butt, has the same length, and tapers conically upwards. The diameter of the butt varies between 9 and 11 inches. The head is fastened to the stem by laying two strips of thin cloth crosswise over the stem-hole, and driving the stem home. The tappet is then keyed fast to the stem, and the shank of the shoe, which is surrounded by small wooden wedges pointed upwards and held in position by a string, is set vertically under the shank-hole of the boss. The stamp in falling wedges the shank of the shoe firmly into the shank-hole.

The weight of the stamp varies between 600 and 900 pounds; most frequently it is between 750 and 850 pounds. The weight per square inch crushing surface is $10\frac{1}{2}$ pounds. The sum of the working surfaces of the shoes is to the mortar-bed as 1 to $1\frac{3}{4}$. The shoes are 1 inch apart, and 1 inch from the linings of the mortar. The proportional weight of stem, head, shoe, and tappet to the total weight of stamp is as 40 : 29 : 16 : 15 : 100. The weight of the die when new is usually $\frac{15}{100}$ of the weight of the stamp.

The cam-shaft is of wrought iron, generally of 5 inches in diameter when turned down in the lathe, and is provided with 2 key-ways, 1 by $\frac{3}{4}$ inch, at right angles to each other, for the purpose of insuring the normal position of the cams. The center of the cam-shaft is usually 5 inches from the center line of stems. It is placed $9\frac{1}{2}$ feet from the mortar-bed.

The journal-boxes are constructed as shown in Plate III, Fig. 6. The journal-cap is held down on the feed-side by a wooden wedge, *a*, secured by a bolt passing through a slit, so as to allow its tightening.

Attached to the cam-shaft is a bevel clutch or toothed flange-coupling, *v*, Plate I, Fig. 1, by which the cam-shaft can be disengaged from the pulley-shaft by means of a fork or lever. It also fills the important function of preventing the breaking of cams and bending of stems in case of a reverse motion of the cam-shaft.

The cams, Plate III, Fig. 5, are of cast iron, have a face of 3 inches by a depth of 1 to 2 inches, and are strengthened by a rib, *b*, $1\frac{1}{4}$ inches thick, gaining in depth toward the hub, which has a thickness of $2\frac{1}{2}$ inches. The hub is always on the off-side of the stem, allowing thereby a close approach of the cam-shaft to the stem center. Two cams, standing diametrically opposite, Plate III, Fig. 5, are always attached to one hub, which is strengthened by a wrought-iron band. The cam-curve is an involute of a circle, slightly modified at the end, as the point of application of the lifting force is removed at the end of each lift from the center line of stems to the end of the working face of tappet. Fig. 5 shows the construction, *a n* being the distance from center of cam-shaft to center of stem, *n a* the length of the greatest lift *plus* distance from center of cam-shaft to the first front of contact of cam with tappet. The curve *b a* is changed to *b a'*; *a a'* is in this case $\frac{3}{8}$ of an inch.

The lift varies between 8 and 11 inches, generally it is 10 inches, with a corresponding cam curve of $21\frac{1}{2}$ inches. The friction between cam and tappet causes the stamp to revolve, insuring an even wear of the shoe.

The mortar, Plate I, Fig. 1, is covered by two 3-inch planks, which are held in position by bolts, *m m*, attached to the side of the mortar. They join in the center line of stems, and are provided with semi-cylindrical grooves for the stems.

The guides, of sugar-pine, are 15 inches deep and 10 inches broad. They are firmly bolted to the uprights carrying the cam-shaft. The center of the upper guides is 3 feet 4 inches above, and the center of lower guides 4 feet below, the center of cam-shaft. A wooden lining, consisting of two 3-inch planks, 15 inches deep, with semi-cylindrical grooves to fit and inclose the stems, is bolted on to the main guide-timbers. The grooves are lubricated with tallow. The whole arrangement is shown at *s*, *s*, Plate I, Fig 1.

The discharge or sieve frame, Plate II, Fig. 3, is of cast iron, and divided into 5 panels, $11\frac{1}{2}$ by 15 inches.

The screen, of nearly the same size as the panel, but exceeding it about $\frac{1}{2}$ inch all around, is bolted tight to the panels by means of a cast-iron frame, Plate II, Fig. 4, 3 inches deep. A blanket-binding is sewed around the edge of the screen to make a tight joint.

The screen, Fig. 5, is made of Russia iron, weighing $\frac{8}{10}$ pound per square foot. The rectangular holes, punched by machinery, are $\frac{3}{8}$ of an inch long, and wide enough to allow the passage of a No. 6 sewing-needle. The holes are $\frac{3}{8}$ inch apart horizontally, and their centers $\frac{5}{8}$ inch apart vertically, leaving a space of $\frac{1}{4}$ inch between them. The turned-up edge faces the inside of the mortar. When the turned-up, tapering edge is worn down, the holes are closed or made smaller by pounding the edges with a mallet.

The splash-box, of cast iron, Plate II, Fig. 2, provided with three discharge-spouts, is tightly bolted to the mortar with the aid of blanket-packing.

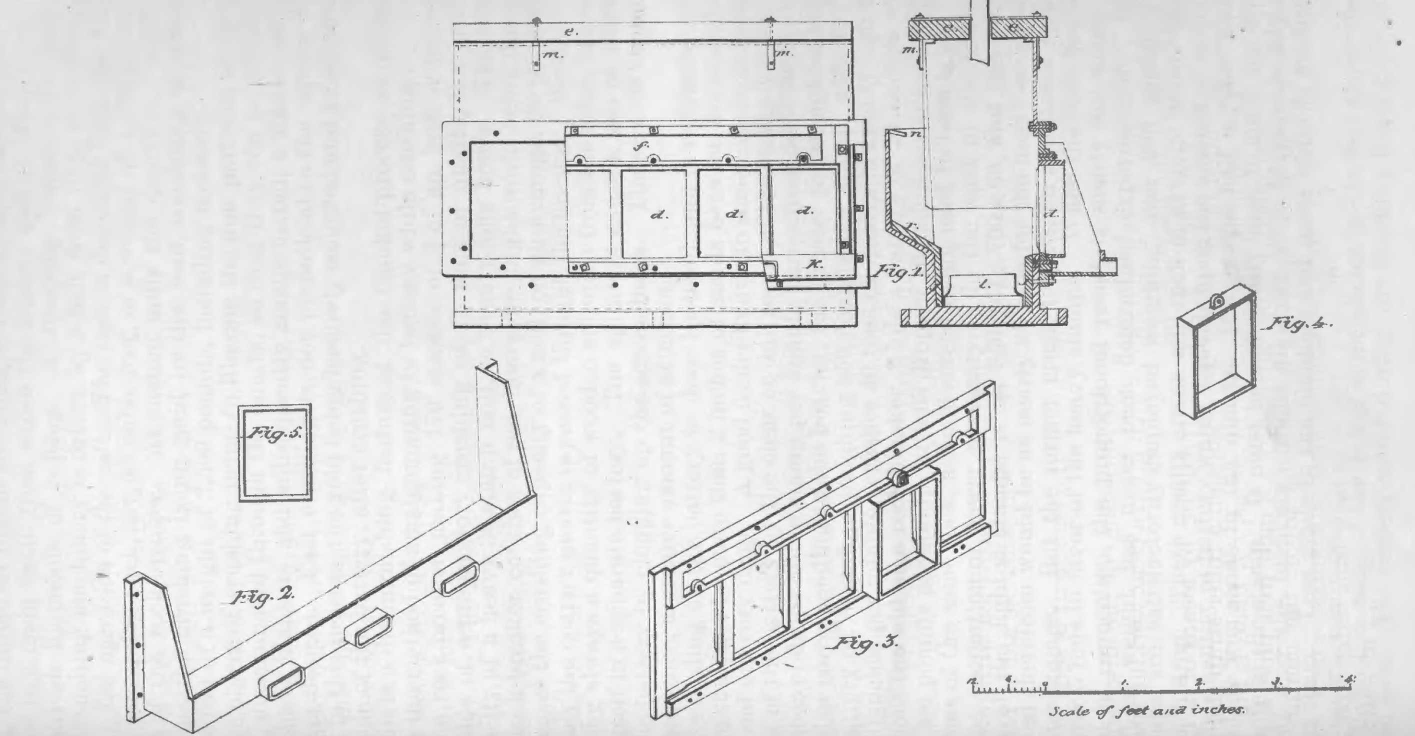
The manner of bracing the uprights of the cam-shaft is seen in Plate I, Fig. 1.

As the strain of the belt is in the direction of the discharge, no bracing is needed on the feed-side, which gives a clear working space on the feed-side of the battery.

The stamps are usually raised for repairing by means of a tackle, which is suspended in the line of the stamps on a roller strap sliding on a beam. They are held in suspension by props, *f f*, Plate 1, Fig. 1.

The water is supplied to the battery by a 3-inch iron pipe, *h*, (Plate I, Fig. 1,) passing over the feed-slit near the top of the mortar. The vertical discharge is through small round apertures, which can be closed by wooden plugs. There is also a $1\frac{1}{2}$-inch iron water-pipe along the discharge-side of battery for increasing the quantity of water over the blanket-sluices.

CALIFORNIA GOLD EXTRACTION. PL. 2.



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The power is usually derived from high-pressure steam generated with wood, the universal fuel of the mills, or from a water-wheel. It is transmitted to a main shaft, from which the battery and all other machinery are driven by means of belting. A 10-stamp battery with auxiliary amalgamating machinery is driven by a belt from 10 to 13 inches wide.

(*b*.) *The operation of the mill.*—The rock is delivered from the mine in cars, containing each, say, 13 cubic feet, of a weight of 1,300 pounds, in front of the rock-breaker. At custom mills the quartz is delivered in wagons, the crushing being paid by the load, consisting of about 35 cubic feet of a weight of 3,500 pounds, including moisture.

The object of crushing being to liberate the fine particles of metallic gold, disseminated through the quartz, so that they can be collected or caught by blankets and subsequently amalgamated, a fine crushing is always desired. Fast crushing is not prejudicial to the saving of the gold in this process, the gold being leisurely collected and amalgamated, outside of the battery, after crushing.

This is a distinguishing feature of the blanket-process as compared with the method of amalgamating in battery while crushing.

The rock-breaker, making 170 strokes of $\frac{3}{4}$ of an inch a minute, is capable of a preparatory crushing of 72 tons of quartz, the crushing capacity of a heavy 30-stamp mill, in twenty-four hours. The shift at the rock-breaker consists of ten hours, no night-work being done. It increases the crushing capacity of a mill, on an average, 20 per cent.

Only the coarser quartz is passed through the breaker; the finer, containing always a quantity of wooden splinters from the mine, is crushed by itself in a separate battery. The splinters cause a loss of efficiency of the battery by clogging up the screen-holes. The screens require, in consequence, a greater amount of attention.

The feeding of the battery is done by hand, and is regulated so that there shall not be more than 2 inches of sands between die and shoe at the end of every drop. A good feeder knows to some extent the requirement of the battery by the clear or dull sound of the stamp-stroke. The number of drops of the stamp per minute varies from 50 to 70, the lesser number corresponding to the heavier, the greater to the lighter stamps. A battery of 20 stamps weighing 850 pounds per stamp, with 61 drops of 10 inches per minute, crushes 40 tons of quartz in twenty-four hours without the aid of a rock-breaker, while a battery of 20 stamps weighing 700 pounds per stamp, with 68 drops of 10 inches per minute, crushes 32 tons of the same rock, a No. 6 screen being used in both trials.

The proportion of power necessary to do the work of the heavier to that of the lighter stamps is as $850 \times 61 : 700 \times 68$, and the work expected therefrom would be as nearly 35 tons for the heavy to 32 for the lighter stamps. But the former crush 40 tons, an additional quantity of over 5 tons in favor of the heavy stamps. When the rock-breaker is used in connection, the proportional result is nearly the same. The limit of weight has never been determined experimentally, though stamps are satisfactorily employed weighing over 900 pounds with a 10-inch drop. These results are on mill-rock of average hardness.

The quantity of battery-water depends upon the amount of sulphurets or black iron-sands in the quartz. It averages half a cubic foot per minute to the stamp. It must be sufficiently large to move the crushed sands over the blankets without allowing them to permanently settle upon them. Less grade to the blankets and more water is preferred to the reverse condition.

The bottom edge of the lower screen-holes is 3 inches above the dies when new. The battery-water during the crushing has a wave motion along the screens. The water has its natural temperature while passing through the battery and over the blankets. Further on, when passing through the rubbers and copper plates, it is warmed somewhat by the influx of hot water from the amalgamators.

After leaving the battery the crushed sands are distributed by the spouts *g g*, (Plate I, Fig. 1,) on two sets of sluices, *m m*, covered with woolen blankets. There are three sets of blanket-sluices for every 4 or 5 stamp battery. Each set consists of two sluices made of $1\frac{1}{4}$-inch planed sugar-pine boards, one $10\frac{1}{2}$ feet long, the other $5\frac{1}{2}$ feet, with a drop of 3 inches between them. They are from 16 to 17 inches wide, with sides of 2 inches in the clear, and have a grade of $\frac{3}{4}$ inch to $\frac{7}{8}$ inch to the foot.

The upper sluice *m* carries two strong blankets, 21 inches wide and $5\frac{1}{4}$ feet long each, the upper overlapping the lower blanket about 6 inches. The lower sluice *m* carries only one blanket.

The blanketing is manufactured for the mill-trade, shorn on the lower side, with the nap on the upper. It weighs $\frac{8}{10}$ of a pound per running yard.

The flow of the pulp is over two of the three sets of blanket, the third one being kept in reserve for use when washing the blankets of either of the others. The upper blankets, which catch the bulk of the gold, are washed every twenty minutes, the lower one every two hours. The washing is performed in two tanks, used alternately. They are made of $1\frac{1}{2}$-inch planed pine boards, have a horizontal section of 3 by 4 feet, and taper toward the bottom. They are $2\frac{1}{2}$ feet deep, and are provided with inclined shelves for the blankets and plug-holes for the discharge of water after the settling of the blanket-washings. The water used in these tanks is warmed in a heater by the waste steam.

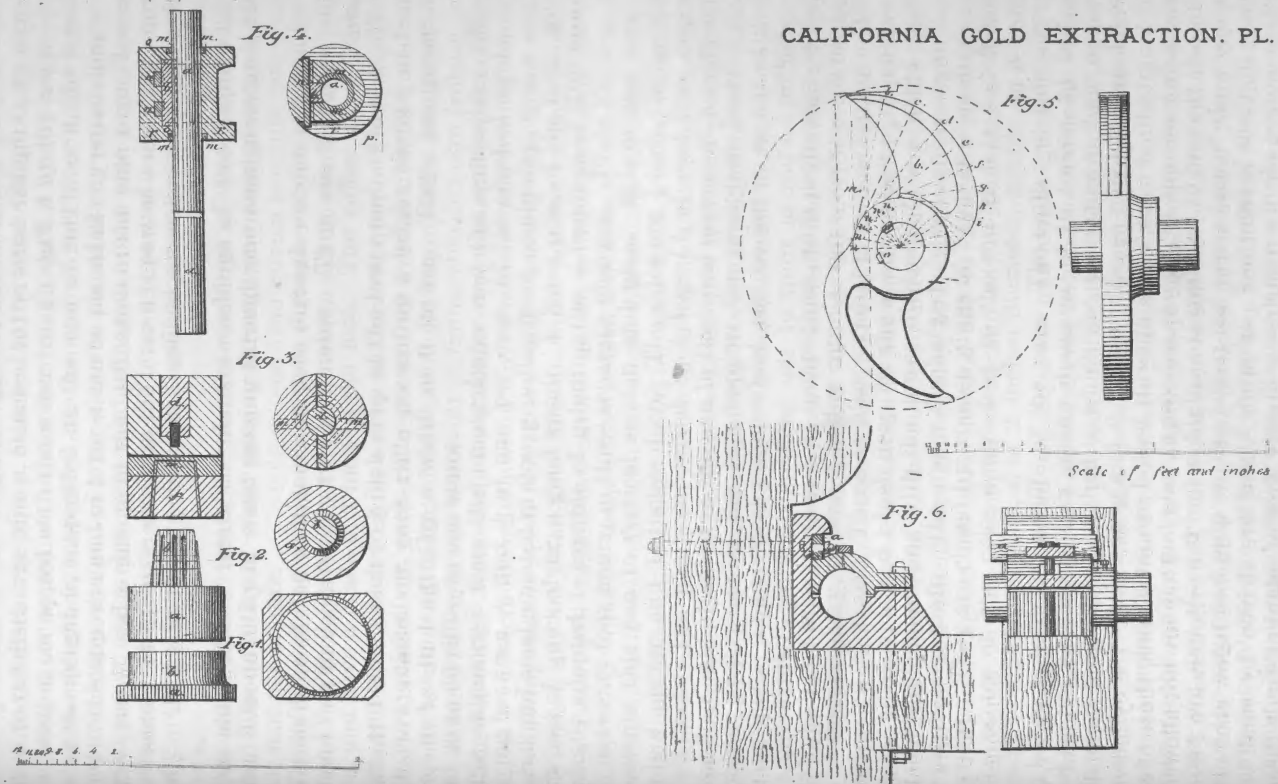
The quantity of crushed sands passing over the blanket-sluices of a 5-stamp battery is 12 tons in twenty-four hours, while the blanket-washings, consisting of gold, sulphurets, iron, and quartz-sands, vary considerably in weight with the percentage of the metallic contents of the rock. The average quantity of dry blanket-washings may be estimated at $12\frac{1}{2}$ per cent. of the rock crushed. They are introduced by the blanket-washer into a box in front of the amalgamators, from which they are swept gradually into the same by a current of clean, heated water of a temperature of from 100° to 130° Fahrenheit.

The amalgamator* (Plate IV, Fig. 1) consists of two hollow cylindrical troughs, *t t*, 17 inches long and 4 inches to 5 inches deep, of wood or iron, which are filled with pure quicksilver, over which the blanket-washings are directed. The gold being specifically heavier than the quicksilver, will sink to the bottom, with the exception of that part which is attached to the quartz or sulphuret, and is, consequently, buoyed up.

The floating skimmings are agitated by wooden cylinders, *c c*, of 8 inches diameter, suspended parallel to and over the center line of the trough, and provided with radial arms of $\frac{1}{4}$-inch round iron, the ends of which are slightly curved. These arms are set along the cylinders in 12 longitudinal rows, containing alternately 8 and 9 arms, those of each row being set opposite the spaces in the next. They are not allowed to dip into the quicksilver, but almost touch it. The cylinders are 2 feet 10 inches apart between the centers, and are 6 inches below each other. They make 60 revolutions per minute, and are driven by small belts. The arrangement for insuring a steady flow of blanket-sands through

*This is the so-called Atwood amalgamator alluded to in my former reports.
R. W. R.

CALIFORNIA GOLD EXTRACTION. PL. 3.



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the amalgamator is shown in Plate IV, Fig. 1. The connecting-rod *m r*, receiving a horizontal movement from the crank *r s*, transfers it by means of the bent lever *m a b* to the ratchet *b d*, which moves the endless screw *k* by means of the wheel *d*. The endless screw *k* gives a rotary motion to the discharge-pipe *p*, attached to the water-trough C, by means of a lever, *n*, connected with the water-trough shaft *o* by the rod *j*. By raising the weight *w*, suspended at the end of the lever *n*, the female screw at the opposite end of lever *n* can be placed at any point along the endless screw, and a change in the inclination of the pipe *p* can thereby be effected. The female screw on the lever *n* is part of a nut cut diametrically. On reaching the point *g* the endless screw ceases to move the lever *n*.

One amalgamator treats the blanket-washings of two 5-stamp batteries. The quantity of water passing through one amalgamator is one cubic foot per minute.

The tailings of the amalgamator pass through wooden riffle-sluices, (Plate IV, Fig. 3,) generally two in number. They are 9 inches wide each, and have a grade of 1 inch to the foot. The riffles are 6 inches apart, and from $\frac{5}{8}$ inch to $\frac{3}{4}$ inch deep at the lower end. They are filled with pure quicksilver, each riffle presenting a bright surface of from 2 to 3 inches in length, by a width of 9 inches. There are generally from 20 to 30 riffles to one sluice.

The skimmings from the amalgamator and the quicksilver riffles, varying between $\frac{1}{10}$ and $\frac{1}{2}$ of one per cent. of the crushed sands, are ground and amalgamated in slow-grinding pans, combining, with a minimum loss of quicksilver, a good result. A Knox pan, of the form most generally adopted, is capable of grinding the skimmings of a 30-stamp mill in twenty-four hours, in three separate charges. Plate IV, Fig. 2, represents this pan in vertical section and plan. It is of cast iron, 4 feet in diameter and 14 inches deep. The sides are $\frac{1}{2}$-inch, the bottom $\frac{3}{4}$-inch thick. The pan is supported by 4 legs, *l l*, of cast iron, bolted to the floor, and attached to the pan in the usual manner of a stove-leg. Cast-iron projections on the legs support the cross-bars bearing the driving-shaft. The vertical pinion-wheel can be put in or out of gear by a bevel-clutch, worked by lever.

The pan has a false bottom, *t*, $1\frac{1}{4}$ inches thick, with projecting vertical rim at the periphery, to form a hollow annular space underneath for the introduction of steam. There is also a radial groove in the false bottom, $1\frac{1}{2}$ inches wide and 1 inch deep, for the accumulation of quicksilver and amalgam, connecting with the lower discharge-hole situated opposite the driving-shaft. The upper discharge-hole is 4 inches above the lower one. They are closed by wooden plugs of 2 inches diameter.

The center of the yoke *d*, attached to the muller *m* is keyed to a vertical wrought-iron shaft, *s*, of 2 inches diameter, guided by a cast-iron hollow cone in the middle of the pan. The muller *m* consists of a flat ring of cast iron, of an inside diameter of 10 inches, $4\frac{1}{2}$ inches wide and 1 inch thick, attached to which are four arms at right angles to each other, 12 inches long and 6 inches wide, to which the cast-iron shoes *u*, $1\frac{1}{2}$ inches thick, are bolted through slits *c c*.

Between the muller and shoe, a wooden shoe, *r*, of the exact shape of the iron one, and about 6 inches high, is introduced to prevent the settling of the unground pulp on the latter, the upper face of the wooden shoe reaching above the surface of the pulp. The head of the bolt, passing through the shoe and muller-arm, fits into a recess in the bottom of the iron shoe, and wears off gradually with it.

The yoke *n n*, bolted to the muller, serves for the purpose of raising or lowering it, by means of the screw *f*, resting on the vertical driving-shaft, passing through the center of the pan.

The muller makes from 12 to 14 revolutions per minute, communicated by bevel-gearing from the horizontal shaft, making from 30 to 35 revolutions per minute.

Of skimmings, 100 pounds are charged into the pan, and water is added until the pulp will just adhere to a stick dipped in, without dropping off. After three hours' grinding, the pulp is heated up by steam under the false bottom. The chemicals, introduced at the same time, consist of one cupful of a mixture of equal parts of saltpeter and sal ammoniac. About 5 pounds of mercury are added for every charge, simultaneously with the chemicals, to the amount in the pan, which consist, for the first charge, of from 10 to 15 pounds. After an amalgamation of three hours, the pulp, now very fine, is diluted with water and a few handfuls of caustic lime are added, which is found to aid the coagulation of the quicksilver particles to a great extent. The diluted pulp, reaching within 1 to 2 inches of the top of the pan, is agitated about 20 minutes, after which it is discharged, while the muller is kept in motion, through the upper plug-hole, and, subsequently, through the lower. A bucket, placed in front of the discharge-holes, catches any quicksilver or amalgam which escapes during the discharge. When a clean-up is required, the quicksilver and amalgam, and the small quantity of sulphides yet remaining, are washed into the bucket. Quicksilver is added and the skimmings are removed, which go back into the pan again to be reground. The amalgam is worked by hand; the lumps are broken up; the impurities floating on the surface are removed, and the bright quicksilver is strained through a canvas filter.

The whole of the pulp from the pan is made to run into a large tank and settled. It still retains in many cases a considerable quantity of gold, amounting to as much as $100 to the ton. They are added to the coarser sulphurets, which are subsequently saved by a process presently described in these pages and treated by chlorine process.

The sands, after passing the blankets, and also those from the amalgamators, discharge into the Eureka rubbers, in which the particles of gold are intended to be further cleaned and brightened by rubbing and detached from the sands, while they have an opportunity at the same time to be caught on the amalgamated copper plates of the rubber.

The Eureka rubber, Plate V, Fig. 1, consists of a rectangular cast-iron box, 7 inches deep and 4 feet 8 inches square, provided with a false bottom of cast-iron dies or plates, on which cast-iron shoes, fastened to a wooden frame, receive a rectilinear motion by rods connected with an eccentric. The wooden shoe-boards are covered with amalgamated copper plate.

In preparing the false bottom, wooden boards, *c c c*, Plate V, Figs. 1 and 2, 3½ inches wide and 1 inch thick, of the length of the rubber box, are laid in at right angles to the motion of the rubber frame, leaving a space of 4 inches between them. On top of these the false-bottom plates or dies *d d*, 1½ inches thick, are placed, broad side up, leaving 3 inches between the edges. The spaces *e e* are filled with pieces of soft wood, set up endwise and dressed to fit the false-bottom plates. These wooden blocks are 2½ inches long, 4 inches wide, and from 6 to 12 inches broad. This arrangement is found to answer better for rubbing than a solid cast-iron false bottom. The lower boards *c c* are introduced to give a better hold to the wooden blocks *e e*, after a partial wear of the iron false-bottom plates *d*. These plates are firmly secured by strips of wood, *g g*, 1 inch thick, bolted to the sides of the rubber-

CALIFORNIA GOLD EXTRACTION. PL. 4.

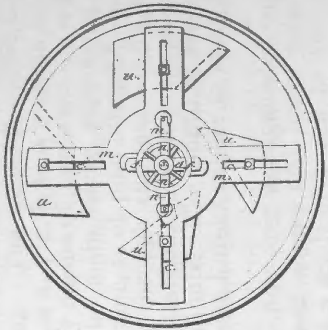
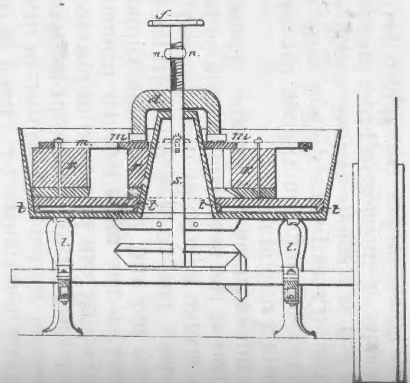


Fig. 2.



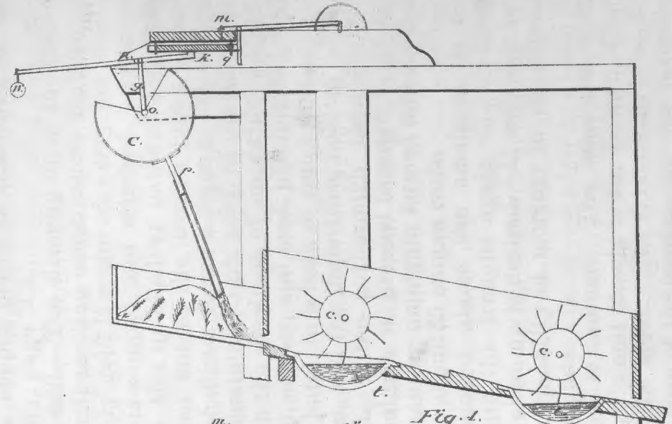


Fig. 1.

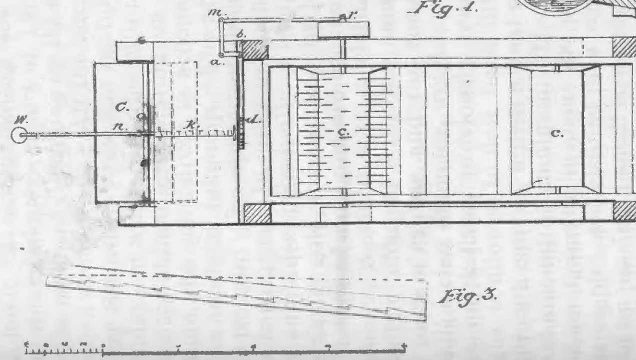


Fig. 3.

Scale of feet and inches.

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box, and fitting into the recesses *f f* on both ends of the bottom-plates.

The construction of the movable rubber frame is shown in Plate V, Fig. 2.

The iron and also the wooden shoes *k k*, which carry the amalgamated copper plates, fastened by iron clamps and bolts, are secured by two cast-iron frames, *l l*. Each of these iron frames is attached each to a piece of timber, *g*, as shown in drawing. The movable rubber frame is attached by four wrought-iron rods, *a a*, Fig. 1, to a wooden frame, *m m*, which can be raised or lowered by means of two screws, *s s*, supported on the main wooden frame. The main frame, supporting the rubber box and the movable rubber-frame, is of pine lumber 6 inches square. The ends of the bolt, passing through the journals *j j*, form the pins to which the eccentric-rod is attached. The number of revolutions of the eccentric-shaft is 55 per minute. The length of stroke of the rubber frame is 4 inches. There is one Eureka rubber to every battery of 4 or 5 stamps.

After passing the rubber the sands flow over amalgamated copper plates. These plates, $2\frac{1}{2}$ feet wide, of soft copper and heavy material, are laid in wooden sluices, which have a grade of $\frac{1}{2}$ inch to the foot. The sides of the sluices are 3 inches high. They are from 20 to 30 feet long. Three inches per stamp is the usual width of the copper-plate sluices.

The mode of amalgamating the copper plates is described in the mining commissioner's report of 1871, page 363.

(*c.*) *The manner of cleaning up the mill.*—The cleaning up of the mill is performed every week. All the amalgamating contrivances are cleaned up every Saturday, while the battery gold is removed every few weeks on Sunday, on which day the mill is stopped and repaired. After removing the skimmings floating on the quicksilver baths of the amalgamators, the quicksilver is scooped out of the trough into a bucket and the amalgam taken up. The amalgam forms a layer in the bottom of the trough. The upper trough contains 95 per cent. of the amalgam in the apparatus. In order to clean the amalgam of impurities consisting of sulphides, principally of iron, copper, and lead, precipitated with the sinking gold, it is worked by hand in a bath of quicksilver. The small lumps of amalgam are broken, and the impurities, floating on the quicksilver, removed with a cloth. After a thorough cleaning, the quicksilver charged with the amalgam is pressed through a strong, thick piece of canvas, and the remaining amalgam formed into balls of about $2\frac{1}{4}$ inches diameter, weighing about 35 ounces each.

The quicksilver, previously removed above the amalgam in the troughs, is allowed to flow back into the troughs again without filtering through canvas, unless a final clean-up is desired. It contains but a small amount of amalgam. The quantity of mercury in the trough of one amalgamator is about 700 pounds.

The ripples are cleaned in a similar manner. The amalgam is removed by passing a small scoop slowly and closely to the bottom, allowing the quicksilver to escape on the sides. The skimmings from the surface of the ripples are added to those of the amalgamators and treated in the pan.

The amalgam on the copper plates is removed by means of a dull chisel. This operation has to be carefully performed so as not to expose the copper. When the amalgam is removed quicksilver is sprinkled on the plates and spread by means of a piece of rubber belting, and the bright mercurial surface is finally washed with water.

The amalgam from the copper plates is freed from impurities by rubbing it in an iron mortar with an addition of quicksilver, while a current of water flowing in and out of the mortar removes the impurities.

All scum, sand, sulphurets, &c., removed from the amalgam by washing, are subsequently treated in the amalgamating pan with the skimmings.

In cleaning up the battery the stamps are removed from the mortar by means of block and tackle. The corner die, provided, near the foot of the cylindrical body, with a wedge-shaped recess for the introduction of the crowbar, is started out first. All the casings are removed by the same means. Dies and casings are raised and taken out of the battery. The battery is cleaned, and the sands are washed through a sieve of 81 to 100 holes per square inch into a wooden hopper, through which they are discharged into a wooden sluice-box 6 inches wide and 6 feet long, and provided with 3 to 4 ripple-boards to catch the particles of gold. The sluice has a grade of 1½ inches to the foot. The resulting coarse sands of the sieve, after removing the iron by hand or magnet, are returned to the battery, while the finer sands which passed through the sieve are treated by pan amalgamation. When poor, they also go back to the battery. The gold taken out of the ripples is freed of accompanying sand and iron by panning and the magnet, and is added to the amalgam.

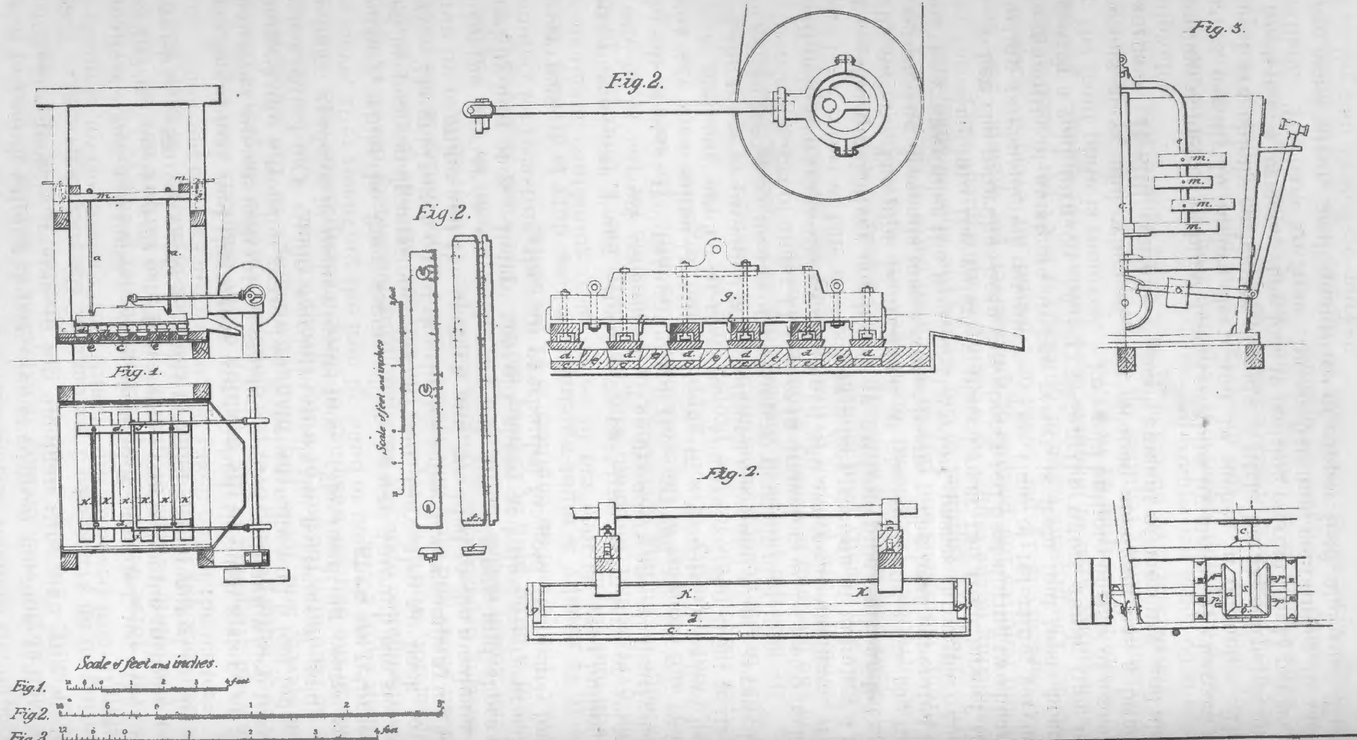
When the mortar is emptied, worn-out dies, casings, and shoes are replaced by new ones. Before the old shoes and dies are returned to the foundery for recasting, they are overhauled for gold, frequently found in the crevices.

The amalgam, containing from 36 to 40 per cent. of gold bullion, is retorted in cast-iron pans, placed into cast-iron cylinders or retorts, supported by brick work on flanges. The cylinders are set nearly horizontal, with a slight inclination toward the rear end, so as to give the quicksilver, condensed on the front cover, an opportunity to flow back to the rear end, surrounded by the fire. The rim of the front plate or cover of the retort is provided with soft fine clay, and firmly screwed to the rim of the retort by means of a clamp to make it air-tight.

A cylindrical retort of about 11 inches in diameter, and 4 feet 6 inches long, will hold five trays of a capacity of 1,350 ounces of amalgam. The fire-grate for a retort of this size is 1 by 2 feet, section of chimney 4 by 8 inches. The quicksilver condenses in an iron pipe, surrounded and cooled by water. The pipe is attached at the rear end near the roof of the retort, and descends into a water-basin. The heat generated by wood on the grate under the front of the retort, passes through a return flue over the same into the chimney placed over the front face of the retort. When the retort has been in a cherry-red heat during two hours, the retorting is considered complete. The time of retorting, varying with the quantity of amalgam in the retort, is from four to six hours, starting with a cold furnace. After giving the retort ample time for cooling, the front plate is removed. The gold bullion consists of a somewhat porous mass, and when of well cleaned amalgam has a bright yellow surface. It still contains a small amount of mercury, and also some sulphides.

The bullion is melted in black-lead crucibles by means of charcoal in air-furnaces usually 16 inches deep and 16 inches in diameter. The fluxes used are chiefly carbonate of soda, a little borax, saltpeter, and sand. No matte is formed. The loss in melting is from 1 to 1½ per cent. of the bullion. The bars are from .700 to .940 fine, containing, in addition to the usual silver, small quantities of copper, lead, and iron. They are sold in the San Francisco market.

CALIFORNIA GOLD EXTRACTION. PL. 5.



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(*d.*) *Workmen in the mill and their duties.*—The labor of attending to the crushing and amalgamating machinery is divided in the following manner:

One man at the rock-breaker is expected to handle 25 tons of rock in a 10-hour shift. He also removes the greater part of the waste-rock, amounting on an average to 3 per cent. of the rock delivered. Wages, $3 a shift.

For every three 5-stamp batteries one feeder is employed, who handles in an 8-hour shift 12 tons of quartz; and also throws out all the wood and waste rock left by the hand at the rock-breaker. Wages, $2.75 per shift.

The hand attending to the washing of the blankets also regulates the quantity of water passing over the blankets, watches the proper discharge of the sieves, and feeds the blanket-washings to the amalgamators, while he regulates the flow of water through them. One blanket-washer attends to the blanket-washings of three 5-stamp batteries. Wages for an 8-hour shift, $2.75.

The attendance upon the amalgamating-machinery devolves upon the amalgamator, who also prepares the screens, attends to the cleaning of worn-out shoes and dies, and various other minor duties in the retorting and melting department. Wages, $3.50 per 10-hour shift.

When steam is the motor, two engineers attend to the engine and boilers of a large mill, in 12-hour shifts. The wood is brought to the boilers. The pay of an engineer is $4 per shift.

There is usually a night-watchman, whose duty is divided between the mill and the mine.

The overground foreman, who generally has a thorough practical knowledge of milling operations, is responsible for the regularity, efficiency, and economy of the working of the mill. He sees to the proper quality and quantity of mill supplies, and, together with the amalgamator, is responsible for the proper delivery of the amalgam and battery gold to the general superintendent or manager of the mining property. He has the power of discharging any common mill-hand. The pay of the foreman is usually $150 per month.

All employés are subject to discharge by the general superintendent. The wages are usually paid monthly.

(*e.*) *Wear and tear of a mill.*—In a well-managed mill accidents are of rare occurrence. Occasional breakages are unavoidable, considering the strong vibrations and jars to which all parts of the battery are subjected. They are confined to the stems, the shoe-shanks, and screens. The splitting of the tappet by wedging is unfrequent.

A mill requires 130 pounds of quicksilver per stamp. The monthly loss of mercury is $1\frac{1}{2}$ per cent., or 1 pound for every 31 tons of rock crushed. The present value of quicksilver is $1 per pound at the mill.

The monthly wear of blankets is $1\frac{1}{6}$ yards to the stamp. The cost per yard at the mill is from $1 to $1.75.

A 5-stamp battery requires on an average 13 sets of screens a year. A set consists of five sheets of from 1 to $1\frac{1}{4}$ square feet. The cost of screen is 60 cents per square foot.

To run a 30-stamp steam-mill requires from 32 to 36 inches of water, (miners' measure,) *i. e.*, the discharge of an aperture of 32 to 36 square inches under a 6-inch pressure measured from the center of the aperture. The water-charge is 20 cents per inch for a twenty-four hours' run. The water is usually supplied by ditches.

It takes $6\frac{1}{2}$ cords of fire-wood to furnish the steam necessary for a

30-stamp mill. The price of wood per cord varies, with the locality, from $2 to $6. At Grass Valley it is $4.

A shoe lasts from twenty one to forty-three days, on an average thirty-three days, crushing 79 tons of rock. Wear, $1\frac{1}{8}$ pounds of iron per ton of rock.

The die lasts on an average seven weeks, crushing 100 tons. Wear, $\frac{6}{10}$ of a pound of iron per ton of rock.

The stem breaks generally square across the fibers near the upper face of the head, and wears, without breaking, about sixty weeks, crushing 864 tons. When the irons are new and of fine quality the breakages are rarer, occurring, perhaps, but once in one hundred and twenty weeks. The rewelding, including the necessary new iron, costs on an average $10. The stems as well as the cams last at least ten years. The battery-linings wear six months; the tappets from two to three years.

The dies of rock-breakers, weighing 250 pounds each, wear about three months. Wear, one-half of the original weight.

The false pan-bottoms wear one year; and a set of 4 pan-shoes lasts three months.

The cost of a complete mill, including engine and boiler, is usually estimated at $1,000 per stamp. In a large mill of at least 20 stamps, this includes the concentrating and the chlorination works.

(*f.*) *Expense of the mill process.*—The following is a tabular statement of the expense of crushing and beneficiating one ton of quartz in a 30-stamp steam-mill, stamps weighing 850 pounds each, with 61 drops of 10 inches; crushing capacity, 72 tons per day:

Steam-power:		
Engineers	$0.1111	
Wood-wheeling to boilers	.0383	
Wood	.3636	
		$0.5130
Labor:		
Rock-breaking	.1250	
Feeding	.2292	
Blanket-washing	.2292	
Night-watchman, one-half shift	.0200	
Amalgamator	.0486	
		.6520
Management:		
Foreman, one-half salary	.0400	
Manager, one-half salary	.0800	
		.1200
Repairing:		
Carpenter and blacksmith, (repair)	.0100	
Lumber	.0032	
		.0132
Supplies:		
Quicksilver	.0321	
Blankets	.0100	
Screens	.0019	
Chemicals	.0054	
Hardware and light	.1031	
Lubricating material	.0072	
Charcoal	.0020	
Hauling and freight	.0043	
		.1660
Water-rent	.....	.0834
Foundery	.....	.2270
Interest on cost of mill at 1 per cent	.....	.1603
Payment toward repayment of capital invested, per ton	.....	.0802
Insurance	.....	.0227
Full cost per ton	.....	2.0378

The full cost of milling one ton of rock, \$2.04, does not include the expense of concentrating the tailings and chlorinating the concentrates. In a smaller mill, with the same expense of engineers, the milling-expense is, of course, proportionately higher.

When water is the motor a reduction of 80 per cent. can be calculated on the expense of the power, which, for steam, is $51\frac{3}{10}$ cents per ton; 20 per cent. of the expense of steam still remains for the heating up of the water of the amalgamators, &c. This calculation is based upon the supposition that the cost of engine and boilers is the same as that of the water-right, dams, flume, and water-wheel.

The labor-account amounts to a fraction over 65 cents per ton. In this item considerable reductions are contemplated at no distant day, by doing away with part of the labor on the rock-breaker, and by introducing automatic feeding and blanket-washing. This is calculated to be done in the following manner:

1. By introducing screens, consisting of heavy inclined iron bars, which allow the passage of all rock, below a certain size, to the feed-boxes of the battery, while the coarser quartz discharges into a strong hopper-like platform situated over the rock-breaker. Two men per shift would be capable of attending to the whole work on the rock-breaker, consisting in directing the passage of the quartz through the same, besides attending to the adjustment and repair of the battery.

2. Automatic feeding and blanket-washing, though not in favor among mill-men on account of the many unfavorable results obtained by crude and imperfect appliances for the purpose, is still a subject of constant study, and considered a desideratum of a perfect mill. Renewed experiments will be made to prove the economy and efficiency of such devices.

Revolving blankets, discharging the sands into pointed boxes, from which the sands pass in a regular flow into the amalgamators are thought to fulfill the conditions of efficient blanket-washing. The reduction of the labor-account by these means is expected to be fully 40 cents per ton.

The full cost of milling, with the above reductions, would be as follows:

	Steam mill.	Water mill.
Present cost	\$2 04	\$1 63
Reduction of labor-account	40	40
Reduced cost	1 64	1 23

Results of the mill process.—Of the whole amount of gold realized from the sands, after leaving the battery, the quicksilver baths yield $65\frac{1}{2}$ per cent.; the skimmings from the baths and ripples, treated in pans, yield 26 per cent.; the ripples yield 2 per cent.; the rubber yield $4\frac{1}{2}$ per cent.; the copper plates yield 2 per cent; total, 100.

The gold from the battery can be estimated at from 10 to 20 per cent. of the whole amount realized by milling. The longer the run, without a clean-up of the battery, the smaller will be the proportional result of the battery gold.

The concentrates yield from 5 to 10 per cent. of the gross yield of bullion.

Summing up these results, the gold realized by milling and concentrating, is derived from the battery, representing $9\frac{1}{2}$ per cent.; from the amalgamators, representing $85\frac{3}{4}$ per cent.; from concentrates, $4\frac{3}{4}$ per cent.

The fineness of crushing is found to be as follows: The battery sands, crushed through a No. 6 slot screen, contain on an average of:

1. Slimes, which remain suspended, after a three minutes' rest, in still water, 19 per cent. These slimes, which contain when filtered the so-called "float gold," consist principally of the earthy matter, mixed originally with the quartz.

2. Slimes passing through a sieve of 6,400 holes per square inch, (No. 1 excluded,) 51 per cent.

3. Sands passing through 1,600 holes per square inch, (excluding 1 and 2,) 23 per cent.

4. Sands not passing through 1,600 holes per square inch, 7 per cent.

The blanket-washings contain 78 per cent., passing through a sieve of 1,600 holes per square inch, and 36 per cent. passing through 6,400 holes per square inch.

The concentrates of the blankets contain, of course, a larger amount of heavy stuff. The proportion of sulphides contained in the crushed sands, flowing over the blankets to that of the blanket-washings, is as 22 to 100.

To determine the loss of gold by the mill process, a series of assays were made of the tailings of one of the best mills of the State. The following table gives the various results obtained. Each assay, reported in this table, was made in triplicate, and the result given is the mean from the three operations.

*Assays of classified tailings.**

No.		Sample 1.	Sample 2.	Average.
1	Slime, including float-gold, representing 19 per cent. of the pulp	\$12 40	\$11 66	\$12 03
2	Slime, representing 51 per cent. of the pulp	15 70	14 90	15 30
3	Sand, representing 23 per cent. of the pulp	34 10	22 40	28 25
4	Coarse sand, representing 7 per cent. of the pulp.	22 52	40 18	31 35

The rock crushed paid at the time of sampling \$47.40 per ton, exclusive of the value of the concentrates.

Estimating the yield of the rock in mill at \$47.40, the sulphurets or concentrates at \$2.50, the value of tailings (proportioned average of Nos. 2, 3, and 4,† per assay) at \$16.49, the value of float-gold (see No. 1

* The samples were procured at the end of the tail sluice, and were taken every half hour during a twenty-four hours' run. The buckets were allowed to run nearly full, and the sands were settled exactly three minutes. The water holding in suspension the slime and float-gold, was filtered off on a large paper filter, capable of holding the whole contents of the bucket. The coarser sands, comprising No. 2, 3, 4, were filtered on a separate filter.

† This result is obtained by taking the proper proportions of the different classes, and their value by the above assays, thus:

$$\begin{array}{ll} 2) & 0.51\times15.3 = 7.80 \\ 3) & 0.23\times28.25 = 6.50 \\ 4) & 0.07\times31.35 = 2.19 \\ \hline & 16.49 \end{array}$$

above) at $2.28, we have, as total contents of gold in the quartz crushed, $68.67, of which $18.67, or 27 per cent., is lost in the tailings, 3¼ per cent. being float-gold. No gold was visible in the above samples.

CONCENTRATION OF THE MILL-SANDS.

The sands after leaving the copper-plates of the mill are subjected to concentration, the object of which is to collect the lost freed gold with the auriferous sulphurets to be treated by a subsequent process.

The concentration consists of the following operations:

1. Sizing the sands by means of pointed boxes, (*Spitzkasten.*)
2. Concentrating the pointed-box sands in sluices with self-raising gate or ripples.
3. Subjecting the concentrated sluice-sands to a further concentration in rockers, buddles, Hendy's concentrators, &c.
4. Treating the buddle concentrates by a more perfect cleaning operation in a tossing-tub.

1. *Sizing of the sands by means of pointed boxes,* (*Spitzkasten.*)—All concentrating machines work to better advantage when the sands are of uniform size, and pointed boxes are simple and efficient contrivances for sizing. The pointed box is a wedge-shaped wooden box, the lead of which is attached to a corresponding aperture in the bottom of the sluice boxes, carrying off the mill tailings. The length of the box, measured in the direction of the sluice current, depends upon the size of grain desired for the concentrating machine. The shorter the box, the larger the size of grain, (breadth and grade of the sluices or the velocity of the sluice current being the same.)

The sands settling in the box are discharged by a 2-inch iron pipe, communicating with the interior of the box at the bottom, reaching to the top of the water level in the sluice, and provided on the side with inch plug-holes, from 4 to 6 inches apart from center to center. The proportion of water to sands is regulated by opening the plug-holes at different depths below the water level, the lowest hole naturally discharging the greater quantity of water with the sands deposited in the box.

When the pointed-box sands are concentrated on two machines, two sizes and, consequently, two pointed boxes are used. The sands, flowing over the first pointed box, pass on over the second, and the slime passing the second box runs to waste.

As the length of the aperture of the box depends upon the velocity of the sluice current, which varies with the grade and proportion of *wet* perimeter of the sluice to its water cross-section, it varies considerably in practice. A length of 24 inches has usually a width of four-fifths of an inch per stamp for the coarser sands, when only two sizes are required. This, however, is only an approximation; as no rule can be given *a priori*, experiment determines the dimensions.

The depth of the pointed box is usually equal to its length, as shown in the accompanying isometrical sketch.

2. *Concentration of the pointed-box sands in sluices with self-raising riffle-gate.*—The pointed-box sands flow through wooden sluice-boxes of a rectangular section, provided at the lower end with a self-raising gate, acting as a riffle, in which the heavier portions of the sands, consisting of sulphurets, black sand, &c., form a deposit near the head, while the lighter particles escape over the gate. For the coarser sands, the boxes have a width of one inch; for the finer sands they are from $1\frac{1}{5}$ to $1\frac{1}{2}$ inches wide for every stamp. They are usually 18 feet long, and have

the natural grade of the sands passing through them. For every two boxes or two sets of boxes there is one riffle-gate. The gate opening is generally seven inches wide and eighteen inches deep. The gate is raised to its full height once in twenty-four hours by means of a horizontal ratchet-wheel, which is keyed to a vertical screw attached to the gate. Two ratchet-wheels, one above the other, are attached to the screw, the teeth of one having the reversed direction of those of the other. By applying a lever arrangement on one side of the vertical screw to one of these, the gate is raised; by applying it to the other on the other side, the gate is lowered. Two boxes 15 to 16 inches wide are filled to a depth of 18 inches by a 15 stamp battery in twenty-four hours. Two boxes or two sets of boxes are used alternately.

3. *Further concentration of the concentrated sluice-sands in rockers and buddles.*—When the sluice-sands are subjected to a further concentration on rockers, they are discharged into a tank, by lowering the riffle gate.

The tailings of the rocker, containing the finer sulphurets, are treated subsequently in buddles, worked either by hand or machinery.

Hand buddles are described in the Mining Commissioner's report for 1870, page 357.

The rocker represented isometrically in the annexed figure consists of a wooden table of 2-inch pine plank, 20 inches wide, and 10 feet long, supported at both ends by wooden rockers, representing a section of a width of 20 inches and depth of about three inches.

The table is enclosed on the long sides and the upper end by 6-inch boards, the lower end being left open for the discharge of the tailings. It has a grade of one inch to the foot, which can be increased, when working coarser sands, by removing some of the supporting scantlings at the lower end, the upper end being fixed stationary by a bolt, which, working in a slot, does not prevent the rocking motion.

The floor of the table, when in equilibrium, is 7 inches above the support.

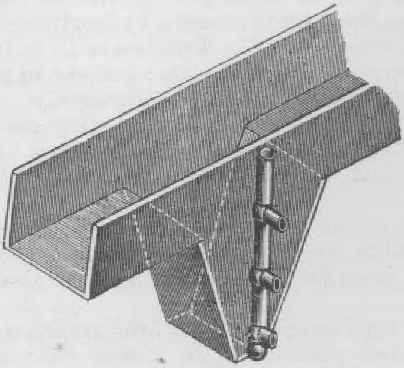
The concentrated sluice-sands are introduced at the head of the rocker in charges of from three to five shovels, (the greater quantity corresponding to the sands poorest in sulphurets,) and a stream of water discharged by a one-inch pipe under a six-inch pressure is turned on the sands by means of a rubber hose. The rocker is set in motion by the left hand of the workman, giving it about 60 strokes of 8 inches a minute. For coarser sands a greater number of strokes is required. The lighter sands gradually work down, while the sulphurets remain nearer the head. With his right hand the workman works the sulphurets up to near the head, with a flat wooden shovel, passing closely along the bottom of the rocker, while the lighter sands pass off. In some mills the rocker receives its motion by machinery. When clean, the sulphurets are removed from the rocker by an iron scoop. One workman can treat about 300 shovels of sand in a 10-hour shift.

The convex buddle is extensively used, and is described in the Mining Commissioner's report of 1870, page 354.

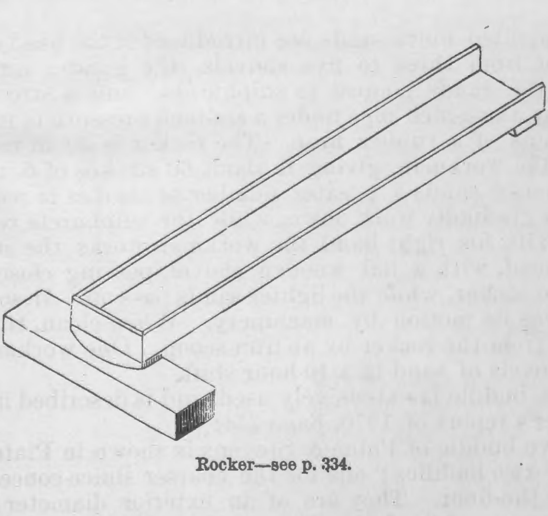
The concave buddle of Paine & Stevens is shown in Plate VI. There are generally two buddles; one for the coarser sluice-concentrates, and the other for the finer. They are of an exterior diameter of 18 to 20 feet, and interior of 2½ feet. The vertical shaft is supported by the wooden block *m*, carrying the journal-box.

Attached to the shafts are:

(*a*,) the self-raising riffle-pulley *g*, which is raised by means of a rod, *p*, receiving its upward or downward motion from the endless screw *b*



Pointed box—see p. 333.



Rocker—see p. 334.

[illegible] the [illegible] rotating the [illegible] [illegible] distributing trough.

The clear water [illegible] is supplied [illegible] of the wheels [illegible] is supplied by the stationary washing [illegible] the water by means of the [illegible] from pipe [illegible] into the [illegible] the [illegible] by the [illegible] from the distributing trough [illegible]. The vertical shaft receives its motion by the pulley [illegible] [illegible].

The next operation of the [illegible] consists in washing the [illegible].

For this purpose the [illegible] is lowered, and the [illegible] are washed through the [illegible] and [illegible] from which they are discharged [illegible] the [illegible] from [illegible] arms [illegible] the [illegible] flow down the inclined conical [illegible] The arms [illegible] carrying the [illegible] the [illegible] at the same time with [illegible] the [illegible] surface of the [illegible]. The [illegible] near the head of the buddle, while the lighter [illegible] finally fall over the circular [illegible] the centre of the buddle. The [illegible] the working buddle [illegible] The pulley [illegible] are gradually raised as the sands fill the buddle.

When working the coarser [illegible] the time [illegible] to fill the [illegible] hours; for the finer sands twelve hours are required. The [illegible] by the buddle [illegible] the [illegible] sands [illegible] [illegible].

When [illegible] the [illegible] of the buddle are [illegible] The central [illegible] This is done by [illegible] the [illegible] and [illegible] The [illegible] The clear water [illegible] and washes out the central ring, leaving the [illegible] The [illegible] ring is [illegible] at the same time. While the central ring of the sands is removed, the [illegible] the periphery of the buddle [illegible] The middle portion [illegible] [illegible] of the [illegible]. The headings [illegible] when washed, are added to the first headings, and the [illegible] ring of sands is removed in the previous manner.

The headings from the first washing go through a second washing, called dradling. This is done by raising the central [illegible] and filling the buddle up to the top of the ring with poor sands from the [illegible] which are introduced into the mixing [illegible] washed into the buddle by the water from the pipe [illegible] and trough [illegible] When ready for dradling, the buddle has a grade of [illegible] inches [illegible] the coarser sands and [illegible] inches when working the finer sands. All the headings are shovelled into the mixing trough, which can be brought to any part of the working floor around the periphery of the buddle, being supported on wheels; the distributing clean water box [illegible] pipe [illegible] attached, also revolving on the wheels [illegible] as previously [illegible] The time occupied in [illegible] the headings of the first washing is [illegible] three hours.

When [illegible] the [illegible]

and pinion-wheel; (*b*,) the arms *f f*, carrying the brusher; and, (*c*,) the sand-distributing troughs *e e*.

The clear-water box *i* is suspended by the wheels *v v* on an annular flat ring. It is supplied by the stationary wooden box *r*, and discharges the water, by means of the iron pipe *k*, into the sieve-boxes *y* and *z*. The box *s s* is fed by the trough *h* from the mixing-trough *y* and sieve-box *z*. The vertical shaft receives its motion by the pulley *a* and bevel-gearing *d d*.

The first operation of the buddle consists in washing the sluice-concentrates.

For this purpose the sluice-gate is lowered, and the sands are gradually washed through the mixing and sieve box *y* and *z*, and box *h*, into the distributing-box *s s*, from which they are discharged, by the six revolving Russian iron trough-arms *e e*, upon the annular apron *x*. From these they flow down the inclined conical table, constituting the buddle. The arms *f f*, carrying the poles to which the brooms are attached, revolve at the same time with the distributors *e e*. The brooms maintain a regular even surface of the sands. The heavy sulphurets lodge near the head of the buddle, while the lighter particles move on and finally fall over the circular riffle *g*, consisting of an iron pulley, *g*, in the center of the buddle. This ring forms a close joint at the end of the wooden buddle floor *u u*. The pulley, and with it the arms of the broom-poles, are gradually raised as the sands fill the buddle.

When working the coarser ore the time consumed to fill the buddle is six hours; for the finer sands twelve hours are required. The water required by the buddle in washing the coarse sands is 8 cubic feet per minute, spread by the revolving distributors making seven revolutions a minute over a periphery of nearly 63 feet.

When full the sands of the buddle are divided into three concentric rings. The interior ring, of a width of 3½ feet, is considered as waste and washed out. This is done by removing the end-pieces 1 1 of the distributors, and turning the collars 2 2, in the manner represented in the drawing in dotted lines. The clear water is fed on by the stationary sluice *r*, and washes out the central ring, leaving the distributors at the connecting collars 2 2. The central riffle-ring is lowered at the same time. While the central ring of the sands is removed, the outside ring at the periphery of the buddle, of a width of 3 feet—the so-called *headings*—is shoveled out by the ore-dresser. The middle portion left standing, of a width of about 2 feet, is washed gradually by directing the water by means of the collars 2 2 of the distributors. The headings of these sands, when washed, are added to the first headings, and the central ring of sands is removed in the previous manner.

The headings from the first washing go through a second washing, called doubling. This is done by raising the central riffle-ring about 3 inches and filling the buddle up to the rim of the ring with poor sands from the tossing-tub, which are introduced into the mixing-box *y* and washed into the buddle by the water from the pipe *k* and trough *r*. When ready for doubling, the buddle has a grade of 1¾ inches per foot for course sands and 1½ inches when working the finer sands. All the headings are shoveled into the mixing-trough, which can be brought to any part of the working floor around the periphery of the buddle, being supported on wheels; the distributing clean water-box *i* with water-pipe *k* attached, also revolving on the wheels *u u*, as previously noticed. The time consumed in rewashing the headings of the first washing is generally three hours.

When the operation of washing the headings is completed, the sands are again divided into three concentric rings. The central portion, of a width of about 4 feet, being removed as before, the outer ring of about 18 inches in width is ready for tossing, while the middle ring, of a width of about 3 feet, is washed down in the previous manner, the headings of it being added to those previously removed by tossing.

The tossing or final cleaning of the sulphurets is usually performed on the buddle-headings, if they are intended to be treated by the chlorination process. This is done in a tossing-tub of the following construction: (See Plate V, Fig. 3.)

The tub, of $1\frac{1}{2}$ to 2 inch staves, is conical in form, tapering toward the bottom, 4 feet in diameter, and $2\frac{1}{2}$ feet deep in the clear.

Through the axis of the tub a hollow cast-iron cone, C, passes, reaching a few inches above the tap of the tub, fastened by a flange to the bottom. A shaft *s* passing through this cone and resting on a journal underneath carries the yoke *l*, to which the horizontal stirrers of flat iron are riveted. Revolution is communicated to the shaft by bevel-gearing *a b*. The hammers are set in motion by the pins *p p*, attached to the vertical bevel-gear, as seen in the drawing. When ready for tossing, the tub is filled to nearly half its height with water, the stirrers are set in motion, making 48 revolutions a minute, and the ore is shoveled in near the periphery of the tub. When nearly full, the yoke is lifted out by means of a rope and pulley overhead, and the sands are allowed to settle while the hammers are set in motion, making 96 strokes each a minute to facilitate the rapid settling of the sulphurets and sands. When the sands have settled the water is drawn off by an iron siphon; the skimmings are removed to a depth of 2 inches and thrown out as waste. The upper half of the sands remaining are retossed, and the resulting sands above the sulphurets washed again in the buddle during doubling. The lower half of about 5 to 6 inches, consisting of sulphurets sufficiently concentrated, is delivered at the chlorination works to be further treated for gold.

Two buddles working the sands of a 30-stamp mill require the attendance of three men at $3 per day.

The manual labor of concentration by this method, leaving out of consideration the expense of power, interest on money invested, and wear and tear, is $12\frac{1}{2}$ cents per ton of quartz crushed.

The riffle-boxes, and also, to some extent, the concave buddles, lose a considerable proportion of coarse sulphurets. To reduce this loss, the tailings from the buddle and riffle-sluices pass through a long string of sluice-boxes supplied with wooden riffles of a square section of $\frac{3}{4}$ of an inch, which are washed every Sunday when the mill stops, into and through a wooden box about 5 feet wide, 10 feet long, and 3 feet deep. The box is open at the lower end. The heavier sulphurets form a deposit at the head, and these headings are treated by the rocker.

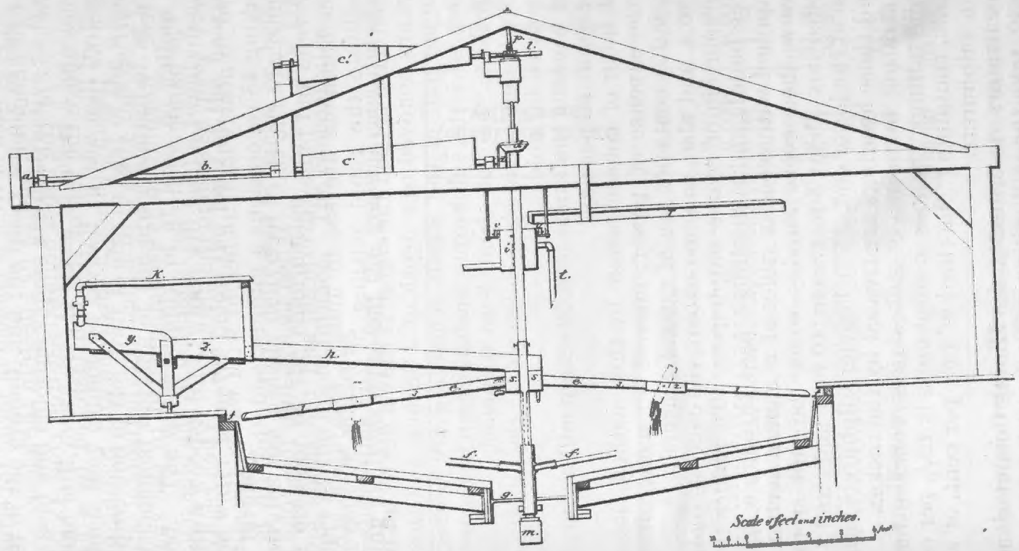
When concentrating by means of riffle-sluices, concave buddles, and rocker for buddle-tailings, the loss in sulphurets is $12\frac{5}{10}$ per cent., treating quartz sands, containing one-third of one per cent. of sulphur, or its equivalent in sulphurets.

Hendy's concentrators, described in the Mining Commissioner's report of 1870, page 699, take the mill-tailings usually without previous sizing or concentration in self-raising riffle-boxes. The tailings of the machine, when the value of the resulting concentrates permit, are buddled.

Good concentrating machines, working with the least loss, and little or no manual labor, are still a desideratum in California.

Rittinger's lateral percussion tables have not given favorable results, on account of the loss of the coarser, globular sulphurets of iron.

CALIFORNIA GOLD EXTRACTION. PL. 6.



AM. PHOTO-LITHOGRAPHIC CO. N.Y. (OSBORNE'S PROCESS)

Experiments will be instituted shortly to try the continuous-working jiggers used in the Zellerfeldt mill No. 40, at Clausthal, for the coarser sands, and the revolving slum-tables for the finer sands or slimes.

III.—CHLORINATION OF THE CONCENTRATES.

The concentrated sulphurets or arseniurets are subjected to a treatment by chlorine gas, after a thorough oxidizing or chloridizing roasting.

The chlorination works are located with reference to the prevailing winds, the fall of the ground, and the ready supply of clean water. As the sulphuric acid and chlorine vapors are destructive to the machinery of the mine and mill, every care is taken to select a location for the furnace from which they cannot be carried to the mill by the prevailing winds. The direction of the draft is also in that of the winds. For the proper and economical working of the process a fall of at least 30 to 40 feet is required. The water supply, of at least 35 gallons per hour, is discharged into a wooden tank, which will hold a twenty-four hours' run. The top of the water is never below the level of the hearth-surface of the finishing furnace.

The concentrates are usually delivered in sacks, or, better, in dump-carts, at the ore-floor of the chlorination works, on a level with the charging hopper of the upper furnace. The concentrates contain on an average 6 per cent. of moisture.

The following analyses represent the general constituents of the concentrates:

	Eureka and Idaho, Grass Valley.	Washington mine, Mariposa County.	Black Bear mine, Klamath County.
Copper	0.85	0.00	0.00
Lead	0.78	1.50	....
Gold	0.02743	0.00914	0.0137
Silver	0.0068	0.0035	0.003
Zinc	0.00	1.34	....
Iron	40.65	30.85	42.05
Arsenic	Trace.	0.00	21.25
Sulphur	32.80	31.33	25.10
Silica	12.64	33.30	10.35
Alumina	0.10	....	0.85
Magnesia	3.50	....	....
Oxygen and loss by difference	8.65	1.67	0.38
	100.00	100.00	100.00

Roasting of the sulphurets.—The sulphurets are roasted in double and treble terrace drop-furnaces. The upper is a continuation of the lower furnace with a vertical flue or chimney about 10 feet in height between the hearths through which the ore falls on its way to the finishing hearth. This flue or chimney is introduced to aid the roasting of the ore by bringing it, when heated to red heat, in contact on all sides with the oxydizing and chloridizing gases of the finishing hearth, while falling in a fine spray.

1. *Construction of the furnace.*—A solid dry foundation is indispensable for a furnace. If good and cheap stone can be procured, the furnace is built of that material to near the fire-line. The stone walls require to be at least 2 feet thick; the interstices between the stones are filled with small stones and coarse clay mortar. The whole of the furnace above the fire-line is constructed of common red brick, laid in clay mortar. Enough sand is mixed with the clay to make it "lay well," or leave the trowel properly. No fire-bricks are necessary. All the walls are one brick thick, with the exception of the spandrel walls, up to the extrados of the arches, which are two bricks thick. The small sides of the drop flues have also a thickness of two bricks. The front wall, which incloses the fire-grate, has a thickness of one and a half bricks.

A furnace constructed of red common bricks, laid in clay mortar, lasts at least four years; the upper furnaces, at least two years longer. In repairing, 6,000 new bricks and thirty shifts of bricklaying will restore the furnace again to its former condition.

The horizontal section of the lower finishing furnace measures on the outside 14 feet in length and 12 feet in width. The back furnace adjoining has a horizontal section of 6 feet in length by 12 feet in width. The drop flue is 12 inches long at the lower end and 10 feet 8 inches wide, the latter measurement parallel to the fire-bridge. It is contracted toward its upper end, and is 4 inches long by 10 feet in breadth at the upper hearth. A few inches below the upper hearth two iron damper frames are walled into the front or door-wall, the gates of which slide horizontally and allow the regulation of the draft of the lower furnace.

The upper furnace measures 13 feet 4 inches in length by 12 feet in width, outside measurement. The whole of the upper hearth is supported by a semicircular arch. The space underneath the arch serves for the working of the back hearth of the lower furnace, through the back doors. The inside wall of the vertical flue, which acts as a retaining wall for the clay filling over the arch, is also built in the form of a very flat arch and strongly tied with $\frac{5}{8}$-inch iron rods passing through the uprights on the outside of the furnace-walls.

The inside section of the upper chimney is 16 by 20 inches, but usually reaches 4 feet above the ridge-pole of the roof. A damper regulates the draft of the same.

The grate is 16 inches wide and 8 feet long. Its surface is from 4 to 6 inches below the hearth line. The fire-bridge is one brick wide, the bricks in the same being laid as row-locks. The top of bridge is 8 inches above the hearth, and 12 to 14 inches above the grate-surface. The cast-iron fire-door has an opening of 14 by 12 inches. The hearth surface, 3 feet 6 inches above the ground floor, has a section of 11 by 11 feet, diminished, however, by projecting points of brickwork between the doors, of which there are two on each side of the furnace. This brickwork fills out the dead spaces which cannot be reached conveniently with the rakes or scrapers by the roaster.

On one side of the furnace, in front of one of these projecting points in the middle of the hearth, the discharge hole is situated; it is 8 by 8 inches and closed with an iron slide, the frame of which is firmly walled in between the hearth and the arch of the ore-vault which supports the hearth.

The center line of the ore-vault is vertically under the center line of the hearth, parallel to the fire-bridge. The ore-vault is 4 feet wide in the direction of the draught, 6 feet long, and open toward the cooling floor of the impregnation-room. The floor of the vault is provided with rails for the ore-car, made of boiler iron. The hearths of the furnace consist of hard bricks laid edgewise, the section of 2 by 8 inches upward. For this purpose the dry clay is firmly bedded and dry sand spread over the same, leveled and settled by pounding. The bricks are bedded dry, with the long sides in the direction of the movement of the working scrapers. When completed, dry sand is spread over the surface and thoroughly worked into the cracks. The surface is finally smoothed off by settling the bricks by blows on a heavy wide plank laid over them, and grinding the same, with the addition of sand, by means of a brick.

The working-openings are 12 inches wide and 6 inches high. Cast-iron frames with sides sloping toward the interior and exterior, protect the brick-work. The inside boxing of the frame, which is exposed to the wear of the working-rakes, can be readily replaced when worn out. The bars on which the rakes are worked are 6 inches above the hearth-line. The arch over the lower furnace abuts against the working-sides, and a part of the skew-back is supported by the upper flanges of the working-doors. To fasten them firmly into the walls it is therefore only necessary to screw or key them against the skew-back by means of tension-bars and vertical uprights, which firmly tie the furnace.

The tie-rods of $\frac{5}{8}$-inch square iron are provided with eyes for the reception of the wrought-iron uprights $\frac{3}{4}$ by $2\frac{1}{2}$ inches in section, which are keyed up to the brick-work. Three parallel wrought-iron bars $\frac{3}{8}$ by 1 inch in section, running along the skew-backs on both sides of the furnace, transfer the pressure of the arch through the uprights to the tension-rods, preventing a sliding out of the skew-backs of the main arches. The main arches are 8 inches thick and have a rise of at least $\frac{1}{10}$ of the span. After "decentering," a good arch of common bricks and clay mortar will settle about 3 inches in a span of 10 feet 8 inches.

The center line of the main lower arch is 22 inches above the surface of the finishing-hearth at the back doors; at the fire-bridge, the skew-back line being four inches higher, it is 26 inches above the same. From near the back door of the finishing-furnace the arch rapidly descends, and the section at the back hearth is contracted as much as circumstances permit.

All the arches are built on wooden centers of $1\frac{1}{2}$-inch pine boards, which can be taken out and used again. Most of the patterns have a span of 128 inches, a rise of nearly 13 inches, and a radius of 168 inches, (equal to 1.3 times the span.) They are set from 2 feet to 2 feet 8 inches apart, on three frames, consisting of sills, posts, and caps, placed on the hearth, parallel to the direction of the draught. For the arch of the finishing-furnace the strips covering the centers are 4 to 6 inches wide and 14 feet long. They must be thin, say $\frac{1}{2}$ inch thick for the part of the arch behind the back working-door, to suit the curve of the arch. For all other arches, 1-inch strips 6 inches wide are suitable, while the centers can be set further apart.

The measurement of the back hearth in the clear is 9 feet 4 inches in width, by a length of 5 feet 4 inches. It is from 4 to 6 inches above the finishing-hearth. The arch is 26 inches above the hearth, and its rise is one tenth of the span, as usual. The two working-openings of the back hearth are opposite the fire-bridge, and their lower edges are 8 inches above the hearth. The cast-iron frames of the working-doors of the back furnace, having an opening of 6 by 10 inches, are provided with cast-iron doors. Wherever the tension rods pass through the flue they are surrounded by iron pipes, passing through the brick-work, to protect them from the oxidizing influence of the hot gases. A sediment of rust and ore-dust soon forms a thick envelope around them, effectually preventing any further oxidation. The portion of tension-rod passing through the flue has double the section of the balance. No weldings are allowed on the tension-rods; all connections have to be made by hooks.

The upper hearth has a length of 11 feet 8 inches by a width of 10 feet 8 inches. The center of the arch is 26 inches above the floor, and has a rise of one-tenth of the span abutting against the long side of the furnace. The skew-back is secured in the same manner as that of the lower furnace. The working openings and doors, of the same pattern as those of the back hearth of the lower furnace, are on the front or chimney-flue end, and on the back end of the furnace. The working-floor for the front doors is suspended from the roof over the lower furnace.

The ore is charged into the furnace by means of a hopper of boiler-iron, supported by strong beams. The top of the hopper is on a level with the ore-floor. When the yield of the sulphurets warrants the outlay, a dust-chamber is attached to the furnace, which saves on an average $1\frac{1}{2}$ per cent. of the gold contained in the ore.

The grate-bars are of $\frac{3}{4}$ by 2 inch wrought iron, 4 feet long. They are kept apart at the proper distance by rivet-heads $\frac{3}{8}$ inch high, fastened to them at both ends and in the center. They are well supported by cross-bars bedded on boiler-plates in the wall to keep them from sagging. They last, when well taken care of, several years. A set consists of 32 bars. The working-bars or scrapers are of $\frac{3}{4}$-inch round iron, 9 feet long. One end is provided with a handle, while to the other a cast-iron plate 4 by 8 inches is attached. The plate, $\frac{3}{4}$ inch thick, is riveted to a heavy T-piece on the end of the bar.

2. *Working of the furnace.*—The charge of a furnace, in a sound working condition, consists of $5\frac{1}{2}$ to 6 tons of concentrates, viz, one ton in the finishing-furnace, $1\frac{1}{2}$ to 2 tons in the back hearth, and 3 to $2\frac{1}{2}$ tons in the upper furnace. There are two men working one furnace, the head roaster and his assistant.

When the finishing-hearth is discharged, the iron slide of the discharge-hole is closed and some rag or woody fiber or bark is introduced into the square discharge-hole with a long-handled shovel, to prevent the caking of the ore on the slide. The hole is now filled with old ore slightly moistened, and leveled up with the top of the hearth, to prevent any new and unroasted ore from lodging in the discharge-hole.

The assistant pushes the ore of the back hearth from the back doors into the finishing furnace, and the head roaster spreads it evenly over the floor of the same.

The imperfectly roasted ore consists now of metallic oxides, sulphates of the alkaline earths, and also a small percentage of sulphides. The heat in the back hearth and in the drop-flue has already decomposed the iron and copper sulphates. The ore is now at a dark-red heat. A charge of one ton being made, the roaster cleans the grate and increases the heat to a bright redness by steady firing. The fuel consists of cedar or spruce, rarely of pine. When the ore, suddenly started with the working-scrapers, shows in falling only a few sparks, which the roaster must be capable of counting, it is ready for the salt, and the chloridizing roasting begins. This is generally the case after a preliminary roasting in the finishing-hearth of from three to four hours. Every ore is benefited by the use of salt for the finishing roasting, as the consumption of chlorine in the subsequent impregnation is reduced thereby, aside from the advantage of a purer precipitate of gold by the proto-sulphate of iron. To some sulphurets only 5 pounds of salt per ton are added for the chloridizing finishing operation ; others require 90 pounds for the same quantity.

When a larger amount of salt is required, on account of the presence of a greater quantity of lead to be removed, the roasted ore has to be lixiviated to remove the coating of soluble sulphates and chlorides remaining, previous to treating it with chlorine. With the usual smaller quantity of salt this operation is unnecessary, as the water used in dampening the roasted ore appears to dissolve this alkaline salt envelope sufficiently to give the chlorine an opportunity to act upon the gold. On an average, only 56 per cent. of the salt is decomposed.

The reaction of this salt in the absence of any sulphates of iron or copper, according to Plattner, is the following: Cu_2 S and Fe_2 S, with air and salt, form sulphurous acid, and by contact with red-hot ore sulphuric acid, which, reacting upon the salt, sets the chlorine free, forming chlorides. When lead is present, the reaction of the salt upon the sulphate of lead in melting produces sulphate of soda, volatile chloride, and oxychloride of lead.

During the finishing roasting, the ash-pit is kept closed, while the necessary air has access through the working-doors. The draught is so regulated by the dampers in the drop flue that but few vapors escape at the back door of the finishing-furnace. The ore is worked systematically in the finishing-furnace. First, it is raked and pushed entirely to one side, then entirely to the other, clearing the middle carefully in every case; then it is piled up in a ridge in the center and cut down from both sides with the rakes. This procedure is continually repeated. When the ore will maintain a vertical face, shows no brighter specks on its glowing surface, is inclined to become black, and cool very readily, which generally takes place from seven to seven and a half hours after the charging, it is ready to be discharged. The iron discharge-slide is now removed; the ore filling out the square discharge-hole in the hearth is forced out with the rake and made to fall into an iron bucket. The remnants of the ore, lodged in the discharge-hole, are carefully removed from underneath the ore-vault. The ore, having been previously piled close to the discharge-hole for a speedy removal, is pulled by the roaster and his assistant into an iron car, holding one ton of roasted ore, and dumped into the coolers. When well roasted, the ore gives abundant white fumes on testing with ammonia. Not until the introduction of the salt in the finishing-furnace is the assistant allowed to rake down a charge from the upper furnace.

The discharging or dropping of the ore into the back hearth has to be done slowly, so as to give the ore the greatest possible advantage from the chloridizing influence of the heated gases. The best results are obtained and the least chlorine gas is consumed in the subsequent impregnation, when but a slight violet-colored flame is produced by the falling of the ore. When the sparkling of the ore is very lively a larger quantity of salt than usual has to be added in the finishing roasting.

When the back hearth is well filled with ore, the sulphides in the upper furnace are moved forward and a fresh ton is charged at the end of the furnace through the iron hopper. The upper furnace is kept as full as possible. When the ore is less advanced in roasting, the damper of the upper chimney is drawn out and *vice versa*.

The heat is high enough in the upper furnace to decompose all sulphates of iron and copper when they arrive near the drop.

3. *Impregnation of the roasted sulphurets.*—A furnace roasting 3 tons a day is provided with a dumping-space or cooler of at least 300 square feet. The cooler consists generally of a brick floor, enclosed with a rim of $\frac{1}{8}$-inch boiler-plate 18 inches high, held in position by wooden uprights on the outside. When the ore is not thoroughly cooled, before treatment

by chlorine, a greater consumption of gas is the consequence, aside from the smaller percentage of gold extracted.

Well roasted sulphurets rarely contain more than $1\frac{3}{8}$ per cent. of sulphur in the unoxidized state. The quantity of sulphates in the ore varies of course with the amount of alkaline earths in the original ore and the alkali added in roasting.

A ton of roasted ore occupies on an average $24\frac{1}{2}$ cubic feet, and is derived from 2,800 pounds of raw sulphurets, occupying about $13\frac{2}{3}$ cubic feet per ton; or, what amounts to the same, a ton of sulphurets weighs after roasting only about 1,450 pounds, occupying $17\frac{1}{2}$ cubic feet. The impregnation vats usually employed have an inside diameter of 7 feet, and are made of 3-foot staves, 2 inches thick, of the best split sugar pine. They are coated with a plastic mixture of pitch and tar. Previous to using them for the first time, all vats are thoroughly soaked with water, to avoid any loss of gold by impregnation. The false bottom consists generally of quartz pebbles, but fine sea-shells (consisting of carbonate of lime) have been used to advantage without any prejudicial result. Talcose rocks, and particularly silicates of alumina, have to be avoided, on account of their power of absorbing the chloride.

When the vats are ready for a charge, 15 small buckets of dry ore are first spread over the false bottom and allowed to draw the water from the same. The ore is then raked together with a hoe and scooped up into the sieve, having 16 holes to the square inch, through which it is made to pass, to give it a uniform dampness and light texture. If too wet, a sufficient quantity of dry ore is added. When it is of the proper dampness, the balls of ore, compressed by the hand, are just able to crumble up again. Should this be neglected, the cake of wet ore over the false bottom would prevent the easy passage of the gas through the same, and would cause a great increase in the consumption of gas. Even the whole of the usual charge of gas may be consumed by this neglect, never rising but a few inches above the bottom.

The ore is kept somewhat drier near the bottom, as it always draws an additional quantity of water from the latter. When the ore is too dry, the gold is not attacked with energy; when too wet, the chloride-water forms an envelope around the gold, which is not as powerful a solvent as the gas itself. The finer the ore, the smaller the quantity of water which can be applied.

The remainder of the coal-ore or charge is sprinkled with clear water from a hose and raked together to be scooped into the sieve by a bucket. The sieve slides on rollers on an iron-plated scantling, placed across the vat.

When the vat is filled within 6 inches of the top, the surface of the ore is made to form the shape of a saucer, higher on the sides, with a flat circular space in the middle. The cover is lowered and the rim closed with dough.

When the gas shows itself on the surface the spy-hole in the rim is closed; and a lively current of gas through the lead pipes, kept up during two hours additional, finishes the operation. From five to eight hours is the usual time required for the impregnation.

The gas necessary for a 3-ton charge of refractory ore is generated in a lead gasometer 20 inches diameter and 12 inches deep. The cover is made gas-tight by a water-joint, 2 inches deep, as are also the stirrer and escape-pipe of the gas. The acid is introduced through a bent lead pipe. The charge of the gasometer for 3 tons of ore consists of 20 pounds of coarse rock-salt, 15 pounds of binoxide of manganese, containing 70 per cent. of mining ore, and 35 pounds of oil of vitriol of 66° Beaumé; to which are added 18 pounds of water. When necessary, the quantity of acid is increased to a maximum of 45 pounds, the water to 23 pounds. The water is not introduced until the acid is wanted. To every pound of acid, half of a pound of water is added. One stick of 4 foot cordwood, cut up, is sufficient to generate the heat, required by the gasometer for one impregnation.

4. *Lixiviation of the impregnated ore.*—The roasted ore is allowed to remain in the gas about forty hours. Of the three impregnation vats, each is filled every fourth day. The filtering and emptying is done every third day. On the morning of the third day, the cover is lifted. The presence of a strong odor of gas is a sign of good work. The surface of the ore is covered by a stream of clear water discharged by a 2-inch iron pipe under an average one-foot pressure. Care is taken to prevent, as far as possible, the rushing down of the water on the sides of the vat. When all the gas has escaped which is not absorbed by the water, the faucet is opened. The clear yellow solution, frequently having a strong odor of chlorine, runs through a canvas bag into a barrel of about 18 inches diameter and 2 feet depth. Into the side of this barrel, 2 inches from the bottom, a conical wooden tube is driven, with the small end outside, over which the rubber hose of one-inch inside diameter is slipped. The gold solution is carried off through the rubber hose to the precipitating tanks. The small quantity of ore and sand escaping with the solution is deposited in the canvas bag.

The following analysis of a gold solution, taken one minute after the opening of the faucet, is from ore yielding $163 per ton, the charge amounting to 3 tons:

500 c. c. deposited after twenty-four hours settling, contained—

Sulphate of lead	4. 16	grains.
Silica	0. 24	"
Sulphuric acid	325. 10	"
Chlorine free and combined	371. 70	"
Gold	6. 77	"
Copper	3. 75	"
Iron	0. 14	"
Alumina	3. 93	"
Magnesia	40. 85	"
Soda	470. 64	"
Total in solution	1227. 28	grains, equivalent to
$Al_2. O_3, SO_3$	6. 98	grains.
$Mg. O., SO_3$	132. 55	"
$Pb. O., SO_3$	4. 16	"
$Na. O., SO_3$	426. 62	"
Au. Cl_3	10. 44	"
F_2. Cl_3	0. 32	"
Cu. Cl	8. 95	"
Na. Cl	536. 00	"
Silica	0. 24	"
Free chlorine by difference	101. 02	"
		"
	1227. 28	grains.

500 c. c. evaporated to dryness gave 1124. 3 grains, agreeing closely with the above total, less 101.02 grains of free chlorine.

When the ore contains lead, the soluble chloride is transformed into the sulphate by sulphates present, and gives the gold solution a milky appearance. A great part of the sulphate is left in the canvas bag, which has to be frequently cleaned. After a run of some time this difficulty ceases with the exhaustion of the sulphate in the solution.

The gold solution is made to run into the precipitating tanks in a tangential direction, which gives the liquor in the vat a rotary motion, facilitating the coagulation of the gold particles and their subsequent settling. It also causes a thorough mixture of the gold solution with the precipitant.

The precipitating tank of the same material as the impregnation vats is $5\frac{1}{2}$ feet in diameter and of 3-foot staves. It receives a smooth finish inside to allow a perfect cleaning. No inside coating is applied. It is set perfectly level to avoid loss of gold while running off the waste liquor. The precipitating solution of the proto-sulphate of iron is introduced into the precipitating vats at the beginning of the filtering operation. Care must be taken not to introduce a wasteful quantity. It is better to make up the deficiency when the vat is nearly full.

Two vats, one $5\frac{1}{2}$ the other $4\frac{1}{2}$ feet diameter, hold the solution from very rich ore. Generally only the larger vat is required.

When the solution from the impregnation vats ceases to give the gold re-action with proto-sulphate of iron the water is drawn off the impregnation vats. The ore is shoveled out through an opening in the side of the impregnation room and washed off by a current of water. The ore has to be carefully removed from the false-bottom so as not to injure it. The vat is now ready for the next morning's impregnation. Every day one vat of ore is impregnated; the second remains in the gas, and the third is filtered and emptied.

5. *Collection of the gold precipitate and final operations.*—The gold settles over night. The supernatant liquor is drawn off by opening the plugs in the side of the vats, the lowest one of which is on a level with the bottom. The gold is finally washed into a common wash-tub by means of a hose and pipe, with the smallest possible quantity of water.

The precipitate obtained is treated with a mixture of sulphuric acid and salt to free it of oxides and basic iron salts. For this purpose a handful of salt to 5 pounds of oil of vitriol is used. By stirring the reddish color of the precipitate changes to the brown-gold color, and the particles of gold coagulate, forming generally a ball of precipitate, which is squeezed in a cloth to free it from liquor. When a greater quantity of impurities are mixed with the gold, the precipitate does not ball.

The precipitate is filtered, dried in cast-iron retorts, and smelted with salt, sand, and saltpeter, in sand crucibles.

The general average fineness of the gold-bar is .960; the remaining .040 consisting principally of iron and lead.

6. *Expense of the process.*—The following table shows the expense of the process, with facilities of working three tons a day:

	Expense per 3 tons.		Expense per ton.
Expense of roasting:			
Two shifts on upper furnace, at $1.50 per day, Chinese labor	$3 00		
Two shifts on lower furnace, at $2.75 per day, white labor	5 50		
One and two-tenths cords of cedar wood, at $4 per cord	4 80	14 60	$4 87
Salt, 50 pounds, at $8 per ton	20		
Freight on salt at $12 per ton	30		
Wear and tear on working-scrapers	30		
Wear and tear on furnace	50		

	Expense per 3 tons.		Expense per ton.
Chemicals at San Francisco:			
Salt, 20 pounds, at $8 per ton	$0 08		
Manganese, 15 pounds, at $60 per ton	45	1 93	
Oil of vitriol (66°) 35 pounds, at 4 cents per pound	1 40		
Expense of impregnation:			
Freight on salt and manganese, 35 pounds at $12 per ton	21		
Freight on acid, 40 pounds, $3 per carboy of 165 pounds	64		
Freights on chemicals to works	85		
Expense of carboy, per 40 pounds of acid, carboy returned	32	5 86	$1 95
Labor at vats, $2.50 per day	2 50		
Flour	06		
Wear and tear on buckets and hose	20		
Precipitation and melting of gold:			
Acid for precipitating liquor, 16 pounds	64		
Freight and expense of carboy	68		66
Old wrought iron	06	1 98	
Charcoal, crucibles, fluxes	60		
Management		6 00	2 00
Interest on cost of works, $3,000 at 1 per cent		1 20	40
Payment towards the sinking-fund		2 40	80
Fire insurance		1 20	40
Full cost		33 24	11 08

It appears from the foregoing table that the principal expense of the process consists in the roasting, the cost of which is $4.87 per ton, while the chlorination proper, costing but $2.21 per ton, can scarcely be excelled in cheapness by amalgamation.

The full cost of working sulphurets, when a steady supply of ore can be procured, does not exceed $11.10 per ton.

By adopting Bruckner's revolving cylinder furnace for the finishing roasting, in connection with a drop furnace for the preliminary roasting, a considerable saving may be effected. Stetefeldt's furnace is not thought to effect as perfect a roasting of highly sulphureted ore as is required for the chlorine process; at least, the drop furnaces in use in California, constructed by the writer—some of them with two 10-foot drops—do not approach the perfection required of the finishing roasting for the Plattner process. An additional finishing hearth is invariably required.

7. *Results of the chlorine process.*—In most sulphurets some coarser particles of gold are found, which are not entirely extracted by the chlorination. This gold can be readily caught by allowing the tailings to run in a regular current over quicksilver riffles, such as are used in the mill. The amalgamation of the gold is effected with remarkable facility.

The loss of gold by Plattner's chlorine process amounts to less than 5 per cent.

By using the amalgamating appliances this loss is still further reduced.

INFLUENCE OF THE VELOCITY OF IMPACT ON THE EFFECTIVE DUTY OF STAMPS.

It is well known that but a fraction of the mechanical work expended in lifting stamps, is usefully employed in the fall, also that the value of this effective fraction varies between wide limits.* The total amount of power developed in the fall, may be divided into two portions: first, that usefully expended in actual crushing; second, that which is wasted, in jarring the foundation and in heat. The heat is produced both by friction and by force of compression, not expended in fracture.

The most economical work would be performed when the blow is exactly sufficient to crush the rock with a minimum of jar communicated to the mortar-bed. A fragment of rock may be just strong enough to resist the blow of a stamp; the whole force of the blow will be transmitted through it to the foundation. A slightly harder blow, or smaller piece of rock, would have caused a useful expenditure of power in breaking the rock to fragments, leaving a smaller residue for useless vibrations.

Stamps may be classed under two heads. First, those with a free fall. Second, those whose fall is accelerated by a force added to that of gravity. The latter division includes all those of which the fall is accelerated by the pressure of steam, air, or springs.

The same amount of mechanical power may be expended in raising a heavy stamp a certain height, or in raising a lighter stamp to a proportionally greater height, or in raising a light stamp to the height of the heavy stamp, and then accelerating its fall by a pressure equal to the difference of weight. In all these cases the amount of power expended is the same, while the useful effect will be different.

It must be distinctly realized that all solid bodies, however hard, are to some extent elastic, and therefore capable of compression, within certain limits, without fracture. A body is harder as the resistance it offers to change of shape is greater; more brittle as the limits are narrower, within which change of shape may be effected without fracture. A stamp falling on a block of rubber may cause a depression of 3 inches; falling on a block of granite, a depression of $\frac{1}{50}$ of an inch. The pressure to which the blow is equivalent is inversely proportional to the depth of compression. The pressure on the granite will be 150 times that on the rubber. The time occupied in effecting this depression will, according to the laws of retarded motion, be twice that occupied by the stamp in passing freely, at its maximum velocity, over an equal space. In striking the rubber block, the stamp will be brought to rest in a time during which, at its maximum of velocity, it would have fallen six inches. Striking the granite block, effecting a depression of $\frac{1}{50}$ of an inch, it is brought to rest in a space of time during which it would have fallen $\frac{1}{25}$ of an inch had the block not been there.

A stamp which has fallen freely 15 inches, will have attained a velocity of 9 feet per second, (very nearly,) and will be arrested by the rubber in $\frac{1}{18}$ of a second, by the granite in $\frac{1}{2700}$ of a second. The speed with which the vibration, or impulse of compression, is transmitted through a solid body, is far greater than the greatest velocity of any stamp. At the instant the stamp has come completely to rest, the compression it has made will have extended into the block to a depth ranging with the nature of the material.

Vibrations are transmitted through granite with a velocity of 1,660 feet per second. In the case presupposed, the stamp will have ex-

* The discussion occupying the remainder of this chapter was contributed at my request by Mr. William Main, jr., of Columbia, South Carolina. It will be found to contain a clear and interesting statement of the principles involved. Whether its application is valid for all velocities, even the very high ones of direct-acting steam-stamps, depends, as Mr. Main hints, upon the success with which the other conditions of feed, discharge, water-supply, and amalgamation are adapted to the increased speed.
R. W. R.

pended its whole force in $\frac{1}{2700}$ part of a second, and the compression caused by it will have extended a little over 7 inches in all directions from the stamp. The figure of this solid of compression, (if it may be so termed,) which has taken up the whole force of the stamp, will approach a hemisphere having a radius of 7 inches.

Let us suppose that instead of raising a stamp of 400 pounds weight to a height of 15 inches, an equal amount of power is expended in raising a 100-pound stamp to four times the height, or in raising it 15 inches, and then accelerating its fall with a pressure of 300 pounds of steam: in each case 500 foot-pounds are consumed, the final velocity of the lighter stamp being twice that of the heavier.

To compare the effects of bodies possessing the same mechanical movement but different velocities, let V denote the velocity with which the resistance R is encountered at the beginning of the time T. Let v denote the final velocity, G the weight of the body, and g the acceleration due to gravity. We have then from the laws of retarded motion the formula—

$$v = V - \frac{R}{G} gt$$

When the body is brought to rest, v becomes zero and the equation

$$V = \frac{R}{G} gt$$

t being the time required in coming to rest.

If a body of one-fourth the weight, ($\frac{1}{4}$ G,) having a double velocity, (2 V,) encounter an equal resistance, it will be brought to rest in a space of time represented by t'. By substituting these values and combining the new equation with the last, we find $t' = \frac{1}{2} t$. The body of one-fourth weight, but double velocity, comes to rest in one-half the time, expending, of course, an equal mechanical power.

Applying these principles to the case in point, we see that, as the lighter stamp expands its whole force in $\frac{1}{5400}$ part of a second, the compression caused by it can extend in that time but $3\frac{1}{2}$ inches into the rock. If the face of the stamp-shoe is very small, the bulk of rock over which the compression would extend itself, would be to that compressed by the heavier stamp very nearly as one to four, or inversely as the cubes of the velocities. If the upper face of the block is not larger than that of the stamp, the whole compression will be transmitted directly downward, and the bulk of rock compressed will be inversely as the velocities.

By the more rapid blow the same amount of mechanical power has been concentrated on a smaller bulk of rock and the crushing effect is proportionally greater. Let us suppose the block of stone to be formed to a die with a face equal to that of the stamp-shoe and a depth of $3\frac{1}{2}$ inches. At the instant when the heavy free-falling stamp has come to rest, exerting its maximum of compression, one *half* of the force of the blow will have passed through the block into the foundation and be expended, in jarring it and the ground about it. If, as before said, the stone be just strong enough to resist the blow, the whole force of compression will pass off in useless vibrations.

If the lighter stamp with accelerated motion strike the same block, the compression produced by the blow will not have extended to the foundation, before the whole force of the stamp is expended. The stone will therefore be crushed to pieces.

Future economy in stamping is likely to be attained, not by increasing the weight of stamps, but the velocity of the blow. Practical objections to a high lift are numerous. Velocity can be much better attained by accelerating the fall, as the height of the lift may remain the same or even be diminished, and a greater number of blows struck per minute. The forging of hot iron so obviously demanded this, that the principle has long since been applied to the trip-hammer.

In wet stamping, the rapidity with which a stamp is raised, influences greatly the amount of solid matter held in suspension. As the stamp rises, water flows from all sides to supply its place. The more rapid the rise of the stamp, the greater will be the velocity of the water, and the more surely will the finely crushed rock be whirled up into a state of suspension. If the blow is succeeded by another before the finer particles have settled, the stamp will act only on the coarser particles, packing less and sending more of the slime through the screen.

In some of the later forms of the stamp-mill, while the principle of an accelerated blow is adopted, other novelties with which it has been combined have been less well conceived, and have done much to conceal its advantages.

The principle of high velocities finds its commonest illustration in the action of a bullet on a freely suspended object. If it be a block of wood, even although too thick for the ball to pass entirely through, almost the whole of the mechanical effect will be expended in crushing and dividing the fibers directly in its path, leaving little residue for producing oscillations. A heavier body with less velocity, would cause less crushing but greater oscillations. Stamps of high and low velocities of stroke have similar comparative effects in crushing the fragments of rock lying immediately under them, or jarring the mortar-bed.

In blasting rock, quickness of explosion is equivalent to velocity of impact. The force of compression radiates in all directions from the drill-hole. While the slower explosives take advantage of the weaker seams and have a splitting effect that runs to greater distances, the crushing and shattering effects of the explosion will vary directly as the volumes of gas generated, and inversely as the cubes of the times of explosion.

CHAPTER XII.

CONTRIBUTIONS TO THE RECORDS OF LEAD-SMELTING IN BLAST-FURNACES.

A marked peculiarity of most of the smelting-works of the far West is the looseness with which accounts of the operations are kept.* Indeed, probably over half of the works do not keep any detailed accounts at all, the yearly gross statement of profit or loss being considered sufficient for all purposes. The reasons for this must apparently be sought in the as yet unsettled state of *all* business relations, and in the deplorable fact, that only in isolated cases educated metallurgists are in charge of the smelting-works. Continual and regular assays of the ores, by-products, and slags are almost unknown, so that it is impracticable to ascertain, even approximately, the losses in the smelting processes. Of cases, where regular accounts are kept of the quantities of ore smelted, of the composition of charges, and of the fuel consumed, I know only two or three. Under these circumstances it is extremely difficult to collect figures which cover the operations for a considerable length of time, and which are so valuable for the metallurgist, who wishes to get an insight into the economy of smelting operations, as shown by practice. Figures obtained by personal observation, which can of course cover only the brief space of the visit of the traveling metallurgist, must, therefore, be made to replace the more valuable data. The writer has had occasion during the last and the preceding summer to visit the larger number of the western lead-smelting works, and offers, in the following pages, such data relating to the economy of lead-smelting in the blast-furnace, at various works, as he has been able to obtain. The only object in doing so is to place these figures on record, so that they may be from time to time supplemented with other data, which are now wanting.

THE EUREKA CONSOLIDATED COMPANY'S SMELTING-WORKS.

These works smelt the ores from the mines of the same company on Ruby Hill, Eureka, Nevada. The supply is almost unlimited, but the ores are comparatively poor. They are ferruginous carbonates, with occasional lumps and masses of galena, containing, in the summer of 1872, on an average about 12 per cent. of lead, and $25 to $30 per ton in gold and silver, the values of the two precious metals being about equal. Arseniate of iron enters largely into the composition of the ore, so that a "speiss," principally an arsenide of iron, is formed in smelting the raw ores. Since last noticed, several important changes have taken place in these works.

There are at present five large blast-furnaces for the ore-smelting, of which Nos. 1, 2, 3, and 4 were in blast during my visit in the summer of 1872; No. 5 being in the course of construction.

No. 1 is a rectangular furnace. The dimensions of the hearth, at the

*This chapter was prepared by my deputy, Mr. A. Eilers, and presented as a professional paper at the Boston meeting of the American Institute of Mining Engineers, in February, 1873. It will be found practically valuable by the owners and managers of American works.—R. W. R.

level of the slag-spout, are 6½ by 3 feet; at the tuyeres, which are 12 inches above the slag-spout, 5 by 3 feet. One foot above the tuyeres a short bosh commences, sloping back at an angle of 45 degrees, until the section of the furnace is 5 feet 9 inches by 4 feet 6 inches. From here to the top the walls are perpendicular. The total height from the tuyeres to the charge-door is 10 feet.

There are eight water-tuyeres of 3½ inches nozzle, two of which lie horizontally in the back and parallel to each other; and three in each side, also parallel to each other. But the opposite tuyeres, instead of blowing directly toward each other, are all pointed forward, so that lines through the axes of the front pair, for instance, meet about 6 inches back of the middle of the breast. The blast is supplied by a No. 8 Sturtevant blower, which makes 2,100 revolutions per minute. Pressure of wind=1 inch mercury.

Nos. 3 and 4 are octagonal furnaces, with the same area of hearth as No. 1; but they have only seven tuyeres each. Otherwise they have the same bosh, height, and vertical walls. They smelt the same charge as No. 1, and do equally good service.

Charge for Nos. 1, 3, *and* 4.

Charcoal:	6 measures at 1.2 bushels=7.2 bushels at 15 lbs.=108 lbs.				
Ore:	40 shovels	at 15 lbs.	= 600 lbs.		(100)
Slag:	2 shovels	at 15 lbs.	= 30 lbs.	630 lbs.	(5)

Smelted in 24 hours:

Ore: 50 tons.
Slag: 2.5—5 tons. 52.5—55 tons.

Coal consumed....................1,200 (1,197) bushels=9 tons.
Coal consumed per ton of charge..22.8 bushels=342 lb.=17.1 per cent.
Coal consumed per ton of ore......24 bushels=330 lb.=18 per cent.

Cost of labor in twenty-four hours per furnace, smelting 50 *tons.*

3 smelters, at $4.50	$13 50	
6 helpers, at 4.00	24 00	
6 chargers, at 4.00	24 00	
		$61 50
To this must be added:		
*¼ of wages of engineers	$4 50	
¼ of wages of two foremen	3 00	
¼ of wages of blacksmith	1 50	
¼ of salary of metallurgist	3 33	
For roustabouts, &c	12 00	
		24 33
Total		85 83

Cost of labor per ton of ore, $1 .71.

The cost of repairing furnaces, wear and tear of machinery and tools, oil, and materials generally, as well as the waste of coal in handling, must be added to the costs given above. They are not in my possession at present, but to judge from the total cost of smelting given in the

*Assuming that four furnaces are running at a time.

annual report of the Eureka Consolidated Company for 1871, these items must foot up heavily.

Furnace No. 2 is smaller than the others, and is charged differently. The size of the hearth at the level of the slag-spout is 5 by 3 feet; at the level of the tuyeres, 3½ by 3 feet. Above the bosh, which effects the transition to the larger section in the same manner as described in the larger furnaces, the size is 4 feet 6 inches by 4 feet 3 inches, and the whole height above the tuyeres is 10 feet. There are 4 tuyeres of 3½ inches nozzle. Pressure of wind, 1 inch mercury.

Charge for No. 2.

Charcoal: 2 measures at 1.2 bushels=2.4 bushels at 15 lbs.=36 lbs.

Ore: 11 shovels at 15 lbs.	=165 lbs.		(100)
Slag: 1 shovel at 15 lbs.	= 15 lbs.	180 lbs.	(9.09)

Smelted in 24 hours: Ore, 30 tons.
Slag, 1.5 to 3 tons—31.5 to 33 tons.

Coal consumed,	870 bushels=6.525 tons.
Coal consumed, per ton of charge,	26.6 bushels=399 lbs.=19.95 per cent.
Coal consumed, per ton of ore	29.09 bushels=436 lbs.=21.81 per cent.

Cost of labor in twenty-four hours per furnace, smelting thirty tons of ore.

3 smelters, at $4.50	$13 50	
3 helpers, at 4.00	12 00	
3 chargers, at 4.00	12 00	
		$37 50
To which must be added:		
½ of wages of engineers	4 50	
½ of wages of two foremen	3 00	
½ of wages of blacksmith	1 50	
⅓ of salary of metallurgist	3 33	
For roustabouts, &c	8 00	
		20 33
Total		57 83

Cost of labor per ton of ore, $1.93.

The remarks as to the other costs, made in speaking of the larger furnaces, are equally applicable here.

THE RICHMOND CONSOLIDATED COMPANY'S WORKS.

This company smelts the same class of ores as the foregoing, but they are richer in lead and silver. They come from the Richmond and Tip-Top mines, on the western end of Ruby Hill, Eureka, Nevada. The furnace running in the month of August, 1872, was an exact copy of furnace No. 1 of the Eureka Consolidated Company, with the single exception of the depth of the furnace above the boshes, which was 6 feet inches.

Charge.

Charcoal: 18 scoops=5.5 bushels at 15 lb.=82.5 lbs.
Ore: 25 shovels at 18 lbs.=450 lbs. (100)

Slag: 2 shovels at 15 lbs. = 30 lbs. 480 lbs. (6.66)
Smelted in 24 hours 180 (?) charges = 40.5 tons of ore, or
43.2 tons of charge.
Coal consumed, 990 bushels = 7.425 tons.
Coal consumed, per ton of charge, 22.9 bushels = 243.5 lbs. = 17.17 per cent.
Coal consumed, per ton of ore, 24.4 bushels = 366 lbs. = 18.3 per cent.

The cost of labor at these works is not in my possession. I can only say that the same number of workmen are employed immediately around the furnace, as at No. 1 furnace of the Eureka Consolidated Company, but the cost of supervision, blast and roustabouts is different, and as only one furnace is run, probably considerably higher per ton of ore than at the works mentioned. At the Richmond works the top of the furnace is intentionally kept blazing, eight billets of wood being thrown in on top after every charge. The effect claimed is the melting of the dust, and its adhesion in that state to the walls of the stack, from which the crusts are from time to time loosened and allowed to fall into the furnace. It is evident that only a very small portion of the dust can be arrested in this way, and more than probable that there is more dust created, when this device is employed, than there would be without it, to say nothing of the lead and silver which must be volatilized.

THE MILLER MINING AND SMELTING COMPANY'S SULTANA WORKS.

The works are located near the head of American Fork Cañon, Utah. The ores smelted come from the Miller mine, near by, and consist of very ferruginous oxidized ores of lead, containing much galena and very little quartz, too little, in fact, to permit the formation of a fluid slag in smelting the ore alone. This fact, however, was not understood by those running the works in the summer of 1872. The ore contained, according to many assays, 40 to 42 ounces of silver and 0.4 to 0.6 ounce of gold per ton, and 56 per cent. of lead.

There are three circular furnaces of the Piltz pattern, 9 feet high above the tuyeres. The section of the hearth of No. 1 is 28 by 36 inches. It has six water-tuyeres with 2½-inch nozzles. The size of Nos. 2 and 3 in the hearth is 24 by 32 inches. They have four tuyeres each, of the same size as No. 1. They lie about 6 inches above the slag-spout, and are inclined inward, so that they must blow directly on the metal-bath, thus occasioning volatilization of lead.

All the furnaces are provided with the automatic tap.

Charge.

Charcoal: 6 scoops = 1.8 bushels @ 16 lbs. = 28.8 lbs.
Ore: 5 shovels at 20 lbs. = 100 lbs.
Slag: About ¾ shovel at 16 lbs. = 12 lbs.
112 lbs.
Smelted in 24 hours: 240 charges = 12 tons of ore or
13.44 tons of charge.
Coal consumed: 432 bushels = 3.45 tons.
Coal consumed per ton of charge: 32.1 bushels = 513.6 lbs. = 25.68 per ct.
Coal consumed per ton of ore: 36 " = 576 lbs. = 28.8 per ct.

The product per furnace at these works in 24 hours was 4 to 4.5 tons of lead, containing 85 to 121 (rarely) ounces of silver and 1.2 to 1.45 ounces of gold. This shows an enormous loss of lead and of the precious metals. There are two causes for this, both evident at once to the observer. The first is the flaming top of the furnaces, out of which a roaring bundle of fire issues continually, tearing along great quantities of fine ore and coal, which are deposited in a thick layer on the roof of the smelting-building and in the vicinity. The second is the fact that the slag produced is far too basic, thus enveloping metallic lead and matte and preventing separation. There is no matte saved, so far as I know.

THE SATURN WORKS.

These works are situated at Sandy Station, eleven miles south of Salt Lake City. The ores smelted are principally ferruginous carbonates with some galena from the Cottonwood Cañons, quartzose carbonates from Bingham Cañon, and occasionally ores from Tintic. (?) There are three small circular furnaces of the Piltz pattern, with four tuyeres, two in the back and one in each side. One Sturtevant blower, driven by steam, supplies the blast, which is kept at a pressure of about 1 inch quicksilver. Two furnaces were running at the time of my visit (August 23, 1872.) Slag free and apparently a singulo-silicate.

Charge.

Charcoal: 4 scoops =1.2 bushels at 16 lbs. =19.2 lbs.		
Ore: 3 large shovels at 20 lbs. =	60 lbs.	(100)
Rawlins iron-ore: 1 shovel	15 lbs.	(25)
Limestone: ½ shovel	6 lbs.	(10)
Slag: 1 shovel	15 lbs.	(25)
	96 lbs.	

Smelted in 24 hours: 345 charges=10.35 tons of ore, or 16.56 tons of charge.

Coal consumed: 414 bushels = 3.32 tons.

Coal consumed per ton of charge: 25 bushels = 400 lbs. = 20 per ct.

Coal consumed per ton of ore: 40 bushels = 640 lbs. = 32 per ct.

BRISTOL & DAGGET'S WORKS.

This establishment is situated in Bingham Cañon, Utah.* The ores smelted are very siliceous carbonates containing little iron, and some galena, principally from the Winnemuck mine, on the hillside behind the works. There are two circular Piltz furnaces, 14 feet high above the tuyeres. Their diameter at the level of the tuyeres is 3.5 feet. There are six of the latter with 2½-inch nozzles, lying 10 inches above the slag-spout. The blast is supplied by two large Root blowers, and a pressure of 1.5 inches mercury is maintained.

A report for three months from April 1 to June 30, 1872, furnishes the following items:

Average assay of ore smelted: Lead, 37.7 per cent.
Silver, 56.18 ounces per ton.

Smelted: Ore	1,268.000	tons.
Iron oxide	407.888	"
Limestone	518.140	"
Own slags	208.352	"

Coal consumed: 74.830 bushels = 598.64 tons.

*A review of the operations of these works for 1872 from the pen of Mr. Dagget, will be found in the next chapter.—R. W. R.

This gives an average charge as follows:

Ore	100	
Iron oxide	32.16	
Limestone	40.86	
Own slags	16.43	
		189.45
Charcoal		47.2

Coal consumed per ton of charge: 31.14 bush.=498.24 lbs.=24.9 per ct.
Coal consumed per ton of ore: 59.00 bush.=944. lbs.=47.2 per ct.

The product from the above materials was:

Lead........................439.951 tons.
Silver........................67,478.2 ounces, which would show an apparent loss of

Lead........................7.9 per cent.
Silver........................5.3 per cent.

This loss, it will be observed, is not a very large one for western circumstances. That Bristol and Daggett's works lose less in lead and silver than any other smelting works in the west, with the single exception of, perhaps, one or two at Eureka, Nevada, seems, at any rate, certain. The average length of campaigns at these works is from twenty to twenty-two days, and 14 tons of ore are smelted in twenty-four hours. Iron ore from Rawlins costs $25 per ton; limestone, $7; coal, 33 cents per bushel, and ore, (mining, including all prospecting and construction,) $6 per ton. The cost of labor is not in my possession.

BELSHAW AND JUDSON'S SMELTING-WORKS.

These works are located at Cerro Gordo, Inyo County, California, and smelt the ore from the Union mine, consisting of gray carbonate, ferruginous earthy carbonates and galena. Small quantities of very siliceous true silver ores are added to the charge for the purpose of concentrating their silver in the lead. The furnace is a low round shaft-furnace with three cast-iron tuyeres of 2½ inches diameter, lying about 12 inches above the slag-spout. The diameter of the furnace is uniformly 30 inches from the tuyeres to the charge-hole, the latter being 7½ feet above the former. The lower part of the furnace up to within 5 feet above the tuyeres is constructed of masonry. On the top of this rests an iron cylinder 2½ feet high, its upper rim reaching to the bottom of the charge-hole. Above are again 3 feet of masonry, from which the flue leads into a so-called "down-throw" and a low chimney. The furnace is not charged up to the charge-door, but only to the lower edge of the iron cylinder, it being claimed that if the furnace is filled to the top, the smelting is much slower, and considerably more coal is used per ton of ore. This can only be explained by great weakness of the blast, the increased weight of a higher column of charge preventing the penetration of the blast to the middle of the furnace. With a proper blast the heightening of the smelting column should cause a saving of fuel and an increased production. The blast is supplied by a small Root blower, (No. 2,) which is driven by a 10 horse-power engine. The blower makes 325 revolutions per minute, which is many times more than it is intended to make by the builders. The consequence is that frequent repairs become necessary. Formerly the ores were first roasted and slagged in a Mexican "galemador," and then smelted in the shaft-furnace, but the slag falling at that time contained still from 15 to 20 per cent. of lead with 1 to 4 ounces of silver per ton. It was found that in smelting the ores immediately in the blast-furnace, the slags contained only from 8 to 10 per cent. of lead, and less silver than formerly. So the latter less expensive process was altogether introduced, as the choice of the least evil of the two. It is the pride of these works that they smelt comparatively more ore with less fuel in twenty-four hours than any other works in the country. But from the great loss of lead it is evident why this is the case, to wit, because so large a portion of the lead in the ore is not reduced at all, and, consequently, consumes no carbon for that purpose, but is converted into a silicate of lead which requires little heat for fusion. The charcoal is a very excellent article, and made altogether of pinon and mahogany.

Charcoal:	175 bushels at 18 lbs.	= 31.5 lbs.		
Ore, fine carbonate:	12 shovels at 16 lbs.	= 19.2 lbs.		(100)
Ore, Galena:	1 "	= 20 lbs.		(10.4)
Ore, quartzose silver ore:	1 "	= 15 lbs.		
			227 lbs.	(7.8)
Slag: 2 shovels at 15 lb			30 "	(15.6)
			257 lbs.	

Smelted in 24 hours, 200 charges = 22.7 tons of ore, or 25.7 tons of ch'ge.
Coal consumed: 350 bushels = 3.15 tons.
Coal consumed: per ton of charge, 13.6 bushels = 244.8 lbs. = 12.2 per ct.
Coal consumed: per ton of ore, 15.4 bushels = 277.1 lbs. = 13.8 per ct.

The consumption of fuel is remarkably small, and it is only possible for the reasons above stated. It is to be regretted that exact data could not be obtained at the works, to elucidate the economical bearing of the Cerro Gordo process fully and incontrovertibly. As it is, there is barely a sufficiency of data on hand to show that fuel is economized by means of an almost unprecedented loss of lead. It is also claimed by the manager of the works that it is cheaper to lose the lead than to procure iron oxides for the purpose of mixing with the charge. But whoever has seen the enormous masses of hydrated oxide of iron in the Cerro Gordo mines, will hardly be able to realize this.

The whole management of the works is rather calculated to create the suspicion that the proper composition of the charge is not understood. It is certain that either by an addition of iron oxide to the present charge, or by omitting the addition of the quartzose silver ores altogether, far better results might be obtained than at present. The exact proportion of the smelting mixture ought, of course, to be regulated upon determination by analysis.

The following are a few additional data, which help to give some idea about the work done at this smelter. Two hundred charges are generally made in twenty-four hours; when the furnace is in the best smelting order, the number of charges in twenty-four hours rises sometimes as high as 240. From 100 to 148 bars of bullion are made in twenty-four hours, a bar weighing 85 pounds. Different lots of bullion contained respectively 130, 125, 147, 145, 134 ounces of silver per ton. The lead bars, after deducting the silver, contain 98 per cent. of lead, the principal impurity being copper, which comes originally from the quartzose silver ores. It enters into the lead, because the lead-copper-matte, which forms in the proportion of 100 pounds to one ton of bullion, is always given back raw into the smelting process. The fine ore contains about 25 ounces of silver per ton, the galena from 50 to 80, the silver ore, third class, 50 ounces, second class, 65 to 100 ounces, first class, 250 to 300 ounces, the abundance of these three classes being in the order given. The silver ores proper are bought from other parties, $20 per ton being paid for third class. The Union mine, furnishing the lead ore, belongs to the works. The average contents of lead in the charge is not precisely ascertained at the works, but from calculation it must be about 34 per cent., if 22.7 tons of ore furnish 5.25 tons of bullion, and the slag contains 15 per cent. of lead.

All that has been said of the last works applies also to Beaudry's furnace in the same district.

THE OWEN'S LAKE SILVER MINING AND SMELTING COMPANY.

The works of this company are located at Swansea, ten miles west of Cerro Gordo, on the eastern shore of Owen's Lake. This company has two furnaces, which are in their general features like those just described. They are 8 feet high above the tuyeres, of which there are three, with 3-inch nozzles in each. They lie only a few inches above the slag-spout, and are inclined downward. This accounts for the formation of the extremely small quantity of matte produced, though there is more sulphur in the charge smelted here than in that of Belshaw's works. Hereafter these works will smelt the lead ores of Santa Maria and Cerro Gordo, together with such small quantities of quartzose silver ores as can be bought to advantage, and the charges for the furnaces can, therefore, be kept more uniform than formerly, when small lots of different custom ores were smelted, as they could be picked up. Daily records have heretofore not been kept at the works, but the following is given as about an average charge: *

Charcoal: 60 to 80, average 70 bushels at 18 lbs.=1,260 lbs.

Ore: 3 tons of carbonates	=	6,000 lbs.	(100)
1 ton galena	=	2,000 lbs.	(33.3)
0.5 ton of quartzose silver ore	=	1,000 lbs.	(16.6)
		9,000 lbs.	
Slag: 0.675 ton......		1,350 lbs.	(22.5)
Total......		10,350 lbs.	

Coal consumed per ton of charge, 13.52 bushels=243.36 lbs.=12.16 p. c.
Coal consumed per ton of ore, 15.55 bushels=280 lbs.=14.11 p. c.

Fuller returns from these works are promised hereafter.

For the purpose of comparison, I give here the blast-furnace charges and a short description of the furnaces of European works, which beneficiate lead ores by the same or similar processes, as practiced at the American works above enumerated.

WORKS AT LA PISE, DEPARTEMENT DU GARD, FRANCE.

These works employ a circular furnace of about 30 inches diameter at the tuyeres and above. The tuyeres, of which there are three of not quite 2-inch diameter, lie in pillars of masonry between water-cooled cast-iron plates, 0.82 feet above the slag-spout. Only two of the tuyeres are generally used in smelting. The total height of the furnace above the tuyeres is 9 feet 6 inches. Campaigns last from two to three months. Pressure of blast 1.18 inches mercury.

The ores treated come from Pallières, near Anduze, and from Sardinia.

* These items were obtained in September, 1872. Since then the charges have been changed.

The former are reported to contain, after roasting, 40 per cent. of lead, 0.11 per cent. silver, and 20 per cent. silica. In twenty-four hours 8.8 to 11 tons of ore are smelted with 25 per cent. of coke = 2.2 to 2.75 tons.

Charge.

Roasted ore		10 tons.
Limestone		2.5 tons.
Iron ore	0.3 to	0.4 tons.
Iron	0.2 to	0.3 tons.
		13.2 tons.

Metallurgists generally rate the effect which can be produced with one ton of coke equal to that of 200 bushels of inferior charcoal, weighing 12 pounds per bushel, or 2,000 pounds of coke = 2,400 pounds charcoal. According to the above, 25 per cent. of coke is used in smelting the ore in the La Pise shaft furnace. The charge, in which there are ten tons of ore, requires, therefore, 2.5 tons of coke. Expressing this in charcoal, weighing 15 pounds to the bushel—which is the fair average weight of western charcoal—we have 400 bushels of charcoal consumed to smelt ten tons of ore. Therefore:

Coal consumed per ton of charge, 30.3 bush. at 15 lbs. = 454.5 lbs. = 22.7 p. c.
Coal consumed per ton of ore . . . 40 bush. at 15 lbs. = 600 lbs. = 30 p. c.

SMELTING WORKS AT CLAUSTHAL, LAUTENTHAL, AND ALTENAU.

The smelting is done in Raschette furnaces, 3 meters (9.8 feet) long, and 0.94 meters (3.08 feet) wide at the tuyeres, and 6.277 meters (20.59) feet high, with ten tuyeres of 0.049 meters (0.16 feet = 1.92 inches) diameter. In twenty-four hours, 7,500 kilograms = 16,500 pounds of ore, or 20,000 kilograms = 44,000 pounds of charge, are smelted with 2,500 kilograms = 5,500 pounds of coke, the latter, according to the data above given, equal in effect to 440 bushels of charcoal.*

From the above it appears that, expressing the values for fuel as charcoal, there are consumed—

Per ton of charge . . . . 20 bush. at 15 lbs. = 300 lbs. = 15 per cent.
Per ton of ore . . . . 53.33 bush. at 15 lbs. = 799.95 lbs. = 39.99 per cent.

The charges at the three works named are as follows:

	Clausthal.	Lautenthal.	Altenau.
Ore	100	100	100
Roasted matte	51	56	50
Copper slags from the Lower Hartz	60	115	87.3
Slags from the same smelting	93	75	55.3
Dressed furnace scrapings	3		
Slag from the smelting of scrapings in the copper process			26.6
Scraps rich in lead			4
	307	346	321.2

Early in 1872, when the "Kast" furnace had been introduced and in operation for some time, Mr. A. Wolters, M. E., assayer of the United

* Further and late information in regard to the furnaces and smelting operations at the Upper Hartz can be found in *Metallurgie des Bleies*, by Dr. C. Rammelsberg, pages 8-270.

States assay office, Boise City, returning from Clausthal, brought the following notes: The charges for both the "Kast" and Raschette furnaces were, with due regard for the differing gangue of the ores and the varying contents of lead and silver, mixed so in quantities of 1,000 cwt., (dry,) that the average contents were—

Lead	58 to 60 per cent.
Silver	0.1 per cent.

and the proportion of the different gangues was made so as to furnish an easily fusible slag.

Such a quantity of 1,000 cwt. was divided into 20 "charges" of 50 cwt. each. To this "charge" are then added the following substances in the proportions given:

Ore	100
Roasted matte from former smelting	50
Copper slag from Lower Hartz	80
Slag from matte-smelting	40
Impure slag from same process	32
	302

The last two items vary somewhat, according to the acidity of the gangue. To the charge of the Raschette furnace there are often added twenty additional parts of slag from the same smelting.

The quantity smelted in a Kast furnace in twenty-four hours, according to an average of a month's working, is 63 cwt. of ore, or 190.26 cwt. of charge, equal to about 9.5 tons—100 cwt. of ore requires 51 cwt. of coke in smelting. One pound of coke carries, therefore, according to the foregoing, approximately six pounds of charge, or 16.66 per cent. of coke are used. Assuming again the effect of one ton of coke, equal to that of 160 bushels of charcoal of 15 pounds each, we have—

Charcoal consumed per ton of charge: 27.7 bushels @ 15 lb.=415.5 lb.=20.77 p. c.

Charcoal consumed per ton of ore: 81.6 bushels @ 15 lb.=1224 lb.= 61.2 p. c.

SMELTING WORKS OF FRIEBERG, SAXONY.

All the ores occurring in the Frieberg mines are now subjected to the same metallurgical treatment, with the exception only of the ores containing more than 30 per cent. of zinc, and those containing a large amount of arsenic. These two classes are specially treated.

The ores smelted at the "Muldener Hütte" during 1869 (16,589,500 kilograms = 36,573,211 lb.=18,286.60 tons) contained on an average 17.6 per cent. of lead, and 0.6 per cent. Cu. The smelting, both at the "Muldener" and at the "Halsbrückner" works, is done in round shaft-furnaces (with 8 tuyeres each) of 1.726 M. =5.66 feet diameter, and a height of 3.84 M. =12.59 feet above the tuyeres.

Charges.	*Muldener Hütte.*	*Halsbrückner Hütte.*
Roasted ore	100	100
Raw matte	10	3.03
Kiln-roasted pyrites	15	—
Slag	80—100, Avg. 90	50
Entzinkungsrückstände.		3.338
Fluorspar		0.35
Calcspar		1.583
Heavy spar		0.145

In twenty-four hours at the former works (25,000 to) 30,000 kilograms ore = (55,000 to) 70,000 kilograms charge are smelted; at the latter 35,000 kilograms ore = 50,000 kilograms charge. (11 to) 12 per cent. of coke (referring to the charge) are used.

This shows for

Muldener Hütte.

Charge 70,000 kilograms = 154,322 pounds English.

Coke consumed 12 per cent. = 18,518 pounds, which is equal in effect to 1,481.44 bushels of charcoal of 15 pounds each.

Charcoal consumed, per ton of charge: 19.2 bushels = 288 pounds = 14.4 per cent.

In the 70,000 kilograms charge are 30,000 kilograms ore = 66,138 pounds English.

Therefore:

Charcoal consumed per ton of ore: 44.8 bushels = 672 pounds = 33.6 per cent.

Halsbrückner Hütte.

Charge 50,000 kilograms = 110,230 pounds English.

Coke consumed, 12 per cent. = 13,227.6 pounds, equal in effect to 1,058.2 bushels charcoal, of 15 pounds each.

Charcoal consumed per ton of charge: 19.2 bushels = 288 pounds = 14.4 per cent. 50,000 kilograms charge contain 35,000 kilograms = 77,161 pounds English, ore. Therefore:

Charcoal consumed per ton of ore: 27.4 bushels = 411 pounds = 20.5 per cent.

The following table gives a comprehensive summary of the amounts per ton, and percentage of fuel used, at the American and European works, brought forward in the foregoing article.

CONSUMPTION OF CHARCOAL IN LEAD BLAST-FURNACES.

Names of smelting-works.	Bushels of charcoal per ton of—		Pounds of charcoal per ton of—		Percentage of charcoal per ton of—	
	Charge.	Ore.	Charge.	Ore.	Charge.	Ore.
American works.						
1. Eureka Consolidated Company:						
a. Furnaces Nos. 1, 3, and 4	22.8	24	342	360	17.1	18
b. Furnace No. 2	26.6	29	399	436	19.9	21.8
2. Richmond Consolidated Company	22.9	24.4	343.5	366	17.17	18.3
3. Miller Mining and Smelting Company	32.1	36	513.6	576	25.68	28.8
4. Saturn Works	25	40	400	640	20	32
5. Bristol & Dagget's works	31.14	59	498	944	24.9	47.2
6. Belshaw & Judson's works	13.6	15.4	244.8	277	12.2	13.8
7. Owen's Lake Silver-Mining and Smelting Company	13.5	15.5	243	280	12.16	14
European works.						
9. La Pise	30.3	40	454.5	600	22.7	30
9. Clausthal, Lautenthal, and Altenau:						
a. Raschette furnace	20	53.3	300	799.9	15	39.99
b. Kast furnace	27.7	81.6	415	1,224	20.7	61.2
10. Freiburg:						
a. Muldener Hütte	19.2	44.8	288	672	14.4	33.6
b. Halsbrückner Hütte	19.2	27.4	288	411	14.4	20.5

According to a supplement in Rammelsberg's "Metallurgy of Lead," the Raschette furnace at Clausthal consumes for 100 pounds of ore 48 pounds of coke, and the Kast furnace 41.6 to 42.4 pounds. Accepting for the Kast the first of the two figures given, we would have, calculated for charcoal:

	Bushels of charcoal per ton of—		Pounds of charcoal per ton of—		Percentage of charcoal per ton of—	
	Charge.	Ore.	Charge.	Ore.	Charge.	Ore.
Raschette furnace	25	76.8	375	1,152	18.7	57.6
Kast furnace	22	66.5	330	997.5	16.5	49.8

It is evident that these figures cannot be reconciled with those given before. Yet both are on equally good authority, and all those in regard to the Raschette furnace are even taken from the same author. I am inclined to think that the main error is in Dr. Rammelsberg's statement, page 258 of his *Metallurgie des Bleies:* "In twenty-four hours there are smelted 7,500 kilograms ore, with 2,500 kilograms coke." This would be a consumption of coke of only 33.3 per cent., while all other authors, who have written on the Clausthal works, have always given for the Raschette furnace a consumption of 43 to 50 pounds of coke to 100 pounds of ore.

From the foregoing tables it appears that setting the two Cerro Gordo cases aside, (sufficient reason for which is given in the text,) American works use more fuel in smelting their blast-furnace *charges* than European works, although their ores are "kindlier;" but that, in referring the quantities of coal used to the ore in the charge, American works appear to be conducted more economically in this respect. Whether *true* economy is practiced, must, for the present, remain an open question, which can only be answered after American works have begun to control their whole process by means of chemical analysis. European works generally add large quantities of slag, and other indifferent materials, from previous smeltings to their charges, in order to protect the metal; and the slags finally thrown over the dump contain usually only from 0.5 to 1 per cent. of lead, and silver in hardly appreciable amounts. American lead-slags hardly ever contain less than 5 per cent., and in some exceptional cases up to 20 per cent. of lead, while the contents in silver correspond with those of lead. There are cases in which this loss cannot, with economy, be avoided at the present time, but there are more of those in which metallurgical skill could, without increase of cost, compose charges, the result of which would be slags as clean as the European ones. There is, however, one consolation for the present unnecessary loss: while the robbing of mines leaves them generally in such a shape that a subsequent generation cannot repair the losses occasioned by the first method of working, the robbing of ores leaves residues from which, in the future, science can profitably extract the useful constituents.

CHAPTER XIII.

ECONOMICAL RESULTS OF SMELTING IN UTAH.

The following discussion of the costs and losses of metallurgical operations in Utah was prepared at my request by Mr. Ellsworth Daggett, manager of the Winnamuck mine and smelting-works, in Bingham Cañon, near Salt Lake. In the last chapter, Mr. Eilers mentions these works as among the best managed in the West; and in my chapter on Utah, I have accorded to them similar praise. At the same time, it will be noticed by the professional reader that the practice described by Mr. Daggett is not incapable of improvement. In the item of fuel particularly, a considerable saving was effected, at the close of the year, in the introduction of coke from Pennsylvania, instead of charcoal. The results hereinafter detailed are based on the use of charcoal; but they are valuable as the careful records of actual experience. I trust that similar systematic records, the keeping of which I have strenuously urged upon western metallurgists, will permit, in future, comparisons and deductions of great importance. Scarcely any folly which the managers of such enterprises can, under present circumstances, commit, is greater than to maintain secrecy concerning their operations, when the free interchange of trustworthy information would result in immediate gain to all concerned.

The ore smelted in the Winnamuck furnace, during the year 1872, consisted for the most part of oxidized ores from the Winnamuck mine, only 60 tons of outside ore (from the Spanish mine) having been smelted. The latter, like the principal Winnamuck ore, was oxidized; or so-called carbonate ore. There was mixed with those oxidized ores 300 to 400 tons, or 7 to 10 per cent. of galena, some of which was mined with the oxidized ore, while a part was mined separately from the lower portion of the mine, and afterwards mixed with the ore, with a view of preventing the formation of deposits of metallic iron in the furnaces.

The average assay in silver of all the ore handled was 51.46 ounces per ton, most of it existing as chloride of silver.

The lead contents were 34.98 per cent., all, or nearly all, in the form of carbonate of lead. The relative amount of silver is not at all constant, the best silver ore often being poorest in lead.

The predominant gangue was silica, several determinations of which have been made on representative samples, yielding, in three such samples, 26, 38, and 58 per cent. silica—the latter test being ore containing but little lead. The average contents in silica are about 35 per cent., with 6 to 7 per cent. sesquioxide of iron and small quantities of alumina and lime. Mechanically, the ore was very fine, and so thoroughly disintegrated that it presented few distinguishing characteristics, rendering sorting or separating of ore from waste difficult and often impracticable.

Experiments on a small scale have been tried with a view to separate the silica by washing, but these were unsuccessful, as the finest slime, requiring a long time to settle in still water, contained a large amount of silver, and on a careful sizing and washing of the sands and coarser parts, the silver contents were found to be less dependent on specific gravity than is necessary for successful concentration. The lead contained admitted of a certain degree of concentration, but not the silver.

The fluxes used were iron-ore, limestone, and slag. The iron-ore used is red hematite from Rawlins, in Wyoming Territory.

Three determinations of the iron-ore yielded respectively 66.5, 67.46, and 68.5 per cent. metallic iron. They were of different samples; the last, of an average sample of a car-load, or 11 tons. The little silica (3 per cent.) found in one analysis was probably due to dirt intermixed in transit, as the only observable gangue is calcspar, which may occasionally be found. The average may be taken at 67 per cent. iron, 2 per cent. carbonate of lime, and 1 per cent. dirt. The limestone used contained about 6 per cent. silica, and traces of magnesia.

The fuel was almost entirely charcoal, only a few tons of coke having been used near the end of December. Of the 311,996 bushels of charcoal used, 85,000 to 90,000 made from nut-pine or "piñon," was of good quality, though not equal to coal from hard-wood, such as maple, hickory, &c. The remainder was from red and white pine, cedar, and quaking asp, which, however well burned, cannot make a good or even fair fuel, especially when compared with the Connellsville coke, lately introduced. It must be understood that this statement is made solely with reference to the comparative melting powers of the two kinds of fuel, and does not take into consideration the possible increased loss in lead and precious metals, due to a much higher temperature, when coke is employed. The exact value of this latter element cannot yet be determined. With regard to the melting power, our work this year proves that one ton of Connellsville coke, weighed into the furnace, is rather more effective than two tons of the charcoal of the country; the cost of the two materials at Bingham being about the same, ton for ton.

In addition to the fact that the soft charcoal lacks in heating power under the most favorable circumstances, there is connected with its use much waste, especially when, as in Bingham Cañon, it must be transported by rail and team for a long distance, and (as is often the case) paid for at some distant point.

The amount of material smelted during the year 1872 was as follows:

Material.	Tons.	Per cent. of ore.
Ore	3, 954, 913	100
Iron-ore	1, 391, 681	35. 19
Limestone	1, 542, 021	38. 99
Slag	639, 339	16. 16

The slag obtained contained from 35 per cent. to 48.7 per cent. silica. The average of four analyses showed 42 per cent.; but as the analyses were mostly of unusually stiff slag, their average is too high.

The only complete analysis of slag at hand is of a sample produced from a smelting mixture containing rather more limestone and less iron-ore than usual. The analysis made at the Sheffield Scientific School of Yale College, under the direction of Professor G. I. Brush, is as follows:

Silica	37. 93
Sulphide of lead	3. 75
Sulphide of iron	. 44
Alumina	2. 00

Protoxide of iron	30.76
Lime	23.62
Magnesia	.57
	99.07

Although the data are not yet as complete as could be desired, we may approximately calculate the average slag analysis. The ore contained by fire-assay about 35 per cent. of lead. Allowing the loss in the fire-assay to be 2 units, we have as actual lead contents 37 per cent., equivalent to—

Carbonate of lead	47.7
Silica*	35
Sesquioxide of iron*	6.9
Other bases not determined:	
Alumina, lime, &c., and sulphur	10.4
	100

Hence, we have a slag-constituting element in ore and fluxes, (except the slag charged, which, being neutral, may be omitted)—

	Silica.	Protoxide of iron.	Lime.	Other substance.
In 100 parts of ore	35	6.2		10.4
In 35 parts of iron-ore		30.2		
In 39 parts of limestone	2.3		20.5	
	37.3	36.4	20.5	10.4

Parts in 100:

Silica	35.6
Protoxide of iron	34.8
Lime	19.6
Other bases:	
Alumina, oxide of lead and magnesia, with sulphides of lead and zinc	10.0
	100.0

As will appear below, one of the difficulties encountered in smelting has been the rapid burning out of the fire-material, and the question has been frequently asked, Why not use less flux to produce a more highly silicated slag and save the fire-material of the furnace? The answer to this is, that, with the poor fuel in use, a reduction of the quantity of the basic fluxes used caused the smelting to proceed too slowly, so that the increased cost of labor and general expenses per ton of ore more than counterbalanced the saving in flux and fire-material. Indeed, our experience indicates that, with the soft charcoal as fuel, when producing slag containing over 36 per cent. in silica, the consumption of the

* Determined by analysis of general samples.

fire-material is not materially decreased by increasing the silica-content of the slag. This may be explained as follows: The capacity of a slag to dissolve fire-material (chiefly silica) depends directly on the temperature and inversely on the amount of silica already contained in the slag. Now, in general, any increase in the silica-contents of a slag of this description necessitates an increase of temperature, and so far as can be determined in the crude operations of a blast-furnace, the new conditions counterbalance one another.

By slags much more basic than the above the fire material is more rapidly destroyed.

The furnaces of the Winnamuck Company are two in number, and in dimensions (except height) follow the plan of the first Piltz furnace erected at the Eureka Consolidated Works, in Nevada, by C. von Liebenau, in the year 1870. There are, however, some essential points of difference in the construction.

The lower part of the furnace is built of stone, which, when properly seasoned, is as lasting as fire-brick. About four feet above the tuyeres commences the shaft of common brick, cased in sheet-iron and lined for three feet up with fire-brick, and supported by means of a flange upon four hollow iron pillars, rendering it independent of the lower part. Under the hearth is a layer of clay 6 inches in thickness, tamped upon the foundation. This latter, with the six iron plates surrounding the outside of the hearth, should render it impossible for lead to escape into the foundation.

The bottom is made of a mixture of ground clay, raw, and sand, or ground fire-brick, just sufficiently damp to pack well, and is renewed or repaired at the end of every run.

The "siphon tap," used in the Winnamuck furnace, is constructed as follows: There is left in the center of each side plate, at the height of the hearth-bottom, a round hole, 12 inches in diameter. On whichever side it is desired to have the tap, a piece of $\frac{1}{8}$-inch sheet-iron the height of the plates (3 feet) and about 5 feet in length is bent and firmly fastened to the plates at the corners. The space thus inclosed and the channel connecting it, through the hole in the side plates, with the inside of the furnace, are now tamped full of a mixture of sand and clay, during which process a round piece of wood $2\frac{1}{2}$ or 3 inches in diameter and $3\frac{1}{2}$ feet long, having through its center a $\frac{3}{4}$-inch auger-hole, is inclosed in the channel. The lead-well itself is cut out to the size and shape of a Hessian crucible, rather less than a foot in diameter and about $1\frac{1}{2}$ feet deep.

To provide for any impediment in the passage at any time during a run, a small hole is made in the sheet-iron casing, in the line of the horizontal passage from the lead-well into the hearth, through which a bar may be driven to the inside of the furnace, and which afterwards may be stopped with a plug of clay, thus forcing the lead up into the well. This siphon tap is a great improvement on the old method, and Messrs. Arents and Keyes, of Eureka, deserve and have the thanks of all smelters for its introduction.

Dimensions of furnace.

	Feet.	Inches.
Height of platefrom foundation	3	•
Height of columns from foundation	8	
Height of feed-hole from foundation	17	9
Height of tuyeres from foundation	3	8
Diameter of furnace at tuyeres	3	6
Diameter of furnace at feed-hole	5	3

	Feet.	Inches.
Diameter of furnace at top of chimney	3	6
Height of tuyere nozzles above slag flow		10 to 11
Height of tuyere above top of plates		7 to 8
Height of water-tymp-iron above slag flow		7 to 8
Diameter of columns at base		8
Diameter of columns at top		6
Thickness		½
Diameter of nozzle		2½
Height of tuyere above bottom		27
Number of tuyeres, 6 or 7.		

That portion of the furnace above the flange to the feeding-floor is cased in ⅛-inch sheet-iron, and above this, for a height of 6 feet, in thinner sheet iron.

Operation.—In starting the furnace (which has been thoroughly dried by a slow fire and strongly heated for several hours with coal) the outer lead-well is first filled with coal, ignited on top, and a blast from one of the tuyere-pipes is forced downward through the coal, driving the flame and heat through the connection into the bottom of the furnace. This rapidly burns away the wooden plug inserted in building or repairing, and heats to redness the sides of the channel. This having been effected, the furnace is filled to the height of 5 or 6 feet with coal, and when this is thoroughly ignited, from 20 to 30 bars (2,400 to 3,600 pounds) of bullion are introduced through the charging-door. This metal, melting and descending through the ignited coal, is received on the hot bottom of the furnace, and, filling the channel, rises in the outer well, where it is carefully covered with coal-dust. A light blast is now started, and regular charges of 6 bushels of coal, and, at first, small but constantly increasing quantities of ore and flux are introduced until the furnace is full, when the blast is increased. The full charge is usually not attained for at least twenty-four hours. Slag, from the starting, is generally saved for reworking, as the greater proportion of fluxes used at the beginning of a run renders the slag more basic than usual. The average length of run during the year was sixteen days; the longest made, with fire-brick or stone, 26 days.

In charging the furnace the coal (6 bushels) is first measured in and spread upon the preceding charge; then the proper amount of ore, which has been equalized by spreading in heaps of 100 to 300 tons, is weighed; the corresponding amounts of the various fluxes are added by weight; and the whole mixture thus formed is spread over the coal. The charge of fuel is maintained at 6 bushels, and the weight of the smelting-mixture is varied as may be rendered necessary by the alteration in slope of the furnace, or by change in the ore.

The products are silver-lead, slag, and a small quantity of iron matte, containing little sulphur, with occasionally metallic iron in small amount. As the limited quantity of matte produced contained only 14 ounces in silver per ton, nothing has been done with it.*

Cost.—The cost of smelting Winnamuck ore for the year 1872 was high, mainly on account of the large amount of flux used, and the poor quality and the high price of fuel. Below is given the cost of coal, fluxes, labor, &c. As a part of the cost of coal, is included all waste occurring after the coal was delivered at the works; but not the "shortage" or other losses on coal occurring in transit to the works.

*Some of the matte produced lately (in February and March, 1873) has contained upwards of 40 ounces (in one instance 90 ounces) silver per ton, and is, of course, saved for subsequent treatment by roasting and reworking with the ore.

Cost of handling 3,954.91 *tons.*

		Total.	Per ton ore.
Charcoal		$96,718 76	$24 45
Iron ore	$34,792 00		8 80
Limestone	7,710 10		1 94
		42,502 10	
Labor		24,269 91	6 13
Other smelting expenses, wood, brick, &c		10,911 26	2 75
Total smelting cost		174,402 03	44 09
Mining cost		23,430 17	5 92
General expense		15,133 85	3 82
Sampling, assaying, and bullion charge		4,582 11	1 16
Total cost		217,548 16	55 00

To find what portion of the smelting-cost is due to the flux used, or, in other words, the difference between actual cost and the cost (at the Winnamuck works) of smelting an ore or a mixture of ores that would flux itself, we must deduct from the total cost the cost of the fluxes, thus:

Total cost of smelting	$174,402 03
Less cost of fluxes	42,502 10
Cost of smelting total material, ore, iron, and limestone	131,899 93
Cost per ton of material (without slag)	19 14

That is, an ore having the composition of our total material would have been handled for $19.14 per ton, probably a little less, as no deduction is made for cost in handling the flux after it arrives at the works, which is somewhat greater than for the same amount of ore.

The other costs given above on the ore handled were: mining, which include all prospecting, dead work, &c.; general expenses, or such as belong equally to both mining and smelting, (superintendence, office expenses, salaries, &c.,) and freight on the bullion, to railroads, sampling, assaying, &c.

While the above figures represent the actual outlay in money required to produce the given result, yet they do not satisfactorily show the true cost. The losses in lead and silver should be represented, since they form as truly a detail of the calculation as does the fuel in smelting, and one greater in value than the mining of the ore; moreover, as the metal lost is value consumed in the process, there is no reason why this value should not be classed as so many dollars and cents per ton of ore, as are the charcoal, the iron-ore, and the mining costs. Although it is the custom, in speaking of the cost of working ore, to name only the actual outlay, yet to one who knows that in such working there is involved a notable and variable sacrifice of the original value of the ore, and that, as in lead and silver smelting in Utah, after the smelting there is a still larger sacrifice of value in freights, separating and refining the silver and lead, the bare statement of so-called cost is far from satisfactory.

It seems necessary, especially in making comparisons of the relative values of different methods of treatment, to have some concise, definite expression which will show at a glance which of two or more methods is best; in other words, which will net to the ore-owner the most money. Such an expression can be found only by including the total value in the ore at the outset, and accepting as cost the difference between this total value and the net return.

If we suppose the average value of the lead to have been, during the year, 7 cents currency per pound, and that of the silver, $1.2929 coin per ounce equivalent, with gold at 113 (the average of the last nine months of 1872) to $1.46 currency, we have—

Value of 3.82 units of loss in lead	$5 36
3 ounces silver	4 38
Total loss per ton of ore in smelting	9 74

There is also a loss in the treatment of the bullion, a portion of which is eventually recovered by the separating and refining works. As the details of cost and losses in the treatment of bullion are known to the separators and refiners only, it will be sufficient here to regard the aggregate of costs and losses, which may be found thus:

Weight in tons of bullion produced	1,232,741
Weight in tons of the 191,661.4 ounces silver contained	6,572
Total amount of lead	1,226,169
1,226,169 tons lead at $1.40 per ton	171,664 66
191,661.4 ounces silver, at $1.46 currency	279,825 64
Gross value of bullion at railroad	451,490 30
Net value of bullion at railroad	353,551 26
Difference, being freight, costs, losses, and profits of separating-works	97,939 04
Bullion expenses, per ton bullion	79 44
Bullion expenses, per ton ore	25 00

General condensed statement of expenses per ton of ore.

Mining expenses	$5 92	
General expenses	3 82	
		$9 74
Costs of smelting to base bullion	44 09	
Losses in smelting	9 74	
		53 83
Bullion expenses, freight and separation	25 00	
Sampling and assaying	1 16	
		26 16
Total cost per ton		89 73

It may be interesting here to compare with these figures the total costs and losses involved in other methods of disposing of ores, as for instance, by selling them in Utah, or shipping them to England. In this comparison it must be remembered that by "costs and losses" is meant the difference between the money received and the gross value of the ore calculated on its assay, assuming lead at 7 cents currency per pound, and silver at 1.46 currency per ounce; also that all expenses on the ore previous to actual shipment or smelting, such as mining, transportation and (in the case of shipment) sacking, handling, sampling, and assaying, the last four items, amounting to about $7.75 per ton, are omitted. The remaining expense, therefore, consists of the costs and losses in smelting and on the bullion produced, amounting with the Winnamuck ore, as above shown, to $80 per ton.

Three lots Emma ore were shipped to England in 1871, amounting to 1,225 tons, and assaying:

Lead, 41½ per cent., worth per ton	$57 83
Silver, 112.09 ounces, worth per ton	163 81
Gross assay value per ton at railroad, currency	221 64
Net value or amount received per ton, currency	109 55
Costs and losses per ton	112 09

Twenty-seven lots Emma ore were sold at open sale in Salt Lake City, August 10 to October 17, 1872, about 2,800 tons,* assaying:

Lead, 45.14 per cent., worth per ton	$63 19
Silver, 69.73 ounces, worth per ton	101 80
Gross assay value per ton at railroad	164 99
Net value or amount received	71 10
Costs and losses	93 89

Some items affecting these figures are omitted here, such as sampling, handling, &c.—necessary in shipping, but not in smelting ore, at or near the mine. Moreover, the small amount of gold in the Winnamuck ore has not been charged to the ore. It would increase the Winnamuck costs about $2.50 per ton of ore.

A comparison of costs and losses in milling ores containing little lead in Southern Nevada and smelting-ores in Utah, though not strictly conclusive, (the conditions being different,) indicates that the advantage usually ascribed to milling is over-estimated.

In a report on the Meadow Valley mine, of Pioche City, made during the latter part of 1871, by Aug. J. Bowie, jr., M. E., it appears (page 20) that the average production for 1870–'71 was $105.34 per ton, being 73.4 per cent. of the total value, (silver)—

Total silver value per ton, therefore, (coin)	$143 51
Value of production, (coin)	105 34
Loss in silver, (coin)	38 17
The same report, (same page,) gives the total cost—mining, milling, taxes, etc.	44 11
Costs and loss in silver, (coin)	82 28

Reducing this to currency at 113, we have total costs and losses in silver $92.97. To this must be added $1.40 for each unit of lead shown by assay to be in the ore. Assuming the average lead contents of the Meadow Valley ores to have been at that time 10 per cent., we would have total costs and losses $106.97.

If, now, in order to institute a comparison, we take from the above sum the increase of cost due to the position of the Meadow Valley mine, involving higher costs of labor and supplies, which we may assume as not exceeding $15 in currency, we have costs and losses in mining and milling Meadow Valley ores in Utah about $92.

The costs and losses in mining and smelting the same ore with lead-ores in Utah should not exceed this; and, with the late improvements, such as the use of coke, &c., should be materially less. In general, the question as to the most economical treatment of an ore will be deter-

* This ore, owing to its amount and the regularity of the supply, was sold to the best advantage and commanded a price rather higher than other ore sold in open market at the same time.

mined only by a careful consideration of *all* the conditions, such as the nature of the gangue, the lead contents, and the respective losses of the different processes, with the cost of the same—the latter consideration being only one of many—and it may happen that a wasteful process is the best, or that a costly process is the cheapest, that being really the proper treatment which, however wasteful, costly, or even unscientific, enables the owner to make the most money out of his ore.*

*I am inclined to lay some weight on a distinction which Mr. Daggett here overlooks. Not only on general grounds of political economy, but also directly to the miner and smelter, *costs* are better than *losses*: The treatment which consumes in freights, for instance, a certain proportion of the value of the ore, is better than the treatment which leaves the same amount in tailings or slags too poor to be handled again. One expenditure assists trade and develops the social conditions which will cheapen all expenses; the other is a sheer waste of value. Even from a selfish standpoint, that mine-owner is not always the wisest who seeks the greatest *immediate* profit. Witness the robbery and speedy apparent exhaustion of many good American mines, by a system of robbing the rich ores.—R. W. R.

CHAPTER XIV.

THE CALORIFIC VALUE OF WESTERN LIGNITES.

The important question of the metallurgical value of the coals of the Rocky Mountains and the Pacific Coast is to be settled, of course, by practical experiment. Meanwhile, as I have had occasion to point out, the proximate analysis of these coals throws little light upon it, and is, indeed, likely to mislead the metallurgist, if he compares it with the results of similar analysis upon bituminous and semi-bituminous coals. With the view of showing how large a proportion of the material usually classed as "volatile matters" consists of combined water, or oxygen and hydrogen presumably in chemical combination, I have collected a number of ultimate analyses from various sources, in the following tables. The numbered analyses in the first table are as follows:

No. 1. Monte Diablo coal, analyst, H. S. Munro, Columbia School of Mines.

No. 2. Weber Cañon, Utah, analyst, H. S. Munro, Columbia School of Mines.

No. 3. Echo Cañon, Utah, analyst, H. S. Munro, Columbia School of Mines.

No. 4. Carbon Station, Wyoming, analyst, H. S. Munro, Columbia School of Mines.

No. 5. Carbon Station, Wyoming, analyst, H. S. Munro, Columbia School of Mines.

No. 6. Coos Bay, Oregon, analyst, H. S. Munro, Columbia School of Mines.

No. 7. Alaska, analyst, H. S. Munro, Columbia School of Mines.

No. 8. Alaska, analyst, H. S. Munro, Columbia School of Mines.

No. 9. Cañon City, Colorado, analyst, Dr. T. M. Drown, Philadelphia.

No. 10. Baker County, Oregon, analyst, Dr. T. M. Drown, Philadelphia.

No. 11. Block coal, Sand Creek, Indiana, analyst, Professor E. T. Cox.

Number.	Carbon.	Hydrogen.	Nitrogen.	Oxygen.	Sulphur.	Moisture.	Ash.	Combined water.	Calorific power I.	Calorific power II.	Calorific power III.	Temperature, deg. C.
1	59.72	5.08	1.01	15.69	3.92	8.94	5.64	17.65	5900	6472	5757	2590
2	64.84	4.34	1.29	15.52	1.60	9.41	3.00	17.46	6056	6685	5912	2536
3	69.84	3.90	1.93	10.99	0.77	9.17	3.40	12.36	6515	7172	6400	2603
4	64.99	3.76	1.74	15.20	1.07	11.56	1.68	17.10	5892	6662	5738	2512
5	69.14	4.36	1.25	9.54	1.03	8.06	6.62	10.73	6679	7264	6578	2630
6	56.24	3.38	0.42	21.82	0.81	13.28	4.05	24.55	4768	5498	4565	2313
7	55.79	3.26	0.61	19.01	0.63	16.52	4.18	21.38	4814	5766	4610	2375
8	67.67	4.66	1.58	12.80	0.92	3.08	9.29	14.40	6522	6729	6428	2532
9	67.58	7.42	......	13.42	0.63	5.18	5.77	15.10	7439	7845	7330	2683
10	60.72	4.30	......	14.42	2.08	14.68	3.80	16.22	5768	6760	5602	2497
11	72.94	4.50	1.79	11.77	....	4.50	4.50	13.24	6938	7208	6843	2654

This table affords some suggestive comparisons, to facilitate which a remark or two explanatory of its construction will be useful. In the ultimate analysis of coals the proportions are frequently calculated (as, for instance, in the report for 1872 of Professor Cox, State geologist of Indiana) upon the dry coal; that is to say, excluding the percentage of the moisture. Thus the analysis (No. 11 above) of the Sand Creek block coal is given in that report, (p. 18,) as follows: Carbon, 76.38; ash, 4.71; hydrogen, 4.71; oxygen, 12.32; nitrogen, 1.88—the previously-given proximate analysis having shown 4.50 per cent. of moisture. To secure uniformity in the table I have reduced these results to the basis of a full analysis, including the moisture. The justice of including the moisture of the coal in calculations of its calorific power would be unquestionable if the moisture were a constant element. This it is not; it varies in amount, according to the local conditions affecting the samples taken. But, on the other hand, some moisture is always present, and an amount not exceeding 5 or 6 per cent. is scarcely too great to be included in an estimate of average quality. Professor Frazer's proximate analyses of New Mexico coals give an average of 3 per cent.; of the Boulder County coal of Colorado, 16 per cent.; of the Evanston coal, 5.83 per cent.; and the average of 93 analyses of Indiana coals, made by Professor Cox, gives 5.87 per cent. of moisture. Now, this moisture is a greater detriment to the heating-power of the coal than an equal amount of ash, since the water requires to be evaporated, while the ash does not. I have, therefore, included in the above table the percentages of moisture as a basis for caloric calculations, though in several instances (notably Nos. 4, 6, 7, and 10) the amount of moisture is perhaps abnormally great, and the calorific power resulting from the calculation may be less than the average of the coal would give. There are, it will be noticed, three columns of calorific powers. In each of these the amounts are expressed in centigrade heat units, and therefore indicate directly the pounds of water which could theoretically be raised from zero to the boiling-point by the combustion of 100 pounds of fuel. The first column is obtained in the following manner: The amount of combined water is found by adding to the oxygen one-eighth its weight of hydrogen; the remaining hydrogen is multiplied by 34.462, the number of heat-units evolved in the combustion of hydrogen; and the amount of carbon is in like manner multiplied by 8,080, the caloric modulus for carbon. The sum of these two products is the number of heat-units generated by the complete combustion of one unit of the fuel containing the given proportions of carbon and available hydrogen. The heat-units due to the combustion of the sulphur are disregarded, in view of the small amount of sulphur, its low calorific capacity, (about 2,240 units,) and the circumstance that it exists partly in the form of pyrites, the decomposition of which still further diminishes the amount of heat from this source, and partly as sulphuric acid, causing a net loss.

The second column of calorific powers is obtained by a similar calculation on the supposition that the moisture is absent. The third column gives the closest approximation to the available heat, and is obtained by deducting from the figures in the first the amount of heat-units required to vaporize the moisture and combined water. This is 537 units of heat for each unit of water.

The last column gives, in centigrade degrees, the maximum theoretical *temperature* to be obtained by the perfect combustion of the fuel. It is calculated in the following manner: The quantity of carbonic acid, sulphurous acid, water and nitrogen resulting from the combustion of one unit of the fuel in atmospheric air is determined, and the quantity of each of these substances is multiplied by its specific heat. The sum of these products, which we may call the temperature unit, is the number of heat-units required to raise the mixture one degree in temperature. Dividing the number of heat-units given in column III by this temperature unit, we obtain as a quotient the number of degrees centigrade through which the temperature of the fuel will be raised, or, in other words, the average temperature of the products of combustion, on the supposition that the initial temperature is zero; that the combustion of carbon and hydrogen is complete; that no superfluous air is admitted; and that there is no loss by radiation and conduction during the process. The calculation may be illustrated by displaying a single example in detail.

We have in analysis No. 1 of the table the following constitution of the fuel: Carbon, 59.72; hydrogen, 5.08; nitrogen, 1.01; oxygen, 15.69; sulphur, 3.92; moisture, 8.94; ash, 5.64. To find the combined water we add to the amount of oxygen the proportional amount of hydrogen, or one-eighth, since water consists of one part hydrogen and eight parts oxygen. This gives us 17.65 combined water, leaving 3.12 of hydrogen available for the generation of heat. But the moisture and combined water must be evaporated by the combustion of the rest of the fuel; and the heat absorbed in this evaporation is 537 heat-units. Hence, to evaporate 26.59 hundredths of water will require (temperature apart) 142.78 heat-units, which must be subtracted from the calorific power in column I, leaving 5,757.22 as per column III, the available amount of heat.

We now proceed to determine the temperature of the products of combustion. A simple calculation, based upon the chemical equivalents, shows that these products will be as follows:

59.72 carbon will unite with 159.28 oxygen, forming......	219.00 CO_2
3.92 sulphur will unite with 3.92 oxygen, forming........	7.84 SO_2
3.12 hydrogen will unite with 24.96 oxygen, forming......	28.08 HO
26.59 combined water and moisture......................	26.59 HO
Total oxygen required from the air......................	188.16
Amount of nitrogen corresponding to this amount of oxygen in the air	629.86
Amount of nitrogen already in the fuel..................	1.01
Total nitrogen in the products of combustion..............	630.87 N

The specific heat of carbonic acid, that is, the number of heat-units required to raise a unit of this gas one degree of temperature, is 0.216; the specific heat of sulphurous acid is 0.155; that of steam is 0.475; and that of nitrogen is 0.244. Applying these numbers we have for the heat rendered latent by each substance in one hundred units of the above mixture of gases—

$$\begin{array}{lrcl}
CO_2 & 219.00 \times 0.216 & = & 47.304 \\
SO_2 & 7.84 \times 0.155 & = & 1.215 \\
HO & 54.67 \times 0.475 & = & 25.968 \\
N & 630.87 \times 0.244 & = & 153.932 \\
\hline
 & & & 228.419
\end{array}$$

That is to say, it will require 228.419 units of heat to elevate the total products of combustion of 100 units of fuel one degree centigrade; or, 2.28419 is the specific heat of the products of combustion of one unit of the fuel. Dividing 5,757.22, the number of available heat-units from the combustion of one unit, by 2.28419, the heat absorbed for each degree of temperature, we have 2.520, which is the temperature in degrees centigrade of the products. It need scarcely be said that the unit of weight employed is immaterial to this calculation. The temperature is the same whatever the quantity of fuel, provided the combustion takes place as above supposed, and the gases are not compressed.

It should be remarked, finally, that the oxidation of iron in the ash has not been taken into account in the foregoing calculations. The analyses give no means of determining it; but it is certainly insignificant as a source of heat, and its contribution to the resultant temperature would be reduced by the diluting effect of an additional quantity of nitrogen in the air required for its oxidation.

Pure carbon yields by combustion to carbonic acid 8,080 heat-units; and the theoretic resultant temperature of the carbonic acid produced is 2,720°. It will be seen that some of the coals in the table, particularly the lignites of Cañon City, Colorado, and Carbon Station, Wyoming, approach the calorific power of carbon.

Moreover, several of the lignites nearly equal, and that of Cañon City surpasses, the block-coal of Sand Creek in calorific power. Yet the latter is successfully used in the smelting of iron. We are, therefore, led to conclude that high metallurgical temperatures can be obtained from the best lignites of the Rocky Mountains, and that only their physical behavior, which hinders a complete combustion, prevents their use, even in shaft-furnaces. That they can be utilized by means of gas-producers, I think there is no room to doubt.

CHAPTER XV.

THE SEPARATION OF GOLD AND SILVER.

The following interesting and valuable paper on this subject, by Dr. F. Gutzkow, formerly of San Francisco, appeared two years ago in the *Berichte der deutschen chemischen Gesellschaft*, of Berlin:

The usual method employed on a large scale, for a considerable number of years, for separating gold from silver, copper, and other metals, consists in treating the alloy with concentrated sulphuric acid at a high temperature, and precipitating the silver from its dilute sulphuric-acid solution by means of metallic copper, the desilverized liquor being used for the preparation of sulphate of copper. This, however, is in many respects deficient; for, in the first place, there is a large bulk of water required to dissolve the rather difficultly soluble sulphate of silver, and this large bulk of liquid requires, of course, large-sized vessels to hold it. Of far more importance is, secondly, the fact that it involves the production of a large quantity of sulphate of copper, a salt now obtained as a by-product in such large quantities, in various metallurgical and other operations, that, owing to its always yet rather limited consumption, this salt is very difficultly salable. The manufacturer has, in most instances, to content himself with accepting a price for this article which often only barely covers the expense of the sheet-copper employed and the copper present in the alloy which has been operated upon. Taking these matters duly into consideration, the author, who, while residing at San Francisco, in California, was for a series of years the manager of the extensive silver-refining works belonging to the San Francisco Assaying and Refining Company, considered it to be of the highest importance to make a radical change in the method of silver-refining just alluded to, and to limit the manufacture of blue vitriol to the comparatively small quantity of the copper contained in the crude, unrefined ingots. It was found unsuitable to substitute sheet-iron for the sheet-copper in the precipitation, owing to the fact that, by the employment of iron, copper is, of course, again precipitated along with the silver, and the separation of the copper from the silver does not admit of any other method readily executed on the large scale than a repetition of the same process again. The author found, however, that the reducing agency of sulphate of iron (green vitriol) can be applied successfully to the solution of sulphate of silver. The process about to be here described has been employed for a series of years in the works above named, and by this process several thousand hundred-weight of fine silver has been produced. It should be observed at the outset that it is not readily possible, for reasons which are not here further alluded to, to work on the large scale with sulphate of iron upon the solution of sulphate of silver in water. On the contrary, it is required to prepare, first, crystallized sulphate of silver, free from impurities, inclusive of metallic gold in a finely-divided state, sulphate of lead, and other substances, insoluble in a solution of green vitriol. The pure crystallized sulphate of silver is next to be acted upon by a hot and concentrated solution of green vitriol. The very hot, turbid, thickish fluid obtained by the action of boiling concentrated sulphuric acid upon the silver-alloy under operation is poured into a large-sized cast-iron caldron, containing dilute sulphuric acid at 58° Baumé = 1.617 sp. gr., and previously heated to 110°. A small quantity of water is next added; and after the liquor (having been left at rest for a few minutes) has become clear, the solution is siphoned over into another similar caldron, so placed and arranged as to admit of being thoroughly cooled by means of cold water externally applied. For every hundred-weight of silver refined, 10 cubic feet of the dilute acid (sp. gr. 1.617) are taken. The addition of water just alluded to is intended to reduce the very concentrated acid silver solution to the same density, and the quantity of water to be added may be therefore inferred from this explanation. The addition of water is intended, however, to effect something else yet. Precipitates of sulphate of lead and sulphate of silver are formed, and the latter does not become quite permanent until, first, all the lead which was in solution is precipitated; and, moreover, these heavy precipitates greatly aid the throwing down of all substances which render the liquid turbid, and especially the gold. By the means just described, a clear liquid, quite free from any lead and gold, is far more rapidly and completely obtained than by the method usually applied, viz, the pouring of the very concentrated sulphuric acid silver solution into water.

The liquid, having been cooled in the manner just alluded to, and reduced to a temperature of from 30° to 40°, is, by means of a pump, transferred again to the upper caldron, there to be used again as acid at 38° B. At the bottom of the caldron in which the cooling took place, the sulphate of silver will be found deposited, forming a hard, yellow-colored, crystalline crust about 2 inches in thickness. This crystalline mass is tolerably free from adhering acid; but at the deepest part of the vessel will always be found some strongly acid mother liquor, and this acid is to be again used to dissolve a fresh quantity of silver. The crystalline mass, consisting of sulphate of silver, is removed from the caldron by means of iron shovels, and placed on the perforated false bottom of a wooden box lined inside with lead, and placed on wheels, so as to be capable of being moved from one place to another; between the false and real bottom, a tap is placed for running off liquid. Along with the crystals, and adhering thereto, is a red powder, chiefly consisting of sulphate of copper. The next step is to run through, or, more correctly, pour over, the crystalline mass a very hot and very concentrated aqueous solution of protosulphate of iron (green vitriol.) The salt of copper is first dissolved, and therefore that liquid is run off separately, afterwards to be used for the preparation of sulphate of copper. As soon as the solution which runs off begins to exhibit the pure brown color due to sulphate of peroxide of iron, the solution is caused to run into a large, very shallow vessel, in which, on cooling, the largest portion of the silver-salt is decomposed, and some metallic silver is deposited in a spongy state, which substance is collected and placed on a large filter. The greater portion of the crystalline mass of sulphate of silver which has been placed in the box is, however, converted slowly on into a dense coherent mass of metallic silver, and the reduction may be considered complete as soon as the vitriol solution which runs off has assumed the green color it originally possessed. The metallic silver is next washed with pure hot water, then pressed in a hydraulic press, and lastly melted.

The iron solution which has collected in the large-sized shallow vessel just spoken of, after having become sufficiently cool, is poured or run into a lead-lined tank wherein some scraps of old sheet iron are placed, and is thus again reconverted into sulphate of protoxide of iron, to be used at a subsequent operation. The small quantity of silver and copper which are separated in the metallic state by this last-mentioned operation is collected from time to time, and put along with the crystals of sulphate of silver contained in the vessel, wherein they are to be exposed to the action of the sulphate of iron solution. The copper is almost immediately converted into sulphate of copper on coming into contack with sulphate of silver. On the large scale, for every hundredweight of silver reduced from the sulphate 20 cubic feet of green vitriol solution are required.

CHAPTER XVI.

THE PLIOCENE RIVERS OF CALIFORNIA.

The Pliocene period,* to which the deep placer gravels of California are referred, is the concluding epoch of the last great sub-division of geological time, the Tertiary, when the mammalian animals came, that soon, according to the Darwinian school, culminated in the upright, walking, and articulating mammal, man.

The significance of these rivers, *geologically*, is in virtue of their furnishing the oldest authenticated records of fossil man; *economically* and *historically*, in having furnished the gold that extended Anglo-American sway around the world, and created new moral empires on the Pacific, developing several noteworthy features of important future bearing in the march of man to his nobler destinies.

To set forth more clearly that with which I have now to deal, the Tertiary is the period when the hard woods, the oaks, hickories, maples, willows, and palms came, and succeeded in crowding out the cycads, half-ferns, half-palms; when the salmon, perch, and herring came, and succeeded in crowding out the ancient hard-scales, called ganoids; when the reptiles that were oviparous or egg-laying gave way to viviparous mammals that hatch the ovum of their young internally, carry it a long while, as its finer nature requires, and bring it forth alive. Mammals of the same *families* that are now living were universal; but the particular species of mammals, as well as birds and reptiles, are every one extinct—our sure guide as to the ending of the Tertiary.

Vast physical changes in the surface of the globe.—A little tell-tale shell, very characteristic of the Eocene or early Tertiary, is the nummulite. It is the coin of the Tertiary which all the mammals might attach to their watch-guards, for it tells you that in or after the Miocene or middle of the mammalian period, just preceding the gravel period of the rivers, and since these rivers were eroding or cutting in their ancient channels, a portion of the Alps were uplifted 10,000 feet, and the Himalaya Mountains and plateau of Western Thibet were uplifted 16,500 feet. The greatest mountains of the globe and the grandest of plateaus accordingly achieved their height, by the testimony of this little shell of the sea, from about, or not long preceding, the date of these rivers.

And if we can prove that the stone implements of the deep placer mines are *ever* from under the lava, it follows that man was the joint experiencer with the extinct mammals of these vicissitudes, and that he alone was enabled to survive them, in virtue of his well-known independence of geographical range and conditions.

Historical and geographical comparisons.—The "seven hills" of Rome are of the same age as our gravels, Pliocene, but marine. It is worth mentioning in this connection that Cuvier's great fame was based upon the fact that he it was who first discovered in the formation on which

*This chapter was prepared, at my request, by Mr. Amos Bowman, of San Francisco, whose experience in connection with the California geological survey makes him high authority on the subject. It is published without change. Nor have I thought best to alter, in the previous chapter on California, statements derived from local observers, and involving some theories of continuous gravel channels, which Mr. Bowman, probably with better reason, rejects.—R. W. R.

Paris stands these Tertiary extinct mammals, so important as bearing upon man's advent, and reconstructed and described their strange antediluvian forms. All the country in which are the Aral and Caspian seas in Asia is Pliocene, and all Russia is cotemporary sea-mud.

Animal life.—After the Pliocene our volcanic period, and the ice period, followed; and the great elephants came, the American and the hairy one of Russian fame. This country was full of both. They lived in herds, and were twice the size of the largest elephants now living. Our country had horses and oxen in proportionate size, and was full of real lions. England and Germany had bears larger than the grizzlies. Owen's great fame, again, was based in his discovering and describing these beasts of the post-Pliocene in England.

Human remains are abundant the world over in association with these latter animals that are now also extinct, but in the post-Pliocene there were other mammals that survived besides man. Here, then, we are sure that man was able to survive great changes that destroyed nearly all his companions.

We are now prepared for a closer view of the ancient drainage slope of the Sierra Nevada.

ANCIENT DRAINAGE SLOPE OF THE SIERRA NEVADA

Tertiary tailings.—The great valley of California is the child of the "Golden Mountain."* Its Pliocene sea-trough is now a vast agricultural plain, oak-dotted, and filled to 1,000 feet in depth and more with gravel. We know this by the Stockton artesian well, showing golden sands to the bottom.

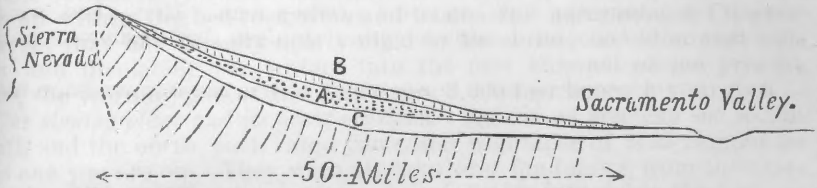
Relation to the sea.—This valley is not yet quite filled up, though, the gates in the parallel ribs of the State were so narrow at Carquinez Straits as to hold back all the coarser detritus within the Diablo range. Suisun Bay and the tules, even as far up as Sacramento, show considerable spots of land surface yet under the sea level. The Bay of San Francisco itself has been locally filled up—as far as the Santa Clara and Napa and Solano valleys extend—affording alluvial fields for delightful Post-Pliocene homes.

Denudation.—We may calculate the vast quantities of subaqueous detritus, and read by the testimony of the ancient rivers, and the present river-cañons, where it came from; calculate by the thousand feet and more of valley-gravel in the great Alta California Basin, for at least 1,000 feet of denudation of the western slope of the Sierra Nevada, over the whole fifty miles of sloping area, from its summit to its base.

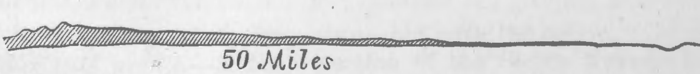
Standpoint, mid-slope, the departed sea.—Standing upon the top of some jutting rocks like the Hog's back in the Central Pacific Railroad surveys, about mid-slope of the Sierra Nevada, and looking westward, before you lies, in plain sight, the whole valley of the Sacramento, in one grand sweep of vision, embracing three hundred miles, or six degrees of latitude, and as far west as the Coast Range, or about 30,000 square miles of country, steeped in the mellowest afternoon light, and set in a framing of forest stems and green.

During the flood season let it be—when the Sacramento is a Nile—like a dream of vivid reality of the "early times" that are involved, geologically speaking, the glistening expanse suggests to the common-

* The appropriate title, referring to the Sierra Nevada, by which the Chinese, in their conversation and "literature of the day," continue to designate the State of California



Cross-section of the Sierra Nevada—see pp. 379, 384.



Profile from the Sierra to Sacramento River, vertical and horizontal scales equal—see p. 379.

est observer the story of the departed sea of the period ot the ancient rivers.

The gold-mining "flats."—The railroad threads the wonders of the chapter which I have not the space to write. An afternoon's ramble, within the capacity of a child, will take you to the spot I have named. Experienced eyes may follow, in many places, the forest-clothed shelves and benches of the Pliocene rivers near these mountain tops, the favorite haunts of birds and animals of the Sierra Nevada in their wild state, and the sites of all the mining-camps, involving other individualities and scenes of our own "early times" of mining.

The lid of the casket.—You will follow in your walk a mountain-crest, as continuous and regular on top as a railroad embankment. It is the volcanic divide, or capping; an ancient lava and mud-flow that filled up the extinct river's bed which gave it direction; covering in and sealing up within the bed-rock rims and basins the accumulated Pliocene gravels that had already nearly filled to the brim the old eroded cañons, and displacing the waters into the new channel of the present time, the yawning gap of the American, 3,000 feet beneath your feet.

The sloping plane and its great erosions.—As far as you can see to the south and the north, each ridge you catch a glimpse of is as regular as this one you are on. They were all lava and mud-flows from the summit, down these Pliocene cañons; they are now invariably the highest mountain-ridges as stated.

In sheer height above the present river-beds, only a gun-shot removed, they exceed in altitude the average summits of the Alleghany Mountains above the sea, a hundred miles away from them.

Yosemite and Jehovah Gap.—In line with the general slope of the Sierra are the tops or dividing-ridges of a score of cañons like this one of the American, each of a depth and grandeur as vast as the mortal eye can compass. For even here one must stay and study before one can realize the sublimities of space and distance. Look at Yosemite. Painters and poets may do much to convey an idea of these sublimities of scenery, but short of seeing the reality not even Milton's imagination could portray such space as that through which the outlawed horde of heaven fell. Or look down from the observation-car of the Central Pacific Railroad as you come down the slope just below Shady Run, into the depths of the Great Jehovah Gap* of the North Fork of the American.

There is no geological mystery connected with the origin.

The fluviatile profile.—A large section of the Sierra Nevada in the office of the Geological Survey of California, made by me from a great number of vertical and horizontal measurements in the course of my examination of the ancient rivers, discloses near mid-slope, in the modern erosion, the simple cycloidal curve (C, Fig. —,) peculiar to the fluviatile profile under the condition of erosion.

In the ancient erosion, or Pliocene cañon, a precisely similar curve, (A) less deeply cut by a difference of 1,500 feet, is seen, expressive of less time, less grade, or less water—one or several of these three *elements* of erosion: I need not proceed to demonstrate, in this connection, which. The intermediate volcanic outburst marking the close of the Pliocene was the turning-point, and furnishes us with the key to the history of the Pliocene rivers, for we find in the fluviatile section of

*This name was given not irreverently to the gap near the Hog's Back (where the post-Pliocene erosion measures 3,000 feet vertical) by poor Paul Grabble, a character of the mines, eloquent and crazy, who lived within the gate of its sunset shadows, and reared there an orchard.

the period, as marked by the volcanic capping, for all time and for all the world to see, the profile of a river of the plains comparatively very nearly a straight line.

Rationale of gravel.—The filling of eroded cañons with quartzose gravel from the surrounding country rock, physical geology teaches us, is due to the inadequacy either of the volume of water, or of the fluviatile grade of the rivers in question to clear themselves any longer. Farther on I shall show what changes of level took place at the time along the base of the Sierra Nevada and outlying islands of the period, as marked by the sea-surface itself, and its living animals, in enduring hills co-extensive almost with California; I refer to the area delineated as that of "tertiary islands and sea-bottom," in the light of the Pliocene terraces of the San Mateo, Livermore Valley, and Napa and Solano hills.

Grade and rainfall.—To what extent these changes of level were attended by alterations of rainfall or of the grades of the Pliocene rivers of the Sierra Nevada I need not discuss at any further length than to state the fact that the rivers carried, during the earlier filling period, enormous bowlders, sometimes 10 feet in diameter, implying steep mountain grades, and thenceforward a tolerably regular average of bowlders, less than five inches in diameter, up to the levels of the lava cappings. With these facts in plain view, any miner may study for himself whether altering rainfall or altering grades had most to do with the formation of the gravels he is engaged in dumping, by the agencies of hydraulics and steeper grades, into the nether space.

THE PLIOCENE GULF OF ALTA CALIFORNIA.

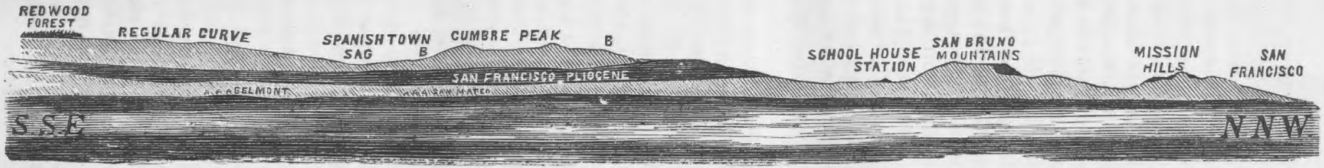
Picture to yourself now a vast inland sea or gulf, separated from the ocean by a row of islands and peninsulas, along whose length it stretches parallel. Opposite the middle of this gulf or sea the range of hills along the coast, or Coast Range as it is known to us, sags down beneath the water, so that only the tops emerge, in the form of points and islands.

This was the Pliocene gulf of Alta California. Its waters stood on the flanks of the Sierra Nevada to an altitude of probably near 600 feet; near the level of Shasta City; above Horse Town; above Piety Hill; not far from Oroville and Turnbucto; somewhere between Pino and Auburn; above Knight's Ferry, and not far below the base of the Calaveras and Tuolumne Table Mountain. Abundant data are at hand to enable us to map the outlines of this Pliocene sea, if only a little pains were taken to follow out the continuations in the field.

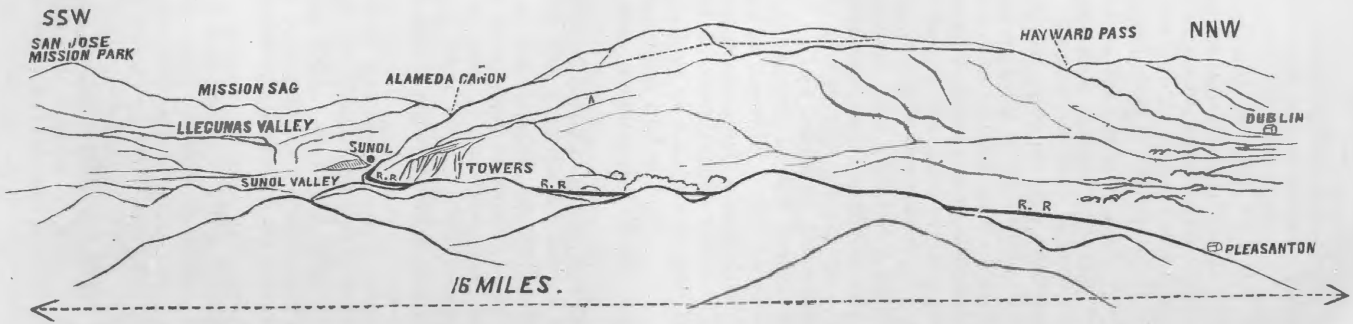
Islands of the period.—The principal islands at the straits connecting the inland sea with the ocean were Tamalpais and Diablo. The peninsular points were Saint Helena on the north, and Mount Louis, of the Hamilton group in the Diablo range, toward the south.

In the course of the vicissitudes and changes above referred to that followed the erosion of those famous rivers, and the piling up of their golden gravels ages ago, when the elephants and mastodons, the tapirs and camels, ceased to inhabit the palm forests that grew on their shores, and the huge turtles ceased to wallow in their shallows, (for we find the woods and bones of all these imbedded,) the sea departed, that until then washed the fiery buttes and the loftier San Francisco, Livermore, Solàno, and Napa Hills, to the base of Mount Saint Helena.

Geology tells no unsupported story. There is always left for you, somewhere or other, a sample-piece, from which you may reason induct-



Sectional view of San Francisco Peninsula—see p. 381.



View west from Pleasanton Hills, Alameda County, Cal.—see p. 382.

ively or by analogy; and from that on to every correct conclusion, evidences are found, not singly, but scattered and multiplied a hundred-fold.

A prototype.—For a prototype of this Pliocene sea, study the bay of San Francisco of our day, with its Angel and Alcatraz islands, its peninsulas of San Mateo and Saucelito, and its Tamalpais.

The Pliocene Gulf of California.—What relation had the sea to the gold-mining gravels of California, is an important question on which the following facts observed in gravels situated nearer the coast, and only in part auriferous, will throw further light. From Piety Hill gold-mining district in Shasta County, situated west of Sacramento River, near the head of the valley, to Tulare Lake, the Pliocene gulf received from the rivers everywhere along its margin, deposits of gravel, forming subaqueous shallows and washes. Marysville and Wheatland Knolls, and Poverty Ridge at Sacramento, &c., are of this character. Remnants of considerable hills, or broad sloping plains along the foot-hills, of this age and character, have been traced and in a degree mapped. Why these deposits are mined for gold in some places, and not in others, is no great mystery. The distribution of the gold-bearing slate formation as shown on the foregoing diagram tells the reason at a glance.

Land-making.—The process by which San Francisco peninsula, and the Contra Costa and Alameda hills and valleys became dry land, was simple, gradual, and commonplace, and is still going on. It was not one of sudden violence. From the salt marshes to the mountain-tops, everywhere, are found systematic evidences, in the loosened material, the gravels and sands in the surface of the older rocks, to which geological attention has hitherto been most particularly directed, of the ocean's presence in successive stages, and in very recent times. What were islands once among the hills and valleys of California, now farmed and populated, can be traced by the following line of facts.

Birth of the coast counties.—We may see almost with our own eyes the birth and creation of the coast.

The accompanying sectional view of San Francisco peninsula shows the situation and significance of the San Francisco Pliocene hills. The scope and scenery of this section of country can be well studied from the older San Bruno Mountains, a point easy of access in an hour from the city; but to get to the Pliocene hills themselves, that were in the Pliocene course, under water from that island standpoint, one must go to School House station, and drive three miles along the Laguna road to the southwest.

The Pliocene plateaus and terraces of San Mateo.—Any one, on attaining the divide here, in full view of the Pacific, would observe a peculiarity in the scenic outlines of the hills. A broad palpable plateau, yielding the Italian renter easily-won potatoes, lies at your feet in the glory of the afternoon sun of the Pacific, tinctured by fairyland clouds in the far west.

All the highest hills, some 700 feet above the sea, within five miles radius of this point, are Pliocene. The abundant fossils in them, as determined by the geological survey, tell the story.

Simplicity and regularity of the record.—The San Francisco Pliocene and its subordinate terraces, down to the recent valley and the salt marshes of the sea of to-day, should be portrayed by a bird's-eye sketch, as they might be seen from a point half a mile in the air above Goat Island. The same can be recognized from Oakland wharf, or anywhere along the railroad thence to San Leandro, in a favorable afternoon light. What is most remarkable in these, is the testimony they bear of the exceeding regularity and simplicity of the movement upward, whereby the waters of the sea were caused to depart. The terrace lines show unequal movement, sagging a little about the road from San Mateo to Spanishtown, and southward rising again up into the redwoods near the summit of the peninsular ridge, opposite San José.

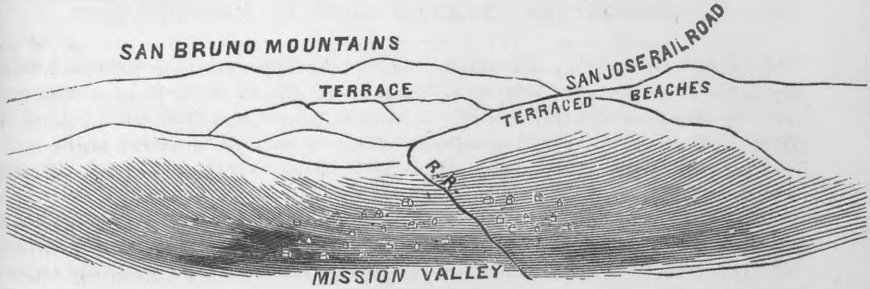
Local peculiarities.—Wave-worn beaches and flats on the Mission hills overlooking San Francisco, show the continuation of the Pliocene sea-levels to our very doors. The terrace in the San Bruno Mountains which gives scenic individuality, in the soft blue distance as seen from San Francisco, is not, as might be expected, of detrital material, but of rock as hard as the Pliocene. It appears to be a terrace of marine abrasion, rather than of subaqueous deposit.

In the Diablo Range.—The Pliocene sea lines so plainly marked on all the highest hills of the peninsula of San Francisco, are not wanting of obvious continuation into the interior. Toward establishing their immediate relations with the Sacramento and San Joaquin Valleys, I have sketched the annexed diagram, being a view west from the highest hill of the Pleasanton Gravel Range in Livermore Valley, Alameda County. The importance of establishing as near as possible, from such data as are below set forth, the exact altitude on the flanks of the Sierra Nevada, of the Pliocene sea into which flowed the ancient rivers of California's gold-mining pride and greatness, is so obvious that it need hardly be alluded to, for the relations of fluviatile forces and conditions to the existing sea plainly constitute the elements of their dynamical history.

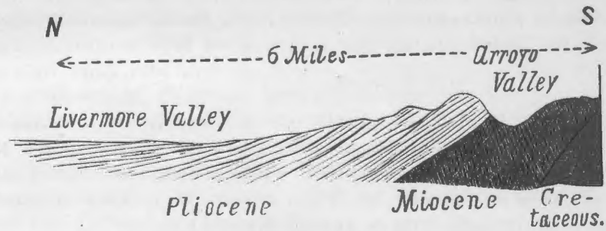
Around the base of Saint Helena.—Applying the same method of inquiry to the Northern Coast Range, I found that all higher hills of Napa and Solano Valleys hold forth abundant testimony of the character of those of Livermore Valley and Pass, the geographical situation of which may make the latter suffice.

A Pliocene island bay.—The view from the summit of the Pleasanton Gravel Range, however, in any direction of the compass, is most rich in suggestive things, scenically as well as geologically. Diablo looms up in noble grandeur to the north, enhanced in its sunny blue altitude by the level perspectives of the intervening valley and a range of Pliocene surfaced hills. Everything in the shape of hill, mountain, and valley here groups itself into forms suggestive of relations to surface-lined hills or terraced valleys. The long-reaching, subaqueous plains, now straight-topped highest hills, having been sliced up into several parallel ranges by the erosions of the Valle and Mocho, (500 feet deep,) give to the excursionist a spice of novelty of situation. Again and again he is reminded, by glimpses of vast slides in the flanks of these gravel hills, that this is only another hydraulic-mining country. Walls of broken gravel 400 feet perpendicular, like that so prominently in sight beyond the Arroyo Valle, near Popes', a few miles east of our point of view, would overtop the tallest of the Sierra hydraulic banks. Go to it, and you will wonder, in the silent solitude, what race of extinct Titans formerly existed and mined here, and ask yourself, what could they have been mining for, or deemed worth sluicing for other than gold?

Lines and terraces in the inside of the Alameda Range.—The diagram shows a series of lines on the inside of the Alameda County hills, just opposite San Francisco Bay and peninsula. The dotted line and first range of hills to the right of Sunol station, being in continuation of the terraced valleys of Llegunas to the south, and the remarkable flat-topped summits stretching beyond Hayward's Pass to the north, present



View south from Leavenworth and San Francisco streets, San Francisco—see p. 382.



Section of south rim of the Livermore Pliocene Bay—see p. 383.

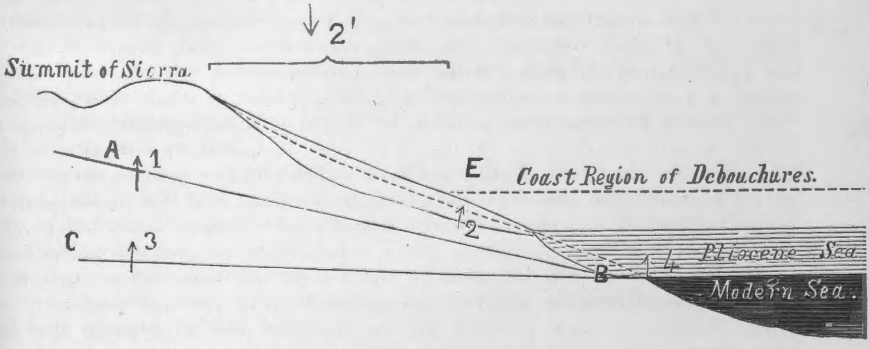


Diagram illustrating successive uplifts, &c.—see p. 385.

to the eye similar slight shovings and saggings out of level (probably still in progress) to those observed in the section of San Francisco peninsula.

POST-PLIOCENE CHANGES OF LEVEL AND EROSION.

The changes of level here since the Pliocene, in the ten miles from Mission sag to Decota bulge, must have been 100 feet, or as much as 10 feet to the mile, being perfectly regular. When the Mission sag had got so low at Alameda Cañon as to form an outlet, more easily eroded, being shorter than the natural and longer one over Dublin Plain and San Ramon Divide to Suisun Bay, the surplus or drainage waters of Livermore Bay united their forces at Alameda Cañon. That abrupt gorge has been cut since the Pliocene. It affords us a pretty good integer of the time involved in these recent changes, so interesting to us, by the 300 feet of erosion shown, at this proximity to the ocean and ocean level of the present.

The hand level applied to the top of Alameda Cañon and Dublin water-shed from points between the two, proved the slight beginnings that determined the outlet in favor of Mission sag. The most simple of natural processes, here illustrates in this case a popular paradox in geology: how rivers will sometimes flow directly across, over, or through a mountain range of the hardest rock, when they might have taken an apparently level and easy road.

Fossiliferous evidence of Pliocene levels.—While on the peninsula of San Francisco these lines generally are shown by fossiliferous evidence to have a close relationship to the Pliocene fossils, the evidence of the Pliocene age of those in the diagram is mainly their proximity to the former, and continuousness of levels. But at Big Slide, above alluded to, the whole of the Livermore Gravel Range is seen to rest conformably upon rocks containing plentifully, fossils of Miocene age.

The top of the gravel range on which the observer of the sketch is supposed to stand, rises—be it understood—to the level of the dotted line, and the San Francisco Pliocene. *In nuce:* a post-Pliocene uplift of at least 900 feet, accompanied by departure of the sea, the latter giving grades of vantage for post-Pliocene erosion.

Consolidation of materials.—While on the ocean peninsula the Pliocene detritus is chiefly very hard rock; here, in Livermore Bay, it is mainly unconsolidated gravel and sand. The dotted line itself indicates the situation of washed beaches, and the highest of a series of porch-like bench formations, from the levels of which, in successive stages, Robber's Cañon was eroded.

Submarine gravels.—The enormous Pleasanton and Livermore Gravel Ranges, 500 to 600 feet in thickness, are subaqueous deposits. In that they differ from the ancient river gravels of the Sierra Nevada, though they belong to the same period. Their bedding, scenic outlines and material, &c., establish these points. From the railroad in Livermore Valley anywhere, one may discern, at various altitudes, consequent marks of system in the hills.

Relations to the sea.—These gravels originated in the very long coast range longitudinal valleys of the Valle and Mocho Creeks, coming into Livermore Valley from the south and east—one of them sixty miles long—where the older hills are largely composed of easily disintegrated conglomerates.

On the San Joaquin side of the Livermore Pass, near Midway station to southwest, a similar terrace formation has been outlined on the maps of the Geological Survey, showing that the Pliocene gulf levels rose at that point over the flattened hill-tops of the railroad summit at Altamont.

Plutonic agencies.—Let us note what other great changes have taken place, the story of which is found in the records of the Californian hills and mountains.

Shasta was built up to a height of 14,000 feet by the erupting lavas, along with Hood, Reignier and Baker, his brother. The hundred transient volcanoes of the Sierra Nevada, extending south to Silver Mountain and Mono, thenceforth associating themselves with things beyond, flamed up for a period and marked the end of an epoch.

Then the extinct Pliocene mammals, unassociated with living ones, also disappeared from the earth as the climate became icy, and vegetation also materially changed.

The lines of change.—Here is a series of natural events, corresponding to periods of time, as follows, the physical condition of which must be accounted for:

1. The Pliocene or ancient eroding period, when the bed-rock was at Fig. on p. 378 a.

2. The Pliocene filling of the cañons with gravels, or the choking and damming period.

3. The volcanic period of the Sierra, when the gravels were capped.

4. The cold or glacial period.

5. The modern eroding or recent period.

And two things we know concerning these changes, viz:

(1.) This peculiar action of successive eroding and filling is not due to local causes, as it applies with great uniformity to all the streams alike, throughout four or five degrees of latitude.

(2.) Neither was it spasmodic in character, as the conditions of the Pliocene erosion evidently continued uniform throughout many thousands of years of time, and the conditions of the gravel-making epoch followed in perfect succession, and lasted as many thousand years more, before the present cañons began; that is, we are dealing with secular causes, that lasted throughout centuries.

Conditions of erosion and transportation, rain, and river grade.—We solve the problem of the Pliocene rivers when we ascertain what made the rivers to cease cutting some time in the Tertiary, and to fill up 1,200 feet deep with gravel, &c., and at the end of the Pliocene, as marked by the volcanic outbursts, to renew the conditions of erosion which have given us our present great cañons.

Only two causes of a general nature, such as the case calls for, can be mentioned:

1. Changes in the quantity of rain.

2. Changes in the grades of the rivers, whereby the same or even a larger quantity of water, would yet be inadequate to clear the cañons of the loosened material from the heights where such water was enabled to disengage it, and to bring it as far as the cañons, where the gravels remain to this day.

Hypothesis of a rainless Pliocene.—A rainless Pliocene period, such as would be implied under 1, we know could not have existed, from the rich tropical character of the vegetation found fossil in the gravels. Instead of being a drier epoch than the present one of stupendous erosion, it was at least as rainy, judging by the erosions, and the rivers must have carried at least as much water.

Further, a rainless term would not have seen the washed-gravel bowlders loosened and rounded and carried as far as the cañons, and there dropped. There would not have been any power to make gravel, let alone the carrying of it.

Under the hypothesis of a rainless Pliocene period there must have been three secular changes in the rainfall, the causes for which could be none other than the relations of land to sea-level, indirectly also implying alterations in drainage grades.

Alterations in the river grades by uplift and subsidence.—I accordingly ascribe the filling of the Pliocene cañons with gravel to a lessening of the grades—perhaps attending the uplift of the Coast Range. This latter took place during the Pliocene river period to the extent of *at least* 800 feet near Monte Diablo, that being the difference between the height of the Miocene rocks that were uplifted in the Pliocene and the Pliocene gravels of Livermore Valley and Bay County sea-lines and sea-beaches of the same period, uplifted in the Post-pliocene, or the subsidence of the coast may have had something to do with it.

The general Post-pliocene rise of the land, including the Sierra, furnished the erosive grades for the present cañons.

Alterations in grades by uplift alone.—While in the light of geological history elsewhere, the world over, it may be accepted as highly probable that there were oscillations of the land on the Pacific coast, that is, periods of depression alternating with and subdividing the general upward movement, the question is immaterial so far as the clogging of the Pliocene rivers of the Sierra Nevada is concerned; for the same result as to change of grades would have been brought about merely by alternating periods of uplift affecting now the coast region of the period, now the summit, in the order of the figures on the diagram.

Particular effect of movements.—The movement expressed by (1) and (3) whereby the Sierra was uplifted, was in short interrupted in the Pliocene at the stage of elevation expressed by the line A B; in all other respects it was one and the same movement.

The movement (2) took place in the Pliocene river or gravel period in the elevation of the entire Coast Range, as is elsewhere demonstrated in this paper. But to what extent this identical movement may have extended across the subsiding valley of Alta California, if at all, must be read in the uplifted Miocene or older Pliocene strata by which we read the same movement in the Coast Range, or, what would be equivalent, in such evidences as may exist of a general subsidence of the land, as indicated by (2^1) in the diagram, bringing the sea-line of the Pliocene temporarily to E D.

Final altitude of the Sierra.—Attention being called to the proper methods of observation, it remains only to be said that the alteration of river grades in different periods wherever established will enable us at once to solve numerous other highly important geological problems; as, in this instance, the exact period and the extent of the *final* uplift of the Sierra Nevada.

Instability of the relations of land and sea.—The first grand fact, indeed, established by, and lying at the foundation of, geological science, is the instability of the relations of level of land and sea. Nothing is stationary; the law is that of eternal change. But there in the hills is the original Book of History, the Unchanged Record." The ocean has its quantum of fluid, but the solid crust is the changing element, forever either rising or sinking in relation to the surface of the sea. The uniform operation of simple laws throughout cycles of time will furnish us with the cause, though no one has yet been able to interpret unequivocally the law or combination of physical laws. Whether the varying conditions which produce these opposite results of uplift and subsidence reside in the rocks or in the central sun of the universe; whether it be adjacent submarine accumulation that causes the wrinkling of the layers, or the shifting of the earth's belt of equatorial spheroidicity, attributable to cosmical causes, or both.

Alterations on the shores of the Atlantic.—Several alternating depressions and uplifts of the coasts of Europe and America on the Atlantic shores have been well established from the geological records, attested in a thousand localities.

A clear record is requisite.—Now on these Pacific shores the record is even more plain, and far more striking and vast as to uplift. But how are we to know what shores sank or went out of sight under the sea? We are to read the book in those places where it has again risen, and to discover the records, if any exist, of its having been above sea-level before any subaqueous materials were deposited.

The stationary sea gives the perpetual datum, whose position is as well defined by its coast deposits and abrasions as is its horizon to the eye. But I shall not attempt to enter into the facts, however important, now involving broad, continental movements, and bearing only locally upon the problem of the Pliocene rivers.

Altered courses of drainage.—The course of the ancient rivers of the Sierras has been frequently remarked to be "at right angles" to that of the present streams. In any change of bed such as has been here described, there would necessarily be crossings and recrossings at right angles, and all other angles, by the displaced waters. No uniformity of crossing or angle in one direction more than another has ever been attempted to be made out by actual measurement. After devoting considerable pains to the collecting of facts for the determination of this question, the conclusion I have arrived at is that the Pliocene rivers have not varied at all in the *general* course from that of the present rivers; and if such be not the case, the contrary at least remains to be proven.

THE GOLD-BEARING GRAVELS.

The Big Blue lead.—The "Big Blue" lead is a myth, passing through every miner's claim, where there is deep gravel.

The usually received evidence of any ancient stream's crossing a present mountain water-shed into another basin is that there is gravel found on both sides, and that a range of mining camps can be sought out upon the map on the supposed line of an ancient river's course. But gravel is as universal as are drainage gutters. The primary point in the geography of such a river usually is that it runs where there is rich ground—perhaps for sale. All the facts as to irregularities or incompatibilities of grade can easily be ignored in hypothetical cases. The character of the gravel, as to the distance it may have traveled, or the volume of water in the stream which carried it, within broad or narrow valleys, are points too fine to be worthy of attention. So general is the belief among miners in great changes of level since the period of activity of these rivers that no attempt is usually deemed necessary to prove the fact of all facts, universally admitted. No mountain, then, need stand in the way of anybody's Blue lead. The whole country was "hove up."

A lank philosopher of the pick, at Quaker Hill, carried this logic to bed-rock, in expressing to the writer his opinion that "the gravel itself was hove up, for he did not see why the stones might not just as well have been hove up round as in any other way."

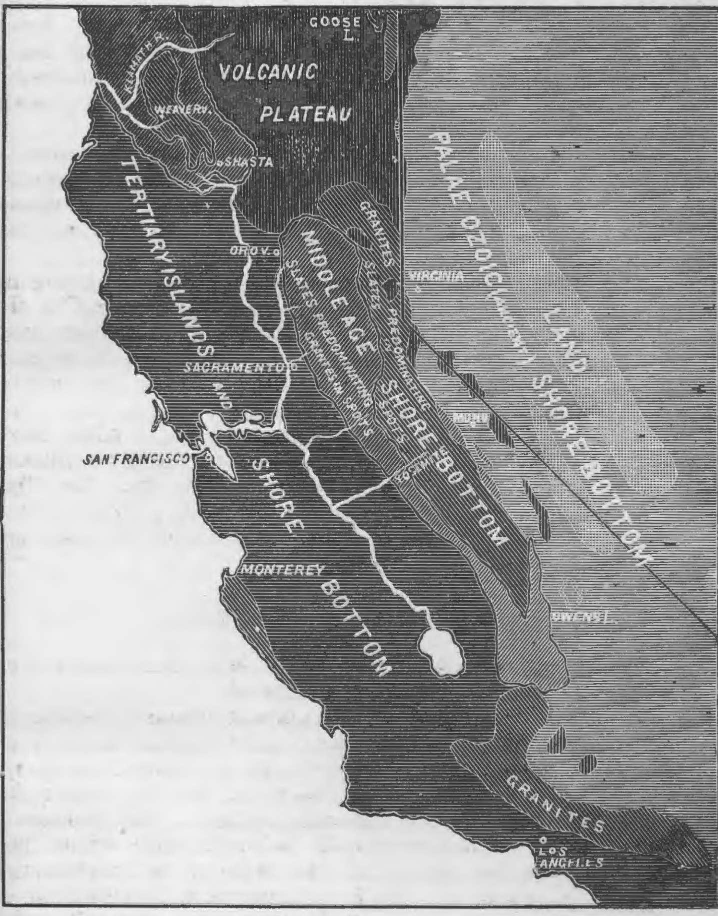


Diagram showing geology and relations of the gold-bearing slates of California—see p. 387.

No faulting—the movements secular and general.—The facts, as far as developed by the State geological survey, establish an almost perfect local quiescence of the beds, shown in the unbroken local continuousness of the gravels. Faults are rare and always doubtful as to the bed-rock. I have recognized but one unmistakably, (at Timbuctoo,) and that may have been due to the operations of bank-blasting and washing.

Whatever changes of level took place on the western slope of the Sierra Nevada after the period of the Pliocene rivers, were not paroxysmal or local, but secular, *i. e.*, they endured throughout centuries of time and were general, as already intimated.

Axes of uplift of the volcanic period.—Yet what variations of drainage the newer volcanic axes of disturbance may have brought forth in general in the region between Lassen and Pilot Peaks, where the older bed-rock of the Sierra sags to an altitude half that of the Central Pacific Railroad Pass, only fifty miles further north, remain to be established, if such variations exist. No one, so far as I am aware, has ever taken the trouble to point them out otherwise than hypothetically by the evidence of the gravel-range in general.

The blue lead in Sierra and Plumas.—Now the evidence of the local origin of the gravels of the region around Pilot Peak and Slate Creek Basin is plainly read in their gradual assimilation to the character of cañon or ravine gravels, as you approach the present water-shed at Sepsidan, under Pilot Creek. And the Plumas gravels may as reasonably be supposed to belong to the ancient Oroville and Spanishtown gravels of the Pliocene Feather River, which loses itself under the lavas near Spanishtown, and to be identical with the present drainage of the Feather River in Plumas County, as with any other drainage-basin, fifty miles farther south on the general slope of the Sierra. Certainly, this is more reasonable until the contrary has been established by other facts than that there are simply gravels in both Sierra and Plumas Counties, adjacent in Yuba and Feather River Basins. A further study of Pliocene and volcanic dynamics in this region, though interesting, would be beyond the scope of this paper.

Whence came the auriferous gravels of California?—The accompanying diagram of the geology of the gold-bearing slates, with their relations to the older and newer sea-bottoms or land, will tell the story.

The unshaded white in the accompanying diagram represents the ocean-bottom of to-day, along shore; the lightest shading, not cross-hatched, the paleozoic shore-bottom in the early or dark ages of geology; the lightest, cross-hatched, the land, or the Pacific coast of that period.

Silurian, Devonian, and Carboniferous fossils brought by Mr. Clayton, and others, from Silver Peak and other points lithologically related in Nevada, have determined for us in general terms the great fact as represented.

The Middle-age shore.—The intermediate one, between the lightest and darkest shadings of the sketch, is the one which concerns us most. It represents in general the area of the auriferous slates. A portion of this shading, it will be observed, is done by lines sloping down towards the left; this represents the off-shore or deep-sea mud which washed down from the Paleozoic or ancient shore in the Middle-age or Reptilian period of geology that next followed the Paleozoic time, or age of fishes.

Islands and shallows.—The area so shaded was dotted by islands from which came the conglomerates we find interspersed here and there in the slates, or muds as they were.

Another portion of the same general tint, it will be observed, is shaded by lines sloping down towards the right, this and the last mentioned having a close relationship to each other. This is the area of predominating granite which was once probably pretty generally covered by slates, which were accordingly subjected to all the vicissitudes attending the uplift of a granite mountain core, that of the Sierra Nevada, showing only spots of slates, as represented. The slates are mostly gone; they would naturally have been less thickly bedded so close to the middle-age shore.

A transverse break and sag.—Between the Oroville Table Mountain and Piety Hill (near Shasta City) gold-mining districts, the slate or gold formation sags into or crosses Sacramento Valley, and is partly cut off, partly only exposed by the deep erosions of the upper Sacramento; being covered at the surface throughout this fifty miles of distance by a broad sheet of lava from Lassen and Shasta Peaks, the tabular cliffs of which, as plainly seen from the railroad, designate the shore-line where these lavas broke into the Pliocene sea.

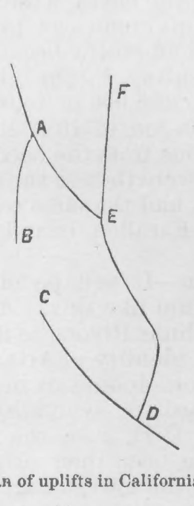
Deep-sea mud and mountain dome.—That the slate-forming muds were deposited in pretty deep water throughout a long period of time, we have good reason to believe, from their consistency, and from their vast thickness. No careful geological measurement of the thickness in feet has ever been attempted with satisfactory results. Yet it would seem that in the extreme simplicity of the regularity of the bedding of the slates as here indicated along the entire western slope of the range, we should not find it difficult to hit upon the precise method of granitic uplift whereby the off-shore mud-strata became shaped into a dome of unparalleled sublimity, presenting to our view a base or section of seventy miles, and an altitude of 8,000 or 10,000 feet.

Type of relations.—The relation of this Mesozoic formation to the Paleozoic shore becomes obvious from the accompanying diagram. The granite island centers as they were then in the axis of the Sierra Nevada, before the uplift of these beds, had the same relation to the Pacific shore of the period that the granite Farallon Islands have to the Pacific shore of to-day.

Axial geometry of California.—It will be observed that the axes or efforts of uplift developed a form like this. A valley was formed opening northward like Eel and Salinas Rivers, as if intended to connect with the Klamath (see the striking identity of axis) and drain into the ocean at its mouth. But the Siskiyou Mountains near Weaverville developed a split or spur, A B, to seaward, in sympathy with the Monterey and San Francisco granitic arms, C D, from the Tejon, thus backing the waters from what would have been their original natural course, and forcing them to find a way by the lowest sag, B C; laying the foundation for the future topography of the great California Valley, itself a valley of depression.

The volcanic plateau.—The extensive (scarcely explored) volcanic plateau of Shasta and Lassen Peaks extending to Goose Lake, (the Modocs' country,) represented by the letters A E F, owes its origin primarily to the manner in which these forces of uplift affected that intermontane area which discharges its waters through the break or sag of the auriferous slates into Sacramento Valley. Ages later, in the Tertiary, when the Pliocene rivers were done scooping out their treasure-chests for the hydraulic miners that are now at work in them, and when the great valley of California was not yet dry land, there were further changes of

Relation of Mesozoic formation to Palæozoic shore—see p. 388.



Skeleton plan of uplifts in California—see p. 388.

level, interesting to consider in connection with this plateau, the history of which, as read in the Pliocene gravels, is only the later history of the auriferous slates.

Bearing upon the northern auriferous coast-gravels.—I have gone somewhat definitely into the coast-gravels near Monte Diablo, Mount Saint Helena, and San Francisco for a purpose. They furnish the clew to the recent geology of a thousand miles of the Pacific coast. Following out their suggestions, I visited the auriferous-gravel regions of Trinity Basin and the far north British Columbia. Their relations to the gold-bluffs and north coast-gravels, and to the Klamath and Trinity subaqueous gravels, found in the higher hills, suggested to me other points of importance, as expressive of the recent geological history of the country.

But to enter into the dynamical geology of the coast at large, as read in the light of the gravels of the Fraser, the Columbia, and the Colorado, &c., or to transcribe the notes I have gathered bearing upon the ancient rivers of auriferous note in the great interior, would be to extend too far the dimensions of the present paper.

For the same reason I do not touch upon the economical results of the occurrence of different methods and conditions in this natural concentration of gold in the ancient gravels that have been developed by placer-mining, the fuller understanding of which is the world's ample inducement for the study of the geology of the gravels.

CHAPTER XVII.

HYDRAULIC MINING IN CALIFORNIA.

The origin* of this branch of mining dates back as far as the spring of 1852, and illustrates the old adage, that necessity is the mother of invention. The crevicing knife and spoon had done their duty; the gold-rocker was generally displaced by the "Long Tom" and "Grizzley," and these again were superseded by long lines of sluice-boxes, and, *pari passu*, the fissures and crevices in the exposed or denuded bed-rock on the river-banks were relieved of their gold-nuggets; the shallow ravines were mostly worked out; rich gravel "leads" were followed into sides of hills or mountains, hiding themselves under apparently worthless masses of earthy matter, the height of the latter increasing with every step onward, and the miner saw that neither "stripping" nor "ground-sluicing" could secure to him a proper reward for his labor.

Besides this increase in labor and decrease in pay the frequent occurrence of accidents by the caving of banks urged the adoption of other plans for working. Tunnels and drifts were started in many places; shafts were sunk and gold-bearing strata of gravel were found one below the other, the richness generally increasing with depth. The richest deposit was worked by drifting, and the mine was abandoned as worthless after this was extracted.

Thus stood matters in the spring of 1852, when a miner, whose name is not remembered, put up a novel machine on his mining claim at Yankee Jim, in Placer County. This machine was very simple. From a small ditch on the hill-side a flume was built towards the ravine, where the mine was opened; the flume gained height above the ground as the ravine was approached, until finally a "head" or vertical height of 40 feet was reached. At this point the water was discharged into a barrel, from the bottom of which depended a hose, about 6 inches in diameter, made of common cow-hide, and ending in a tin tube, about 4 feet long, the latter tapering down to a final opening or nozzle of one inch.

This was the first hydraulic apparatus in California. Simple in design, dwarfish in size, yet destined to grow out of its insignificance into a giant powerful enough to remove mountains from their foundations. The news spread among the miners, the wonderful practicability of the new invention was at once acknowledged, and, wherever circumstances permitted, a "hydraulic," the name adopted for the novel apparatus, was "rigged."

Improvements suggested themselves from the beginning. The hose, made out of green cow-hide, rotting under the steady exposure to water, became very soon not only offensive, but altogether useless. Some old sailors adopted sailcloth, or heavy canvas, as a substitute; and the sail-maker's trade was called into requisition at every mining-camp.

* This chapter was written by Mr. Charles Waldeyer, of Cherokee, Butte County, California. My own share in it amounts to nothing more than a slight revision and condensation, incidental to the preparation of the manuscript for the press. I need not vouch for Mr. Waldeyer's thorough acquaintance with this subject in all the bearings of practice. The internal evidence of his work is conclusive on that head.—R. W. R.

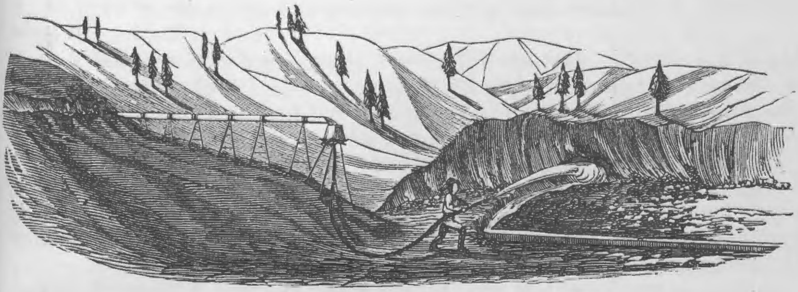


Fig. 1. Hydraulic mining in 1852. (See p. 390.)

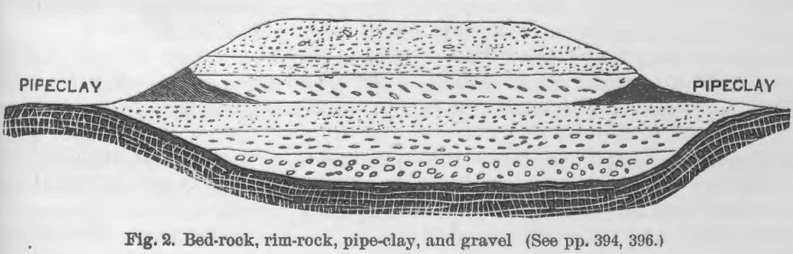


Fig. 2. Bed-rock, rim-rock, pipe-clay, and gravel (See pp. 394, 396.)

How well this canvas hose has answered the purpose is evidenced by the fact that even now, after a trial of twenty years, it is used to a great extent, particularly in mines to which the transport of iron pipe is inconvenient. With the increasing strength of the material for hose greater pressure could be applied, and, in some favored places, hydrostatic pressure of a hundred or more feet was created, producing a working power, which overwhelmed in a short time by its own strength the facilities for its application; or, in other words, absorbed the grade or fall, indispensable to hydraulic mining, in both directions; filling, in the downward direction, the natural outlet with *débris* or tailings, and leaving in its progress the richest part of the deposit, the bottom, beyond reach.

The same venturous spirit which induced the California miner to rush to fabled Gold Lake, or to Gold Bluff, and later to Frazer River, Idaho, Arizona, &c., had led him to seek, in the hydraulic process, the quick realization of his hopes for great wealth; but when it became evident that *besides* the rich placer, large water-ditches and long tunnels were necessary, requiring both money by the hundred thousand, and time by many years, then the zest for hydraulic mining drooped, and only a few enterprises outlived the reaction. These were carried on generally by men of small means, but of indomitable energy. Many years of anxiety and hardship passed, but the time came when ditches, from twenty-five to fifty miles in length, supplied plentiful water, and tunnels, long and deep, carried in endless flow hill and mountain side to the river-beds and valleys below. Success was gained; experience had shown that the larger the scale on which hydraulic mining was carried on, the more profitable the results would be. New inventions were made; instead of discharging streams of two or three hundred inches against the "bank," a thousand inches of water, about equal to 1,579 cubic feet per minute, were discharged with a velocity of about 140 feet per second. Bank-blasts of from five to fifty tons of powder were fired, preparing the ground for the action of water. Splendid results were realized, and hydraulic mining became a favored field for the investment of capital.

Not only such inventions as Craig's "Globe Monitor" and "Dictator," or Fisher's "Knuckle-Joint and Nozzle," all of them instruments admitting of any desirable strength or size for the discharge of hundreds or even thousands of inches of water, but the discovery of the most powerful explosives, such as nitro-glycerine, giant-power, &c., and, furthermore, the invention of the diamond drill, have raised hydraulic mining to one of the foremost and most lucrative pursuits in California.

Already chasms of a thousand feet vertical depth are successfully crossed by huge iron pipes to convey water to isolated points. The practical test has proven that air can never collect at the lowest point of the inverted siphon, the point where the greatest pressure of water results. Uncalled for as this remark may seem, it must be excused for the reason that actually men of good sense and some engineering capacity expressed fear that air would be carried down with the water to the lowest point of the pipe or siphon, and collect there finally to a great extent under the pressure of two immense columns of water, and might explode at any moment as in an over-charged air-gun. This question was decided like the dispute about "weight or no weight of the fish in water"—not by philosophy, but by practical experiment. After the great pipe of the Spring Valley Canal and Mining Company, of Cherokee, Butte County, was laid across West Branch—a depression of about

900 feet—great care was taken in filling it, and the air-valves were carefully watched. These air-valves showed action on that side only from which the pipe was filled; when the column of water rose to the point of discharge not a single air-bubble could be perceived, and the water decanted gently and without a ripple. As the danger of accumulation of air was only feared for pipes conveying water under enormous pressure, the experiment cited above must necessarily dispel all false theories, and it must be acknowledged that the only question in the conveyance of water through pipes is that of sufficient strength of the pipe to stand the pressure of the water, be the vertical height 500 or 5,000 feet.*

Thus the field for hydraulic operations is immensely enlarged; almost all gravel deposits are accessible, no matter at what elevation they are found, and the production of gold will keep pace with the development of other great industries of the country.

Legislation.—The Congress of the United States and the legislature of California have done much by passing wise laws for the protection and encouragement of mining interests; and it is to be hoped that further protection and facilities will be granted where justice and good sense recommend them. How necessary more legislation to protect the great hydraulic mining interest will be must become evident when the unavoidable consequences of hydraulic mining are duly considered. The whole process of hydraulic mining tends to remove mountains of auriferous gravel deposits from their natural position and to transfer their bulk to the valleys below. Where water-courses, like the Yuba, Feather River, American River, and other large tributaries of the Sacramento River are the first recipients of the debris and tailings produced by hydraulic mining, the danger of a serious blockade of the flow of tailings is, to a great extent, removed by the floods, which generally occur every winter season, and culminate, as experience has shown, at least once in ten years, in an immense rush of waters.

These floods clear the rivers to a great extent, and wash the accumulation of tailings into the Bay of San Francisco, and perhaps into the Pacific Ocean. But where such water-courses are entirely inaccessible, and where only small streamlets (generally known in California under the name of "dry creeks," carrying great volumes of water during the rainy season, but altogether dry in summer and fall) are the natural outlets, or where even these streamlets are wanting and artificial outlets have to be made, serious questions about the deposit and accumulation of tailings arise and threaten to cripple one of the most important branches of that industry, to which California owes her rapid rise and wonderful prosperity.

Since the lands of the United States were thrown into market, farming locations have been made in closest proximity to the mines; in fact alongside of those "natural outlets" which had been used for many years prior as the recipients of tailings, an unfortunate rivalry has arisen between the mining and farming interests of the State; some of the most influential newspapers of the country unqualifiedly pleaded the cause of the agriculturist, and the miner was represented as a mere defacer and destroyer of the face of nature. When it is considered how immense is the area of agricultural land, and how limited, comparatively, the extent of mineral land, it seems surprising that such antagonism should arise, or that all legitimate means are not used to remove the causes of irritation.

*The trouble arising from air, as well as the danger of a collapse by a vacuum, will be discussed later.

It is evident hydraulic mining necessarily creates an immense flow of debris or tailings, and, therefore, this modus of mining requires not only the introduction of great quantities of water, through long and costly ditches, or the boring of long tunnels, equally expensive, but also facilities for the deposition of the debris or tailings in whatever natural or artificial outlet and place of deposit is offered. If, therefore, this place of deposit for the tailings is denied, hydraulic mining is at an end. On the other hand, whenever the farmer receives his patent from the United States he is sole master of his quarter-section, and can and must protest against any trespass on his property. Should his property cover the only outlet to the richest mining region in California, and even should this outlet have been used for twenty years as the recipient of tailings, the farmer's right would not yield to any priority, and the only way to dispossess him of his farm would be to buy him out at his own price.

It might not deserve the name of hardship if the miner were called upon, in a few isolated cases, to secure the legitimate pursuit of working his mines by paying enormous prices for land thus necessary to him; but when whole townships would have to be acquired in this way, and when farming locations were made more for speculative than for agricultural purposes, such proceedings would become the most offensive tyranny.

The proximity of these lands to some of the great gravel channels of the country has *enriched* them more or less with fine gold, in such a way that the question whether they are truly mineral or agricultural may arise, and at the same time *impoverished* them by thick layers of volcanic debris, sand, and other unfertile materials. Common sense declares that such lands, as a whole, are not fit for agriculture. Where exceptions occur let them have their full weight; but even then it must be borne in mind that certain portions of the lowlands flanking the great gravel-streams of California are as necessary to hydraulic mining operations as water or deep placers themselves.

The General Land Office has withdrawn some of the lands in question from market, an act of justice which deserves the highest praise; but, nevertheless, these lands may be thrown open to entry again, and then the question will arise.

The miner pleads that the lands are necessary to him as a place of deposit for his tailings; that, in fact, without them work in his mines is altogether stopped; that millions of dollars have been spent in improvements, and that these improvements will be almost a total loss in case these lands are deeded away by the United States Government; that the right of way for canals and ditches, granted by the United States Government, must necessarily include the right of *in* and *out;* that the water coming *in* is generally pure; that the water going *out* is surcharged with tailings, and must necessarily commit damage of some kind unless discharged into a stream large enough to carry all tailings along; that the Government has granted this right of way over its own land; that the outlets for tailings were used under this authority long before the United States parted with the property, and that therefore the right of way ought not to be alienated from the miner, and all damages legitimately and necessarily originating from it ought not to fall to his responsibility; and that a new disposal by the United States of the lands necessary as an outlet to the miners would be an act of injustice.

Could not these lands, worthless for agriculture but indispensable for mining, be altogether withdrawn from market, leaving them open for all mining operations of the vicinity, so that no individual interest could enter upon them? Should a settler go upon these lands he might do so at his own peril, reaping for the time the benefit of their use, without being entitled to damages whenever the tailings overwhelmed him.

Congress might appoint a commission of competent men to investigate and report on the lands in question, and the farmer would no longer run the risk of settling in good faith on lands which would only yield trouble and lawsuits to him; nor the miner fear to see his valuable improvements made worthless, or the proceeds of his mines swallowed up by enormous payments for damages.

The question about the disposition or placing of tailings assumes such importance in view of the increasing hydraulic-mining interest, that the writer has considered it his duty to point to the future with a warning finger.

The three principal requisites of successful hydraulic mining are, first and foremost, a gold-bearing gravel deposit; second, and not less important, the facilities for outlet and deposition of tailings; third, an abundant and permanent supply of water.

THE DEEP GRAVEL-DEPOSITS OF CALIFORNIA.

These deposits occur in basins, channels, or river-beds, differing in depth, width, and length like the living streams, ponds, or lakes of the present day. The deposits themselves, consisting of gravel, drift, or shingle, sand, and clay, differ in size of bowlders and compactness of the different stratifications, as well as in their composite parts. They consist of the detritus of all classes of rock known in California, and have received evidently their gold from the quartz, which appears either in bowlders and pebbles, or in sand, throughout these immense deposits. The great and noted channels* containing those deposits run from north to south, and are indicated by gravel-ridges and table-lands, the latter very often covered with lava, basalt, or other volcanic matter, such as ashes and scoria.

Springs inside of the rim-rock are sure indications of a deep channel or basin. The rim-rocks, or in other words the shores, or banks of the ancient stream, must once upon a time have been high enough to confine the gravel-deposit within their limits. For instance, a gravel-deposit appearing to-day in the shape of a table-mountain, must have represented, in a former age, the shape of Fig. 3, and gained its present appearance only through the agency of water, which destroyed those portions of rim-rock and gravel deposit lying outside the dotted lines marked in the figure. The cause which partly destroyed the rim-rock or shore of the channel, and left high plateaus or table-mountains as isolated landmarks of the ancient gravel-stream, has undoubtedly, to a great extent, obliterated every surface indication of the existence of such a gravel-deposit; or even destroyed the last vestige of gravel-deposit and channel, by creating gorges for modern rivers, which cross the ancient gravel streams nearly at right angles, and many hundred feet lower. As an instance, the table-mountain in Plumas County,

* Theories differ concerning the extent and direction of the gold-bearing channels or deposits. The latest, and probably the most trustworthy, will be found in Mr. Bowman's chapter on The Pliocene Rivers of California. I have not felt myself justified, however, in conforming the statements of this report to any one theory. The chapter on California, and this chapter of Mr. Waldeyer's, reflect the opinions of local observers and authorities.—R. W. R.

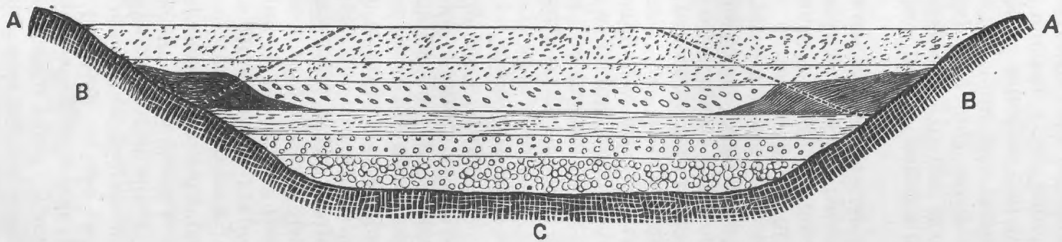


Fig. 3. A A, old rim-rock; B B, pipe-clay; C, bed-rock, or bottom of channel. (See p. 394.)

known as Walker's Plains, and the table-mountain near Cherokee, in Butte County, both of the same formation as to gravel-deposit, &c., may be cited. These two table-mountains were once evidently parts of the same great gravel-stream, but are at present separated by a distance of about thirty miles, and by gorges of more than a thousand feet depth, forming now the beds for the West Branch and North Fork, both tributaries of Feather River. The practical miner has known for a long time that these deep gravel-streams may be discovered by following the presumptive course of the ancient river, though all outward indications have disappeared; and, to sanction the view of the practical miner, and, at the same time, to show how beneficial is the application of science, it may be added that only recently valuable deep-gravel deposits were developed, indicated by the geological survey of Professor Whitney, though hidden under mountains of apparently valueless detrital matter.

Adaptability for hydraulic operations.—Almost all gravel-deposits are fit for hydraulic operations, provided they are gold-bearing and will admit of those improvements which are essential to this class of mining, to wit, sufficient outlet, a place of deposit for tailings, and abundance of water. After gaining the certainty that these requisites can be obtained, the miner may go to work to open his mine, confident of success. If already other mines are worked in apparently the same gravel-deposit, he may be pretty sure to find the same stratifications of gravel, cement, clay, sand, &c., and he must then judge for himself whether it will be advisable for him to drive at once a tunnel, or to ascertain first, by shaft or incline, the depth of the basin or channel.

Should the nature of the ground admit the sinking of a shaft or incline, it would be advisable to do so, since even after a tunnel is completed, water introduced, and everything ready for hydraulic operations, the opening of the mine will have to be done either by shaft or incline. It is, however, very often, and particularly in those deep gravel-deposits which were never submitted to drainage, a costly and difficult job to sink a shaft or incline, by reason of the quicksand and loose gravel. The miner must therefore consult the extent of his means before he ventures upon hazardous operations.

The character of these ancient deposits, generally speaking, is the same. Though they may differ in the hardness and compactness of the gravel, or may have been disturbed by local influences, still there is a prototype, the description of which may fairly apply to all. The oldest gravel-deposit found in these ancient channels is that drift deposit known under the name of the "blue lead."

The blue lead.—This deposit is always found deepest in the channel and nearest to the bed-rock. It is composed of bowlders of serpentine rock, talcose slate, and, in fact, of all other rocks belonging to the slate family; besides this, of quartz in bowlders, gravel and sand, with an admixture of clay, the presence of the latter being always considered a favorable sign for richness. The whole mass is of a color varying from blackish green to indigo blue. The quartz, though originally of pure white, is tinged blue, and neither washing nor exposure to air will discolor it.* Very often a deposit of huge bowlders, rather rough and

* Mr. Waldeyer's description of the blue lead is contradicted by some other observers, who say that the blue color of the lower deposits of auriferous gravel is due to the existence of protosulphides and protoxides of iron, which change on exposure to the air, turning red. They say also that the line separating these two colors in the deposit is not one of regular stratification, but irregular, and dependent upon the access of oxidizing agencies. Also, that the bowlders of the blue lead become "rotten" by exposure.—R. W. R.

angular and intermixed with only a little gravel, is found near the rim-rock—a mass resembling very much a moraine, and of no value for mining purposes. This deposit, however, will slope down toward the center or depth of the channel or basin, and the regular blue lead will appear on the top of this "moraine," sometimes only a few inches in thickness, but gaining steadily in size in the same ratio as the "moraine" diminishes, till finally the bed-rock is reached by the blue lead, which may have gained a thickness of 40 feet or more.

This blue lead is found in deposits rising from a few inches to over a hundred feet in thickness, and is generally considered the richest and most reliable gold-bearing deposit in the country. Though tightly packed, it can be easily removed by the pick, and affords, therefore, under proper circumstances, an excellent material for hydraulic operations.

Blue cement.—There are exceptions, however, to this condition. We find this deposit sometimes changed into the hardest kind of blue cement, yielding only to the constant application of drill and powder. This cement is generally very rich, but has to be submitted to a crushing process in mills, similar to quartz-mills. In such cases the hydraulic process can therefore only be applied till this blue cement is encountered, but it produces a double benefit, extracting not only the gold from the upper strata, but also freeing the blue cement from all incumbrances, and making thus its breaking up a comparatively easy matter.

Rotten bowlders.—Next to the blue lead or cement a yellowish or reddish gravel is found, generally very rich. It is known in some localities under the name of rotten bowlders, and is composed of quartz, gravel, and bowlders of clay-slate. This deposit is from 5 to 25 feet in thickness, in some localities even thicker. It is rather soft and easily worked, and consequently excellent material for the "hydraulic."

Upper gravel.—The blue lead and the yellow gravel, or rotten bowlders, next to it, are the principal gold-bearing strata; still, the deposits of quartz, gravel, and sand overlying these in huge masses, contain fine particles of gold, known as flour-gold, in sufficient quantities to make the working of these upper strata sometimes very remunerative.

These different deposits gain their full characteristics only toward the deeper and more level portions of the channel or basin, and are less pronounced toward the sloping river or shore.

Quicksand.—As on the bars of the present rivers, great bodies of sand are found on the sloping rim-rock, which, under the influence of water, become quicksand and form the greatest obstacles to the sinking of shafts or inclines, whenever found. This sand seems to be nothing but crushed quartz, and yields in many instances small particles of gold. In hydraulic mining it is rather an advantage, as it offers no resistance to a stream of water and facilitates the caving of any superincumbent strata.

Iron cement.—Small streaks of a very hard, brownish cement, generally called iron cement, from 1 to 2 inches thick, may separate the different gravel-deposits mentioned above. These cement-streaks are easily crushed by the falling bank or a blow of the sledge, and thus disposed of.

Pipe-clay.—In almost all deep gravel-deposits a sedimentary deposit is found, which is known under the name of pipe-clay. This deposit is generally found in huge masses near the rim-rock or shore of our deep gravel-streams, and is evidently the sediment of immense bodies of muddy water. Fortunately that substance, which has really the characteristics of clay, and deserves its name, is very rare in our mines and only occurs in small layers. Even thus, it is troublesome and hard to dispose of, as water will not dissolve it, but turns it into a pasty, tough substance, yielding only reluctantly to the pick.

These mud-deposits, however, known as pipe-clay or joint-clay, break under the shock of a blast into fine pieces, dissolve in water, and have generally a worse name than they deserve. Their position is always close to the rim-rock and their bulk disappears toward the deeper and more valuable parts of the gravel-deposit. To account for these facts it will be necessary to look into the origin of this so-called pipe-clay. It must be evident that the immense gravel channels of California were filled by periodical floods, occurring through long ages; furthermore, that from time to time, and particularly when the rush of the waters temporarily had lessened or almost subsided, great blockades in the ancient channels took place, keeping the remaining waters back and thus forming lakes. During such temporary intervals bodies of mud could settle upon the underlying gravel, and, reaching from shore to shore, form in time the deposits now called pipe-clay or joint-clay. Any succeeding flood, carrying with it masses of gravel, sand, &c., would necessarily make a new channel in this mud deposit, destroying the middle portions of it, but leaving both shores comparatively intact. This explains the occurrence, near the shores, of masses of pipe-clay, which, as experience has shown, almost disappear deeper in the channel.

THE OPENING OF HYDRAULIC MINES.

The great gravel-deposits fit for hydraulic mining rest in channels or basins of unknown depths, and it is evident that, unless the depth of the channel can be ascertained beforehand, certain risks have to be taken in boring the tunnels, indispensable for almost all hydraulic operations. In the principal hydraulic mines in the State early operations were commenced from the easiest point of access, without much regard to the lasting sufficiency of the "open cut" or tunnel. The natural consequence was that only a small portion of the mine could be worked by existing facilities; the grade had to be cut down from time to time, and in most cases the constant improvements absorbed or exceeded the whole production of the mine.

The expenditures for opening a hydraulic mine, furnishing it with sluice-boxes, under-currents, &c., besides the introduction of water, generally amount to many thousands, perhaps hundreds of thousands of dollars, and only a large area of hydraulic mining-ground will warrant such an outlay. There should, therefore, be a reasonable proportion between the estimated outlay for improvements and the mining-ground at command. Much can be done by the consolidation of different interests. A plat of hydraulic mining-ground, representing from eighty to two hundred acres, constitutes a security for any capital which can legitimately be employed in its improvement.

Location of tunnel.—This should be low enough to work the whole body of mining-ground. If the depth of the channel can be ascertained by shaft or incline it will be the best policy to do so; if, however, too many difficulties, such as quicksand, or too great a depth of ground, interfere,* it will be better to choose at once the *lowest point* attainable

*In speaking of the difficulties connected with the sinking of shafts or inclines it will be proper to mention here that it took over four years in time and $75,000 in money to sink an incline on one of the great gravel "leads" in California, owing partly to ridges of hard rock rising in waves on the sloping rim, but chiefly to beds of quicksand and loose gravel lying on the sloping rim-rock, and bursting here and there through the "face" under immense pressure, throwing from time to time as many as a thousand car-loads into the excavated part of the incline. However, the object was accomplished, and the firm bottom strata were reached.

for a tunnel, always, however, with due regard to sufficient fall from the mouth of the tunnel for a long line of sluice-boxes, with under-currents, dumps, &c.

In choosing this starting-point for a tunnel, not only the probable depth of the channel must be taken into account, but also the fact that the necessary *grade* of the tunnel, say from $3\frac{1}{2}$ to 4 feet per hundred, will reduce its *depth*, for each additional thousand feet, 35 to 40 feet. Hence, if the extent of the claim to be worked is considerable, say 2,000 feet on the channel and 4,000 feet across it, and the tunnel, as is generally the case, runs across the channel, it will be necessary to have the tunnel in the middle of the channel, at least 40 feet lower than the bed-rock, or bottom. This is illustrated by the subjoined diagram.

It will be seen that the dotted line toward D E, on the left side, is still somewhat in the bed-rock. This is desirable, not only for the lateral extension of the mine, but also for the reason that sluice-boxes, at a reasonable depth in the bed-rock, always facilitate the work in a hydraulic mine, offering chances for grades in all directions to wash the gravel, &c.

Size of tunnel.—This must depend to some extent upon the required work, the quantities of water at command, and the length of the season annually during which the water lasts. Tunnels 5 feet wide and 6 feet high were considered in former years sufficiently large for any purpose, but since hydraulic mining has been conducted on a much larger scale the size of tunnels, in height and width, has increased accordingly. They are now generally constructed 7 feet wide and 8 feet high for single runs of flumes or sluice-boxes, and in those mines where there is a sufficient quantity of water for eight or nine months in the year, and where the remaining three or four months can be used for a thorough cleaning-up, repairing, &c.

A tunnel of such a size, with a 6-foot flume and 4-foot grade per hundred, would admit the use of 2,000 or 2,500 inches of water; the size of tunnel may be reduced if the supply of water is much less, other conditions being the same. For mines which possess a lasting supply, say 2,500 to 3,000 inches the whole year round, a much larger size would be desirable, admitting a double run of sluice-boxes, and thus an uninterrupted washing.

In former years, the idea of running a tunnel 12 feet wide and 9 feet high might have deterred the boldest; but at the present day, when the diamond drill has come into use, such undertakings can be prosecuted with a comparatively small additional expenditure and no loss in time. It has been found that it takes almost as much time to remove the fragments of stone excavated by the diamond drill as for drilling and blasting; and in consequence, the diamond drill is only employed for half the time in tunnels of limited size. But where, after the blasts are exploded, the drilling-machine can be adjusted again, without interfering with the car by which the fragments of rock are removed, a tunnel of double width can be run in the same time.

Grade of the tunnel.—This depends partly on the quantity of grade to spare. Where there is plenty of fall, a liberal grade, say 6 inches per 12 feet, or about 4 feet per hundred, ought to be given.

More grade in large flumes becomes dangerous for the pavement of the flume; a 6-inch grade will not only carry off any desirable quantity of gravel, &c., but materially assist, by the very rapid motion produced, in the breaking up of the gravel and liberation of gold. Where the fall is more limited the grade may be reduced to 5 inches in 12 feet, or $3\frac{1}{2}$ feet per hundred. Whenever less grade has to be applied, difficulties in the

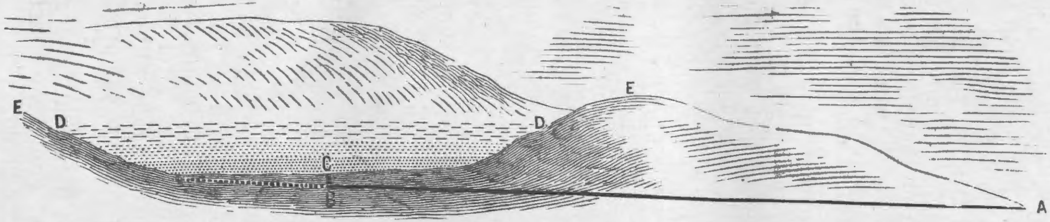


Fig. 4. A B, tunnel to middle of channel; B C, distance (40 feet) from tunnel to bottom of channel; D D, extent of workable gravel; E E, the two shores of the channel. (See p. 398.)

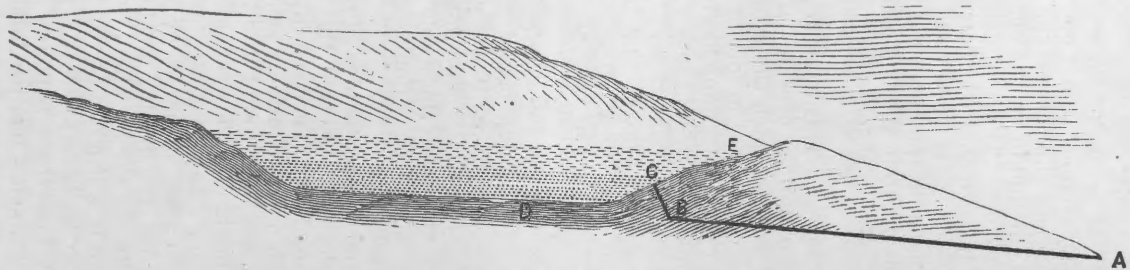


Fig. 5. A B, tunnel; B C chimney; D, bed-rock. (See p. 399.)

removal of the "pulp," and particularly of larger stones, will arise, and many hands will have to be employed to push the material along.

Line of tunnel.—This should be perfectly straight wherever practicable, in order to facilitate not only the general flow, but also the measurement and calculation of all those points, the correct location of which is necessary. Underground measurements of curves are for the simple miner extremely difficult; the magnet loses its reliability, being disturbed by the iron in the bed-rocks, and generally a "tapping in the dark" ensues. Due attention to the straight line in the tunnel will avoid all these difficulties, and insure, besides, the shortest distance.

General considerations.—It is not advisable to open a hydraulic mine too close to the rim-rock. As already remarked, great bodies of quicksand lie close to the rim-rock; moreover, the occurrence of pipe-clay, and perhaps the want of rich "pay-gravel," may combine to render the work tedious, unprofitable, and discouraging; and, finally, the mining-ground brought under control will be comparatively insignificant.

In the diagram given the tunnel A B ought to have been prolonged at least to the point D before being connected with the gravel-deposit. The chimney B C admits only the working of the deposit lying between C and E, which, for the reasons stated, is of but little value. It will be acknowledged by most of the managers of hydraulic mines, that generally either too little importance has been attached to the point where the mine was opened for work, or that an undue outside pressure and a cry for dividends have forced the adoption of half-measures against the soundest argument, and that labor and time have been wasted in many instances by the inordinate desire of saving both.

The chimney.—The advisability of extending the tunnel well into the basin before "tapping" the latter cannot be disputed. If a shaft or incline has been sunk to the depth of the channel or basin, the terminus of the tunnel can be decided upon according to the knowledge gained. Whenever this point is reached, it will be necessary to pierce the bed-rock intervening between the terminus and the gravel-deposit in the channel, by a "chimney"—either a vertical shaft or a slope. This chimney must be started in such a direction as to strike the bottom of the shaft or incline. Should water have collected in the latter it must be removed by pumping before a connection is made.* Want of care in this matter has caused much lamentable loss of life.

Chimney without shaft.—Should, however, no shaft or incline exist, and should the condition of the gravel-bed overhead be unknown, the greatest care must be taken in making the attempt to break through.

As before remarked, great bodies of sand lie in the sloping rim-rock, before the solid bottom gravel is reached. This sand is in connection with loose gravel-deposits overhead, and becomes *quick* under the great pressure of water which always exists in deep gravel-deposits. (See Fig. 6.) Whenever these sand-patches are entered without the greatest precaution, immense rushes of water, sand, and loose gravel will occur, filling often the largest tunnels in a few minutes. There are cases on record where the labor of two or three years was lost, the greatest portion of the tunnel being necessarily abandoned, and a new direction, to the right or left, pursued. When, therefore, the attempt is made to run up a chimney from

*If proper caution and skill are employed, the connection through bed-rock may be safely made, I think, without pumping out the shaft. The question is one of relative expense. When the diamond drill is employed, a long hole in advance of working would be the only necessary precaution. But in the absence of accurate surveys, and in view of the usual recklessness of miners, Mr. Waldeyer's declaration, that the shaft should be pumped out, is justifiable.—R. W. R.

the terminus of the tunnel into the unexplored channel above, the work should be commenced to the right or left of the terminus, and be continued on a convenient slope. The experienced miner will know, whenever the water increases in the seams of the rock, or when the seams turn yellow, or the rock changes to a softer stratum, that the basin or channel may be only a short distance above. When these signs occur, it is advisable to drill a hole far enough to test the thickness of the rock intervening between the chimney and the channel. Should the drill pierce the rock, it is easy to insert a thinner and longer iron rod to feel the deposit above the bed-rock. If hard gravel is struck all will be safe, and the chimney can be continued without any apprehension; but if water and sand are found, and the iron rod enters readily for 5 or 6 feet, it will be better to abandon the chimney at once, and continue the tunnel. The presence of sand and water, or quicksand, indicates that the depth of the channel is not reached, and that the most valuable gravel-deposits lie deeper, and at the same time forewarns the miner of a great danger, a rush of quicksand and loose gravel.

The diagram given herewith, representing a section of sloping rim-rock, and the different deposits as they occurred in fact, will explain itself.

The chimney, if hard gravel is reached, should be continued, as before stated, on a slope, as in this way the work can be more safely done than in a vertical shaft. This consideration may be of little importance so long as the ground is hard and strong, but in softer strata, surcharged with water, a slope offers the only chance to proceed with safety to a certain point. When this point is reached, and a further progress barred, it is best to secure the terminus of the chimney in such a way that the water can drain off, without giving the sand, or loose gravel, a chance to run. After this a careful survey must be made to ascertain the exact spot where a shaft from the surface down will strike the terminus of the chimney. This is an easy matter when the tunnel is straight.

Shaft.—A shaft with square section, (say 4 by 4 feet,) to permit timbering, must be commenced and worked down in the usual way, as far as circumstances will permit. If the drainage established through the chimney is sufficient to free the shaft from water, it will be comparatively easy to go through sand and gravel and connect shaft and chimney; but if this drainage cannot be established, or is not adequate, even with additional hoisting of the water by windlass and buckets, it is best to procure an artesian-borer, and to make thus a connection between the bottom of the shaft and the chimney. (The character of the ground excluding the existence of large pebbles or bowlders, an artesian-borer can be used to good advantage.) After this the shaft can be brought down, but must be secured firmly against side-pressure by good framing and planking.

First washing.—The connection once made between shaft and chimney, sluice-boxes may be laid through the tunnel, and the first washing of "dirt" may commence. This begins by removing the upper sections of timber out of the shaft, widening its mouth by pick, shovel, and water, and tumbling and running the "dirt" and water into it, always, however, taking care not to choke the shaft or chimney. This process is continued downward, in the shape of steps, or terraces, as security against cavings or slides. It must depend on the depth of the shaft, as well as on the greater or less safety of the ground, whether a larger or smaller opening of the shaft is to be made, since dangerous cavings may occur in spite of all precaution. In this way an opening must be made to permit the use of water under pressure. It must be left to the

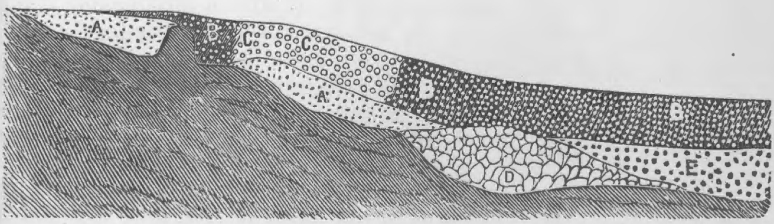


Fig. 6. A, quicksand; B, red gravel, (firm); C, loose gravel; D, moraine; E, blue gravel; F, bed-rock. (See p. 400.)

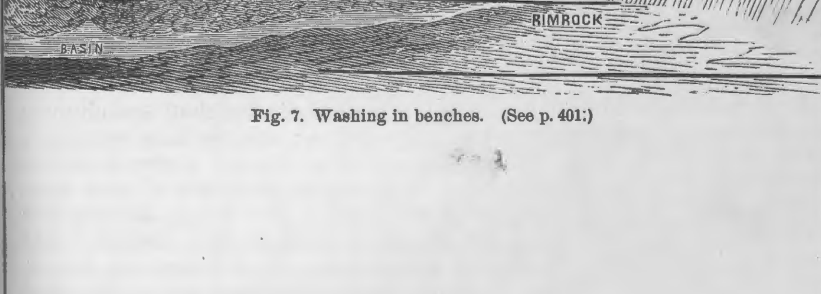


Fig. 7. Washing in benches. (See p. 401.)

[illegible]

manager of the mine to shape the chimney in such a way that an easy and uninterrupted discharge in the sluice-boxes is secured.

If the main tunnel is to be continued farther it will be necesary to leave enough space between the starting-point of the chimney and the face of the tunnel to admit blasting operations. At the same time precautions ought to be taken to protect the blasters in the tunnel from any accident arising from the possible blockade of the sluice-boxes or tunnel, and the only safe expedient will be to have not only a strong barrier between the blasters and the sluice-boxes, but also to have an independent way for ingress and egress. This may be secured by widening the chimney sufficiently to admit a strong water-proof box with a ladder, by which means the miner can reach the surface of the ground, without interference from either the washings or cavings of the gravel from above, or any blockade in the tunnel below.

It will be seen that the existence of a shaft or incline, before the connection between the terminus of the tunnel and the basin or channel, is of great importance. If an incline exists, great facilities are offered to employ hydrostatic power from the lower part of the incline, as soon as a moderate opening is made to the surface.

Upper workings.—Many mines are situated so favorably that the upper strata can be worked without any expensive bed-rock tunnel. In such cases it will be advisable, if circumstances permit, to commence the working of the upper strata at once, particularly if the gravel deposit has a thickness of two or three hundred feet. In this wise a very useful and necessary work can be accomplished pending the construction of the deeper bed-rock tunnel; and perhaps a part, if not all, of the cost of the latter may be earned.

When the gravel-bank rises to a greater height than 125 or 150 feet, the work in a hydraulic mine becomes very dangerous, as the momentum of any mass of matter falling from the high bank will carry it far into the mine, endangering life and property.

To avoid these dangers working in benches is resorted to, and the washing away of the upper strata just mentioned thus serves three beneficial objects: first, in producing the pecuniary means in support of other works to be carried on; second, in lessening the depth of the shaft to connect with bed-rock tunnel; and third, in leaving a "bench," which, under all circumstances, will be necessary in a deep gravel-mine.

Connection between tunnel and surface.—The first opening of a hydraulic mine, as we have seen, is rather a tedious and expensive business; however, after a connection is once made between tunnel and surface, other necessary improvements are easily accomplished. For instance, the chimney represented as running up on a slope may be, if only short, changed into a vertical shaft, or, if long, into terraces, so that the gravel rushing down may be submitted to a crushing process, which a fall of 20 feet or more will create.

Where the bed-rock between terminus of tunnel and basin is of considerable depth a system of terraces will be more advisable than a vertical shaft, for the reason not only that the sloping chimney is far more easily changed into terraces, than into a vertical shaft, but also that the danger of blockading or choking is greatly lessened.

The terraces ought to be constructed in such a way that the first fall is the deepest, each successive one lessening as the tunnel is approached, so that the last fall is not more than a common drop of two or three feet, such as may be found on a line of sluice-boxes.

The diagram given represents a slope of 100 feet vertical height, cut into terraces.

	Feet.
The first fall represents	30
The second	25
The third	20
The fourth	15
The fifth	$7\frac{1}{2}$
The sixth and last, into the boxes	$2\frac{1}{2}$
	100

Whether a vertical shaft or a slope—in other words, a single drop of 100 feet, or a succession of drops of the same aggregate depth, will be preferable, is a matter open to discussion. It seems that a succession of blows, of less force but striking the matter to be crushed from different sides, must be more effective than one very strong blow. The benefit of a drop of even a few feet on the line of sluice-boxes is well known to the miner, and a repetition of such drops must necessarily cause the repetition of the benefit, which consists in the crushing, stirring up, changing of position of the "pulp," and the consequent liberation and precipitation of the gold.

By the time the tunnel is reached the force of the several falls or drops is broken, and a leap of 30 inches lodges the running mass in the sluice-boxes.

Connections with old workings.—The foregoing remarks about the opening of hydraulic mines refer chiefly to those mines or gravel deposits which, having never worked before, offer all the difficulties of new and undrained ground. Whenever other mines have been worked in the same deep gravel-deposit, and a neighboring claim has reached its boundaries, thus setting free one side of the gravel-bank, which shall be submitted to the hydraulic process, the tunnel can be connected with the free side by large drifts, constructed on a grade sufficient to receive sluice-boxes. These drifts must be placed deep enough in the bed-rock to permit the washing of the gravel into the sluice-boxes from all sides.

It must be borne in mind that, under the conditions mentioned, the very gravel bank through which these drifts or cuts run will have to be washed away, and the closing up by cavings of the mouth of one or the other drift can hardly be avoided.

In the diagram given an open gravel-bank is represented, from which three drifts (Nos. 1, 2, 3) run toward the point *o*, where they are connected with the mouth of the chimney (here changed into terraces) which leads into the deep bed rock tunnel, A B. The washing in this hydraulic mine would have to be commenced from the open bank toward point *o*, and the gravel would have to run through either of the three drifts, 1, 2, 3.

It will be easily seen that the closing up of one or the other of these drifts can hardly be avoided, and it is therefore necessary to keep always at least one open, to permit the clearing and opening of the mouth of any closed-up drift.

For instance, drifts 1 and 2 are closed; it will be necessary to wash the matter which closes the mouth of drift 2 into drift 3, and, after this is accomplished, to wash the matter which closes drift 1 into drift 2, and *vice versa.*

The force of the water will easily accomplish this, provided the drifts are deep enough in the bed-rock to keep all the caving matter on a comparatively higher plane.

The best way to clear a mass of caved matter from the mouth of a

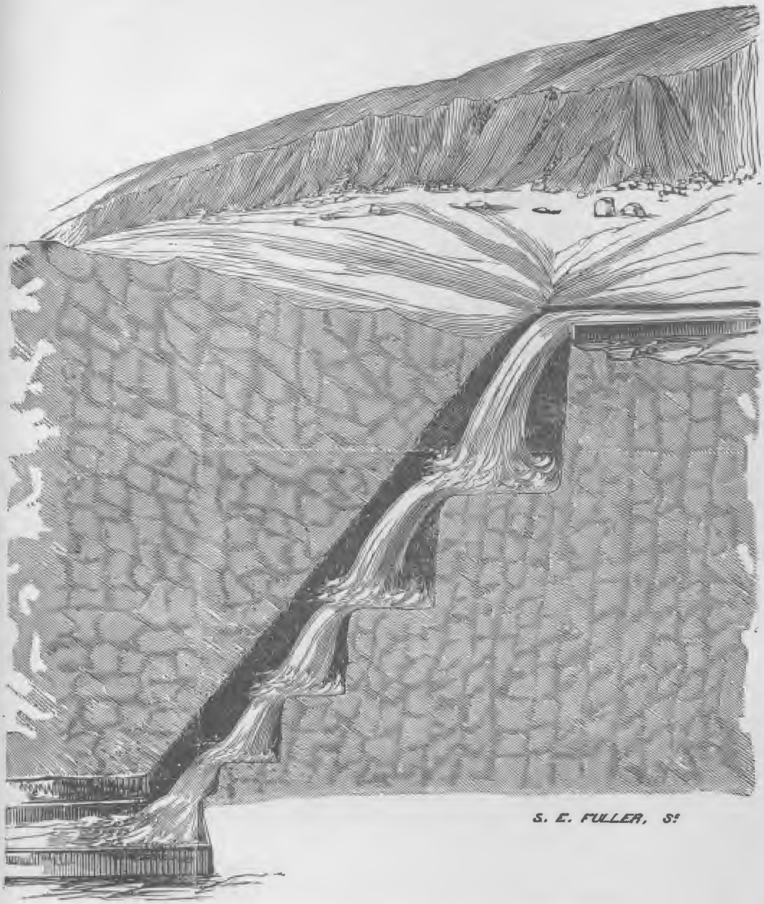


Fig. 8. Slope cut into terraces. (See pp. 401, 402.)

Fig. 9. Gravel-bank, with three drifts; A B, bed-rock tunnel (See p. 402.)

drift is to wash a small channel close to the gravel-bank, so that the caved matter itself forms a wall and barrier on the outside, confining thus the water and gravel-work to a small stream. In this way an opening is soon made, and the bulk of the caved matter can be dispatched through the drift whose mouth was cleared.

THE WORKING OF HYDRAULIC MINES.

This is done by the power of water and powder. The power of the former depends on its quantity, and the pressure under which it can be applied. It is therefore most desirable to have the supplying ditch, or reservoir, not only at a high elevation above the mine, but also in its close proximity. The first condition insures a great hydrostatic pressure; the second a short line of feeding or conveying pipes.

To give an idea what a powerful agent water can be made under pressure, it may be stated that a quantity of water, equal to a thousand inches, miners' measure, and yielding 1,579* cubic feet per minute, can be discharged under a pressure of from 275 to 300 feet, through a 6-inch nozzle, with a velocity of 140 feet per second, and in a quantity of 1,645 pounds, for the same length of time. Such a quantity of water uninterruptedly striking the bank, with one-tenth of the velocity of a cannon-ball, must necessarily do great execution, and suffices, in many instances, to produce the caving of the gravel-bank, without resorting to bank-blasting.

After a hydraulic mine has been opened for washing operations, a long line of sluice-boxes, with under-currents, grizzlies, &c., laid down, and water under a high pressure connected through an iron pipe with one of the improved hydraulic nozzles, the real mining work can commence. The description of the different mechanical appliances will be given further on. At present the operation itself will be described.

A single hydraulic nozzle, connected by an iron pipe of any length, with a distributer—which latter is again connected with the feeding-pipe, receiving the water from the bulk-head of a ditch or reservoir—has been placed at a safe distance from the gravel bank to be washed. A screw, attached to the distributer (for the purpose of opening or shutting a gate commanding the connection and flow of water between the distributer and the hydraulic nozzle,) is turned, and a stream of water issues from the hydraulic nozzle. This stream increases in size and strength as the gate opens more and more, and after a few minutes a body from 5 to 7 inches in diameter, and representing from 500 to 1,000 inches, plays with magnificent force against the opposite bank of gravel. The water issuing from the nozzle is to the touch as hard as a bar of steel, and retains, when thrown from a good nozzle, its cylindrical and condensed shape, till it strikes the gravel-bank. The effect of this lance-thrust of water against the bank is soon visible. At the first shock, a thousand rays of water fly in all directions; a little later, the lance has buried itself deep in the bosom of the bank, and the water boils and hisses over the lips of the aperture, carrying with it gravel, sand, clay, and whatever matter may be at hand. The opening widens; flakes of gravel tumble in all directions; an arch, wide and deep, is made in the gravel-bank. The "jambs" of the arch to the right and left are demolished by turning the jet of water upon them, and the first "cave" in the hydraulic mine takes place.

* This is less than the amount usually given in calculations of the miners' inch. I presume Mr. Waldeyer has applied the "coefficient of contraction," which is, for a stream flowing through a horizontal slit, about .625.—R. W. R.

The caved material is washed into the sluice-boxes, good care being taken that an even flow is maintained and that the boxes are not overcharged. Pieces of hard gravel, clay, &c., too large to be washed through the sluice-boxes, must be reduced to smaller fragments by either the pick or the blast. For all such material as can be perforated by the churn-drill or auger, the process of blasting with giant powder No. 1 is considered the cheapest and most effective. Rocks and bowlders, too large to be sent down by the sluice-boxes, must be first broken up. It is to be presumed that as yet room is wanting to stack them in piles on the ground.

When sufficient clearance has been made to leave ample space for the deposition of heavy bowlders, tree stumps, and other rubbish, either a derrick, or wheelbarrow, or cars can be employed to remove such objects to the place of deposit. Even with abundance of room it will be advisable to go systematically to work and keep certain order in the arrangement. This plan will accustom the workingmen to dispose at once of any incumbrances *for good* and *at the right place*, and will save a great deal of work in the long run.

In working a hydraulic mine it must be the aim to secure as soon as possible a large open front, so as to occupy two, three, or more hydraulic nozzles, according to the supply of water and general capacity of the works.

These different hydraulic nozzles, being supplied from the same distributer, can open a "cross-fire" upon any point within 200 feet from the nozzles and thus do excellent execution.

Fig. 10 represents the gravel-stream as falling into a chimney through the intervening bed-rock, and so into the tunnel below. It will be seen that cuts may be opened into the chimney from all sides, and can be deepened as the gravel-bank recedes and the first grade is absorbed by distance.

Should the surface of the gravel-deposit be covered by a growth of brush-wood or trees it will be necessary to remove this material by cutting it down and hauling it off the ground, or piling it up and setting fire to it.

Bank-blasting.—This is resorted to either when the gravel-deposit is so hard that it will not readily yield to the jet, or when the gravel-bank is so high that the hydraulic nozzle cannot with safety (on account of caving) be brought close enough to the bank to do good execution. The blasts may either be placed in drifts with one or more cross-drifts, (T,) or in shafts with a cross-drift in the bottom, (⊥,) or in shafts with a wider bottom (in the shape of a bottle, the shaft forming the neck of the bottle.) The latter are generally used to blow up patches of bottom-gravel. The quantity of powder used depends necessarily on the quality and extent of the ground to be blown up, and varies from a few kegs up to two thousand. Even larger blasts have been and will be made, as occasion requires. A keg of powder contains 25 pounds.

When a bank is from 80 to 100 feet high the main drift should be 100 feet long, so that a reasonable proportion may exist between the resistance offered by the top pressure and the lateral or front pressure. Thus a general upheaval results, and neither a blowing out of the front nor a partial blowing up of the top. The main drift should be 3 feet wide and 4 feet high, or as small as it can be worked. The side-drifts or "Ts" can be made a little larger. To secure a good effect, it is necessary to use about 600 kegs of powder for the blast, placing the contents of 400 kegs on the cross-drifts at the terminus of the main drift, each arm being from 45 to 50 feet long, and the contents of 200 kegs in the cross-drifts, located about 65 feet from the mouth of the main drift, each arm being 30 feet long. We shall thus have the accompanying figure.

This blast fired by an electrical apparatus and ignited simultaneously at twelve or sixteen different points, will in all probability dislodge and crumble an area of ground equal to that inclosed by the dotted line, representing from fifty to sixty thousand cubic yards.

The powder should be emptied in long boxes placed in the different side-drifts, and electric fuses should be inserted, at proper distances, at least one for every forty or fifty kegs of powder, which would insure the simultaneous ignition and complete combustion of the gunpowder and develop thus its whole force at once.

In Fig. 12, representing the same proportions as Fig. 11, twelve electric fuses are inserted in the different drifts. These fuses are marked in the circuit of the leading wire and are buried equidistantly in the powder. The main drift, from the point where the first cross-drifts intersect, that is, for a distance of 65 feet from the mouth, is safely closed by first making a barrier of timbers across the main drift, where the intersection takes place, and then filling the main drift with sand and fine gravel tightly to its very mouth. The blast is now ready for explosion.

The blasting-apparatus being established at a safe distance, and the two leading wires attached to it, the crank of the frictional apparatus is turned in this instance 22 times to the right, and then reversed for about 6 inches, when the discharge of all the fuses takes place at the same moment. It is laid down as a rule that ten turns are taken for the first fuse and one for every additional one.

When greater areas of ground than that mentioned above are to be blown up the main drift must be extended, and additional and longer cross-drifts must be made. The powder must always be distributed with regard to the work it will have to perform; a little experience and better acquaintance with the deposit to be blasted will soon lead to the proper treatment of the ground.

However, as a general rule, it may be said that a strong charge of powder should be employed. The extra expense for powder is easily repaid by the thorough breaking up of the ground, securing not only a greater yield of gold, but lessening also the manual labor to such an extent that the cost of an additional hundred kegs of powder, or any proportion thereof, becomes insignificant.

Shafts with a ⊥ in the bottom are excellent for high banks, and have all the effect of drift-blasts. Besides this, it is much easier to fill or tamp them than a level drift, as the material extracted from them is deposited round their mouths, and can readily be thrown back as tamping.

To secure from injury the insulated wire, which is to be connected with the blasting apparatus, it is advisable to cut a little groove for each wire, leading from each arm of the cross-drift to the mouth of the shaft or main drift.

In case water should be found in the drifts or shafts it is necessary to use for the powder boxes made water-tight with the help of tar. The lids are perforated with gimlet-holes for the admission of the fuse. After the fuse is inserted the lids are placed firmly on the boxes, either with screws or wooden wedges, and the gimlet-holes are closed either with wax, soap, putty, or even clay, leaving everything well protected.

To blow up patches of bottom gravel 10 to 20 feet deep, bottled-shaped shafts are used. These are sunk from 4 to 5 feet in diameter to the necessary depth, say 18 feet, and their bottom is widened all round from 2 to 3 feet beyond the original periphery of the shaft.

The powder is placed in the lower excavation all round. In the center a layer of heavy rocks is placed, to be the basis for the filling or tamping material, and to prevent the latter from entering the excavated part. The shaft is tamped and the explosion takes place with generally an excellent result. The ground will be crushed from 15 to 20 feet in every direction from the shaft and will yield readily to the hydraulic jet.

Giant-powder blasts have been tried in several hydraulic mines with great success, according to the published reports. Giant-powder No. 2 is used for this purpose.

In drifts, as represented in Fig. 11, very likely 2,500 pounds of giant-powder would have to be used, placing the same in lots of 500 pounds each at different points. For instance, 500 pounds would be placed at the end of each of the arms of the upper T and 500 pounds where the main drift intersects; furthermore, 500 pounds in each of the arms of the first T (65 feet from mouth of main-drift.) Every lot of the giant-powder must be tamped in very tightly, so that no space for air remains.

The discharge is made by the electrical apparatus, as already described.

In all blasting operations, from the simple hand-drill blast, removing only a few hundred pounds of rock, to the bank-blast, removing thousands of tons, a careful calculation of the strong and weak points in the material attacked should precede the placing of the blasts.

WATER-DITCHES.

The ditches of California are the great arteries which bring life to the mines. Their even and constant flow secures a healthy and vigorous state of industry, while the dearth of water in the mines throws a pall over the business world of California, money becomes tight, and hard times are the consequence.

The engineering skill displayed in the construction of ditches in this State is of the highest character, accomplishing the most daring feats, hanging flumes on steep, rocky bluffs, and crossing gorges of a thousand feet in depth; and it must seem almost a presumption to inquire whether any improvements can be suggested.

Leaving the answer to this question open for the time, we will try to state the rules and conditions which justly have governed the constructions of ditches.

Location.—The first among them must be the ample supply of water during all seasons of the year. When this steady flow can be secured, even at a greater outlay of money, let it be done by all means. The winter supply of water is well enough, but the summer supply is far preferable, as the working of a hydraulic mine then has the advantage of long days, mild weather, and water made almost tepid under the rays of a hot sun. The latter point is the most important, as the quicksilver catches the gold far more easily at a high temperature than in cold weather. The yield of gold, therefore, increases always in the summer season, other conditions being equal.

The second condition must be the high elevation of the ditch. A ditch of high elevation commands a greater field of usefulness, as it may supply mines for which it was not constructed, when the original mines are exhausted. Besides this, the increased hydrostatic pressure is always valuable.

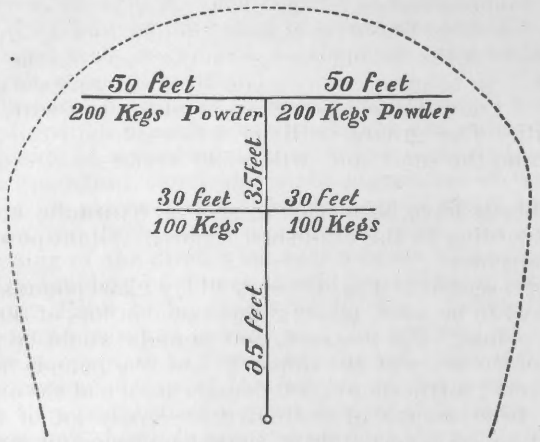


Fig. 11. Ground-plan of heavy blast. (See pp. 404, 405, 406.)

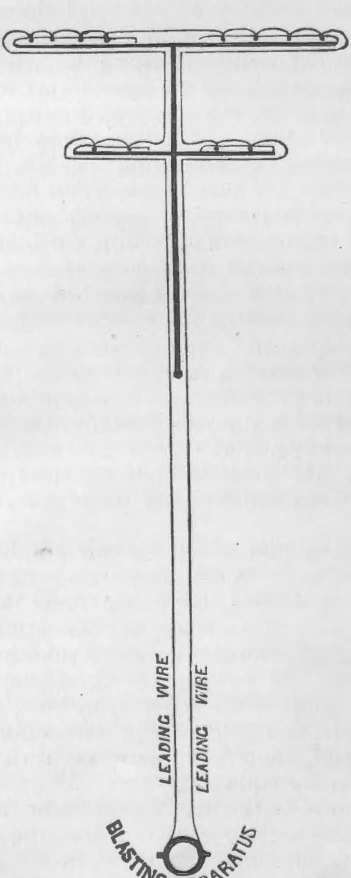


Fig. 12. Manner of firing heavy blast. (See pp. 404, 405, 406.)

The snow-line should be avoided, if practicable; but snow-sheds can be constructed, though in some regions this might involve a great expenditure. Pine boughs, laid thickly across sleepers from bank to bank, have been used with good effect, as the snow rests on them and forms finally an arch, supporting itself.

A third important point is to secure all the small water-courses on the line of the ditch in such a way that they can either empty into the ditch or run over it, according as their water is needed or not.

A fourth important condition is the abundance of waste-gates, and their location in places where the discharge of water cannot wash the ground below the ditch, so as to produce a slide. This will permit the prompt draining of the ditch whenever a break makes it necessary.

Fifthly, the building of flumes should be avoided so far as practicable, since they are liable to be destroyed by fire. When they have to be built, care should be taken to char well the bottom part of the supporting posts or sleepers, so as to prevent the rot. The settling of flumes, due to the gradual decay of the bottom of the posts, or the sleepers upon which they rest, causes a great deal of annoyance.

Experience has shown in many cases that the above-mentioned rules deserve close attention in choosing a route for a ditch, as the advantages or disadvantages pointed out can be weighed carefully beforehand.

Construction.—The building of a ditch can commence after a careful survey has been made. A grade of 10 feet per mile (three-eighths inch per rod) ought to be established by the survey, as this grade has proven itself the most convenient for the conveyance of water, securing an excellent flow, without endangering the banks of the ditch. This grade must be adhered to strictly, and under no circumstances must it be lessened at one point and increased at another, since the flow of water, once checked by less grade, cannot be regained by increasing the grade at another point. The ditch in such a case would have to be widened.

Iron pipes.—In the construction of ditches not only open ditches and flumes are resorted to, but also tunnels and iron pipes, the latter to convey water across depressions in the ground too deep to permit the construction of flumes.

If, therefore, deep depressions, or gorges, have to be crossed by iron pipes, (inverted siphons,) it will be necessary to have the ditch high enough at the point where the water is discharged into the pipe to allow a sufficient "head," not only to overcome the friction, but also to secure enough hydrostatic pressure to force the water rapidly through the pipe, which, of necessity, must be of far smaller dimensions than the discharging ditch.

The resistance of the friction in the pipe of the Spring Valley Canal and Mining Company, crossing the west branch of North Fork of Feather River, near Cherokee, Butte County, is considered equal to 20 feet of "head," (hydrostatic pressure.)

This pipe is about 14,000 feet long, and has a diameter of 30 inches. Its vertical height on the Yankee Hill side, where the water is received, is 980 feet above the lowest point of depression, and its vertical height on the Cherokee sides, where the water is discharged, is 830 feet above the lowest point of depression. It has, therefore, a "head," or hydrostatic pressure, under the necessary supply of water, of 150 feet. The water, however, during its greatest supply and heaviest discharge, never rose more than 50 feet on the Yankee Hill side over the point of its discharge on the Cherokee side, and was then estimated equal to 1,500 miner's inches. Should, therefore, the supply of water be sufficient to fill the remaining 100 feet of pipe on the Yankee Hill side the discharge of water would be enormous, and almost equal a hydraulic jet discharged under 130-feet pressure through a hydraulic nozzle of 30 inches diameter. It will be well to keep this fact in mind, as it may prove that pipes of far less dimensions than the above-mentioned pipe may be sufficient to discharge, under the proper pressure, any necessary amount of water.

Dam.—The place to tap the supplying stream and to build the "head dam" deserves careful consideration. The streams of California are subject to rapid rise, and change their volumes of water constantly, so that at one time all the water in the stream may be needed to supply a ditch, where at another time fifty or a hundred ditches could be made to overflow. Under these circumstances strong dams are needed. The best place to build such a dam will be a narrow place on the river, protected on both sides by projecting ledges of rock. All the mountain streams of California afford many such places. The building of the dam will be done, of course, when the water is at its lowest. The strongest dams are constructed by throwing the trunks of pine trees from shore to shore across the river, putting the first layer, or foundation, from 6 to 8 feet apart, for a width of 40 or 50 feet, then placing another layer of pine trees at right angles and at the same distance across the first layer, and alternating in this way till the dam has reached the proper height. Where the trees cross each other notches ought to be cut and iron spikes driven in, to make the structure perfectly solid. The trees which are to lie lengthwise in the stream ought to be thrown in with part of their top branches on, and turned up stream. The sand, &c., carried down by any future flood will cover these branches, and make the destruction of the dam impossible. After the structure is built, the open places ought to be filled up with stones, earth, gravel, sand, pine branches, &c., and in a short time the dam will be tight and safe against all chances.

On one or the other side of the dam a gate for the ditch must be constructed. This gate should be, if possible, in the solid bed-rock, so as not to be affected by any succeeding flood. If a ledge of rock abuts enough to admit of the construction of a short tunnel, as the connection between the head dam and the ditch, such a chance ought not to be neglected. An iron or strong wooden gate, being controlled by lever or screw, to open or close the mouth of the tunnel, for the admission or cutting off of the water, would defy any flood.

The following diagram represents the river in a low state of water, the ditch receiving the whole supply. During a flood the water would fall over the dam, and the gate being partially closed would admit only enough to fill the ditch.

Lumber.—After a careful survey is made, the best route for the ditch established, and the place for the head dam chosen, the work of digging the ditch may commence on the whole line. Should much fluming be necessary, and a great quantity of lumber have to be used for such purpose, the easy and cheap supply of the lumber deserves great consideration.

The mountain-slopes which flank the streams of California afford an inexhaustible supply of pine timber, particularly in those places which, remote from any market, have escaped the ax of the lumberman. The head of a ditch being almost always located in such a remote region, is, therefore, usually surrounded by a forest of the finest timber.

A portable saw-mill could be established at any convenient point and would furnish all the necessary lumber. The ditch, though commenced along the whole line, must be rapidly finished from the head-dam downward, so that it can serve for the conveyance of sawed lumber where such is needed for fluming, &c. This mode of transport reduces the price of lumber by more than 50 per cent., since the freight amounts generally to more than that proportion of the price.

Excavation.—In digging the ditch along the mountain-slopes the safety of the ground as to slides must be well examined, and the real body of the ditch must be always dug in solid soil, and far enough in the side of the mountain to leave at the outside or lower bank a level surface on which to place a part of the soil of the bank and the ditch.

The bank on the mountain-side must be carried on a good slope at once, so as to prevent slides from it, which, during the rainy season, would otherwise occur, not only filling the ditch, but causing great and dangerous breaks, since the water, checked in its course, would run over the lower bank, causing damages which would take much time and money to mend.

No operation connected with hydraulic mining needs greater care and foresight than the building of a ditch. The best constructed ditch will cause a great deal of trouble for the first year or two, but an indifferently constructed ditch will cause not only as much repairing as the first costs amount to, but be forever after only a second-hand affair.

Deep ditches are preferable to shallow ones, as the evaporation during the summer heat is far less in the former than in the latter. Still, before deciding on the depth of a ditch—whether 2 feet or 3 feet deep—it will be well to examine the soil through which it has to be dug. If the country bed-rock is covered only with a little soil, and if a ditch 2 feet deep would avoid the bed-rock, economy dictates the 2-foot ditch made wider.

All ravines or small water-courses crossed by the line of ditch must be secured in such a way that their water can either be admitted into the ditch or carried over it, as it is wanted or not. Regard must be had in this respect for the increasing volumes of water during the rainy season. It is a notorious fact that the quantity of water carried by established ditches during the summer season is reduced by nearly one-third in its volume by the time the point is reached where the water is to be used. It may be true that in many cases the low state of the river from which the water is drawn is partly the cause of this reduction in volume; but in other cases, where the river affords an unlimited amount, the diminution of the water must be ascribed altogether to evaporation and leakage.

The question arises whether it would not be advisable to counteract this lessening of the water by building the ditches wider at their head and reducing their width for a distance of a few miles till the normal size is reached. In the winter season only a quantity answering the size of the lower part of the ditch would be admitted at the head. In summer all the water the upper part of the ditch could carry would be admitted and brought along, even filling the ditch to the top of the lower (artificial) bank—which would be safe enough in summer. This plan seems well calculated to practically increase the capacity of ditches.

Trees.—Trees found on the line of the ditch, the removal of which is necessary, must never be cut down so that only the stumps remain. To grub up these stumps is a most difficult, tedious, and expensive work, and can be avoided by undermining the tree on the lower side, cutting its supporting roots and felling it down the hill, tree, stumps, roots, and all.

Flumes.—The flumes on the line of the ditch may be built either on a little less grade, or a little smaller, than the ditch, as the smoothness of the boards causes less friction than a rough ditch, and the water, therefore, runs faster.

Flumes are generally built of 1½-inch plank, with a framing of 4 by 4 and 3 by 4 scantling for every 2½ or 3 feet. The strength of the scaffolding for the flumes must be conditioned by their height, and left to the discretion of the builder. The foundation of this scaffolding ought to be on very solid ground, and, if possible, little exposed to water in puddles, coming and going, as the season changes. Moreover, the bottom part of the supporting-posts, or the sleepers, ought to be well charred, as mentioned before, to prevent rot and subsequent settling of the flume. High flumes ought to be well anchored with strong wire, or wire rope, to protect them against winds.

Where a flume is to be built, the underbrush, fallen trees, &c., ought to be cleared away—by ax, or fire, or both—to protect the flume against the conflagrations which occur in our forests from time to time during the dry season.

Flumes of sheet-iron are highly recommended. The iron could be protected against corrosion by immersion in Dr. Angus Smith's preparation of coal-tar, and would certainly afford a very durable and incombustible material. When the present high price of iron shall have fallen to near its former rate, this material will undoubtedly be used with great advantage.

The building of flumes should be avoided as far as possible, since, under the most favorable conditions, using the best kind of sugar-pine lumber, a flume will only last from ten to twelve years; and the cost of its repair is computed to be 75 per cent. higher than that of a ditch.

A flume carrying a constant stream of water is far less exposed to decay than one which carries water periodically. The alternate swelling and shrinking of the wood in the latter not only destroys the fiber of the wood, but also draws the nails, and thus injures the structure.*

IRON PIPES.

The use of iron pipes as aqueducts is not a novelty in California. As early as 1856 or '57 an iron pipe of 40 inches diameter was laid across a small depression at Timbuctoo, near Smartsville, Yuba County. The city of San Francisco is supplied by the Spring Valley Water Company, which has seventeen miles of 30-inch iron pipe, conducting the water across depressions of from 200 to 250 feet vertical depth.

During the summer and fall of 1870 the most important enterprise of this kind was carried out by the Spring Valley Canal and Mining Company, of Cherokee, Butte County.

Under the direction of Joseph Moore, esq., superintendent of the Risdon Iron and Boiler Works in San Francisco, an iron pipe 30 inches in diameter and 14,000 feet long was manufactured and laid across a depression of nearly a thousand vertical feet, formed by the gorge through which the West Branch of the North Fork of Feather River flows. (See illustration on a former page.) This enterprise was a complete success, and found as such a deserved publicity, which makes its particular description at this place unnecessary. For the sake of handy

* Ditches for irrigation in England have been made of concrete, which is cheap and very durable. A long wooden box is made of the shape of the ditch, the concrete (composed of cement and gravel) is mixed and laid down, and the sides are built up of cement, outside the box, which is drawn along as the work proceeds. Cement is made by burning together chalk and clay, having in it a small proportion of sand. Very durable ditches are also made of sand and asphalt, in the same way.

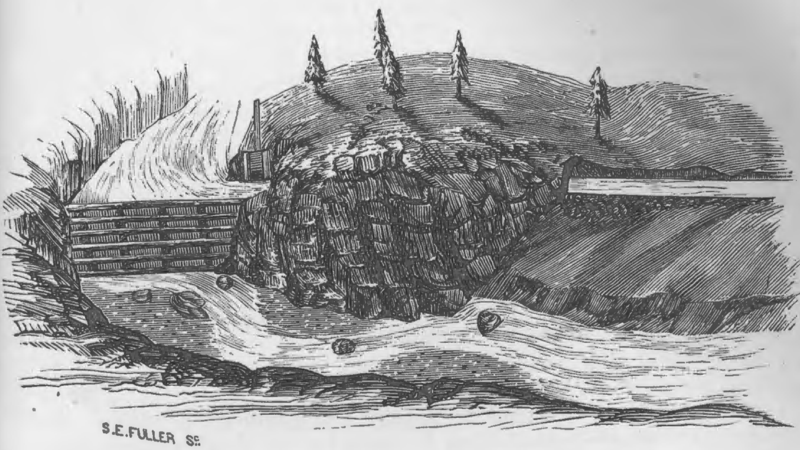


Fig. 13. Low water. (See p. 408.)

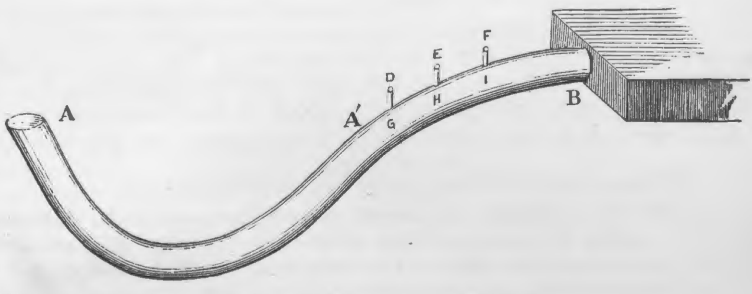
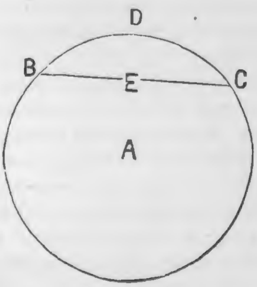


Fig. 14. Air-escapes. (See p. 411).



(Fig. 15. Air-escapes. See p. 411.)

ference, however, it may here be said that the pipe is made of the best sheet-iron, as follows: No. 14 iron was used for 150 feet pressure; No. 12 iron was used for 275 feet pressure; No. 10 iron was used for 350 feet pressure; No. 7 iron was used for 425 feet pressure; $\frac{1}{4}$ iron was used for 600 feet pressure; $\frac{5}{16}$ iron was used for 850 feet pressure; $\frac{3}{8}$ iron was used for 900 feet pressure.

A cistern with sand-box, which serves as receptacle for sand and gravel carried from the ditch, is constructed at the receiving point. An elbow of the pipe dips here in the water, to prevent, as much as possible, the entrance of air. A stand-pipe is adjusted 50 feet from the inlet, to permit the ready flow of water and the escape of air which may have entered the pipe. The pipe is laid in pieces 23 feet in length, riveted together, and in a trench 5 feet deep, and covered with soil to save it from thermal influences, causing expansion and contraction. The rivets used were for No. 14 iron, $\frac{1}{4}$ wire; for No. 12, $\frac{1}{4}$; for No. 11, $\frac{3}{16}$; for No. 9, $\frac{3}{8}$; for No. 7, $\frac{3}{8}$. A steam-riveting machine was employed. Air-valves, with floats, are used at different places, not only to allow the escape of air, when the pipe is filled, but also to prevent a collapse from atmospheric pressure, in case a vacuum should be created by some foreign matter (for instance, a plug of dry leaves accumulated in the ditch) stopping suddenly the supply of water.

In such constructions the entrance of any floating matter should be prevented by a screen of strong wire, or iron bars, placed at some distance from the mouth of the pipe. Particularly in the autumn, when the leaves fall, care should be taken to remove the latter, whenever a quantity is collected before the screen.

The standing air-pipe mentioned above has not proved sufficient for the escape of all the air which is carried down by the water. The consequence is that, from to time, the accumulated air makes an attempt to free itself, and, in doing so, rushes up the stand-pipe with great force, throwing out a large quantity of water, and even emptying the cistern.

The writer thinks a very simple arrangement would secure the undisturbed flow of water, and permit the air to escape as it accumulates, without interfering with the water rushing into the pipe. The water will form a solid body in that part of the pipe, which is filled from the lowest depression of the inverted siphon to an equal height, or level, in each arm of the pipe.

In the diagram given the undisturbed water would rest below the points A A^1, and only from A^2 to B could air interfere with the free admission of water. According to the great or less supply of it, the water would rise or fall between A^2 and B; and the stand-pipes, represented by D E F, would not only become valueless, whenever the water should rise to the point of their connection with the main pipe, but would, under circumstances, discharge great quantities of water, whenever the latter should have risen in the main pipe above their height. Furthermore, there would be no continuous discharge of air, as the resistance of the flowing water against the escape of air would be comparatively as great between points G H or H I, as between A^1 and B. An arrangement is therefore needed, which will not only permit the air to escape at any point between A and B, but also prevent the rushing water from interfering with the free discharge of air.

The writer proposes a simple plan, as illustrated by figure.

The circle A represents a pipe 30 inches in diameter, the line B C a piece of sheet-iron, 23 inches wide from B to C, and 5 inches below the point D. This piece of sheet-iron enters the pipe on a bevel, for a distance of $2\frac{1}{2}$ or 3 feet, falling in this distance 1 inch. The sides B C are securely riveted to the pipe. A second piece of sheet-iron must be inserted in such a way that the first piece overlaps it for about 2 inches, leaving at the same time an open space of 1 inch in depth, and 24 inches in length between the two pieces of sheet-iron, where the overlapping takes place. Any number of additional pieces of sheet-iron are inserted in the same manner, forming, as it were, a shingle roof on the top of the pipe, with an open space of 1 inch in depth and 24 inches in length between each two shingles.

The water enters at the point *o*, and is prevented from entering the air-chamber by the overlapping of the different iron shingles; the air, however, will, under the least pressure, escape through the open spaces between the iron shingles, and can be conducted to any final outlet without interfering in the least with the rush of water.

This air-chamber needs only to be constructed in and a little above that part of the pipe which is subject to the rising and falling of the water, according to the greater or less supply. For instance, in a pipe like that of the Spring Valley Canal and Mining Company, constructed for a head of 150 feet—when experience has shown that a hydrostatic pressure of never more than 50 feet is realized—the shingle roof, or air-chamber, needs only to be applied from near the "solid water" in the bottom of the pipe to a point giving a vertical height of 75 feet above the "solid water." Of this distance, only 50 feet or less would be filled with water, to form the head or hydrostatic pressure, and the remaining 25 feet would secure a sufficient vent for all the air which possibly might come down with the rushing water.

It will be seen that the capacity of the pipe is not lessened by the introduction of the air-chamber; the latter consisting of nothing but pieces of sheet-iron riveted from side to side, and permitting the rising water to fill the air-chamber from below, and thus to occupy the whole capacity of the pipe. The arrangement in itself is simple, and can be introduced into any pipe already in position, provided it is large enough to admit a workman.

For pipes conducting water to the hydraulic machines in the mines, the following plan is recommended to get rid of the air: A pipe of 4 or 5 inches diameter is perforated with holes, each, say, of 2 inches diameter, and at intervals of $2\frac{1}{2}$ or 3 feet. These holes are covered with caps of the shape of half-funnels, and in such a way that the wider part of the funnel leaves an open space, lapping about 1 inch over the hole. The pipe thus prepared is inserted from 50 to 100 feet, according to the length of feeding-pipe, into the latter, the open funnel downward, and is secured firmly to the upper side of the feeding-pipe. The upper end of this air-pipe must rise a few feet above the bulk-head from which the feeding-pipe is supplied.

The air which necessarily enters the feeding-pipe with the rush of water will seek the easiest way of escape, and must, consequently, enter the inserted pipe through the open funnels. The caps over the holes of the air-pipes prevent the water, rushing down, from entering the air-pipe, and the air can be conducted safely to a final outlet.

The above arrangement would not lessen the capacity of the feed-pipe, as the water, rising in the latter, would enter the air-pipe through the funnels, and rise in both pipes simultaneously.

The advantage to be gained from this arrangement would be the almost total exclusion of air from the feed-pipe, and, therefore, the certainty of a solid and even discharge of the water from the hydraulic machine, securing the greatest efficiency and force of the water-jet.

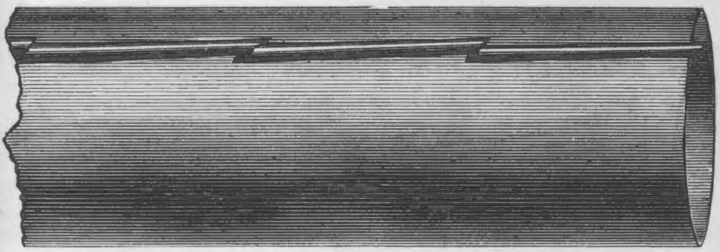


Fig. 16. Pipe with interior "shingle-roof." (See p. 412.)

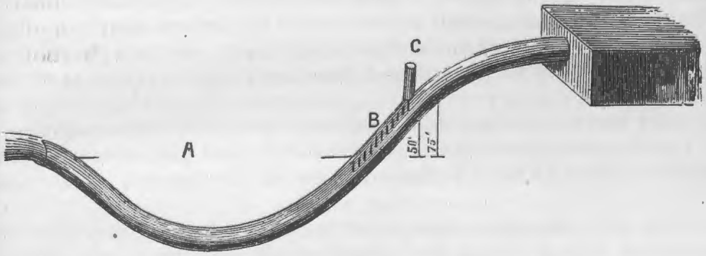


Fig. 17. Pipe with "shingle-roof' and air-chamber. (See p. 412.)

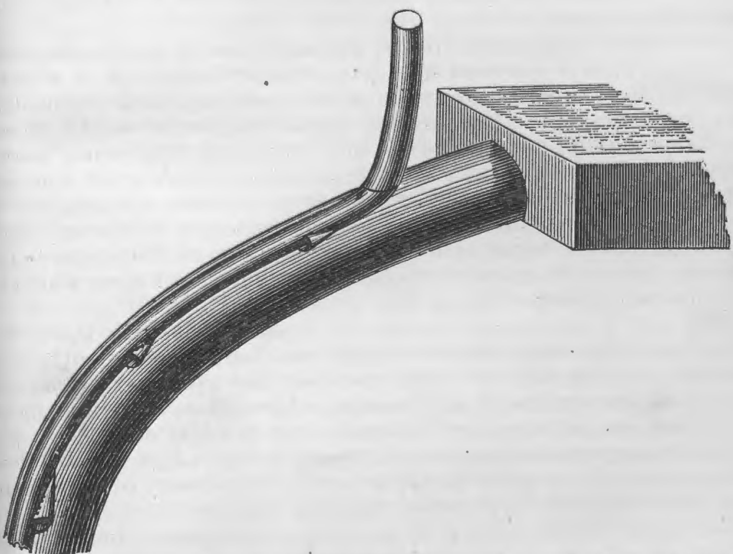


Fig. 18. Feed-pipe with air-pipe for hydraulic machinery. The small or feed-pipe is inside the large pipe. (See p. 412.)

MECHANICAL APPLIANCES.

Sluice-boxes.—These are the highways upon which hydraulic mining is carried on, and their greater or less efficiency has an influence upon this business like that of the establishment of railroads or common wagon-roads upon general commerce.

Just as, by the cheapening of carriage, railroads open coal-fields, grain-producing regions, &c., to the markets of the world and to a brisk commerce, where common wagon-roads would hardly sustain a weak home-trade, so well-adapted sluice-boxes will render inferior gravel-deposits "paying institutions," while, *per contra*, rich gravel-deposits, without proper facilities for the placing of sluice-boxes, are worked at a loss.

The great requirement is sufficient grade, and a careful survey of the route should always be made before the sluices are put in place, so that the existing fall or grade can be husbanded to the best advantage for the establishment of under-currents, drops, grizzlies, &c.

Hydraulic mines are worked with as little grade as 3 inches and with as high as 9 inches per 12 feet. In the first case abundant and cheap water generally makes up in some degree for the want of grade; in the second case a very high grade must make up for the limited supply of water.

Taking the above-cited cases as the extremes, we may say that 6 inches per 12 feet can safely be established as the normal grade, though many important and prosperous mines are worked with 4½ and 5 inches per 12 feet.

The establishment of under-currents and drops must be kept in mind when the grade for the sluice-boxes is laid out, and it is advisable to establish a number of under-currents on a long-line of sluice-boxes, even at the sacrifice of some grade. For instance, sluice-boxes, with 5 inches grade per 12 feet, and with a number of under-currents, are preferable to sluice-boxes of 6 inches grade and without the latter.

These facts must impress once more upon the mind of the miner the vital importance of sufficient fall for the working of a hydraulic mine, as such a favorable condition not only insures: 1, sluice-boxes over a high grade, and, therefore, able to carry immense quantities of gravel, &c.; 2, under-currents, or large, flat boxes, from 10 to 20 feet wide and from 30 to 50 feet long, provided through their whole extent with riffles, to catch gold or amalgam, (see description below;) 3, a grizzly, or an iron grating, placed in such a position as to throw down an embankment or precipice large rocks which have been carried in the sluice-boxes, and permit the smaller rocks and gravel to fall through the grating into a continuation of sluice-boxes, (see description below;) but admits also any additional improvement, such as undoubtedly the future has in store for hydraulic mining.

The size of the sluice-boxes must necessarily depend on the work they will have to perform, and may vary from 4 feet in width to 6 feet.

Supposing that a tunnel has opened the mine for work, of dimensions large enough to admit of sluice boxes 6 feet in width, and from 36 inches to 40 inches high, a grade or route will have to be prepared outside of the tunnel to receive two lines of sluice-boxes of the same width and height. Both these lines of sluice-boxes must be connected with the boxes placed in the tunnel, and provided with strong gates, so as to cut off this connection at will. This arrangement permits the use of the sluice-boxes outside of the tunnel alternately, and the "clean-up" of one line of the boxes without interruption of the work in the mine.

However, when the boxes *in the tunnel* are cleaned up, the washing in the mine must stop till this is done and till the blocks or riffles are replaced. A day is generally sufficient for this work, since the tunnels, with a few exceptions, are short, compared with the outside lines of sluices, and since, moreover, the pavement, or riffles, in the tunnel sluice consist of blocks or sets of scantlings, which are far more easily removed and replaced than the stone-pavement, which usually forms the bottom of the outside sluices.

After the grading is done, according to the fall at disposal, sills are laid across the track 4 feet apart. These sills ought to be 4 by 6 inches, and, for a double sluice, about 15 feet long, so as to project on each side of the flume or sluice, to receive posts and braces. The posts are made of 4 by 5 inch scantlings, and either 36 or 40 inches long, according to the height of the sides of the sluices. The braces are made of $1\frac{1}{2}$ by 6 inch lumber, and the sides and bottom of the sluice of $1\frac{1}{2}$-inch plank. A piece of board 8 inches wide, nailed from post to post flush with the inside of the sluice, not only gives strength to the whole structure but may also serve as a gangway.

Whenever a curve occurs in the sluice, the larger bend, or outside, ought to be raised from $\frac{1}{2}$ inch to 1 inch, according to the degree of the curve. This will check the force of the current toward the outside curve and distribute the flowing matter evenly over the whole bottom of the flume, preventing the wearing of a deeper channel in the pavement on the outside curve.

The pavement of the sluices should be made of hard, flat stone; schist-rock or mica slate is excellent for the purpose. These stones must be placed edgeways, with a gentle slant from their base down the stream, forming a uniform thickness of 10 or 12 inches.

This pavement should be built in separate compartments of 6 or 8 feet length, confined by pieces of strong plank or scantling fixed permanently across the bottom of the flume, to protect the pavement against a wholesale destruction in case the current of the stream should dislodge some stones in one or other of the compartments. For 12 feet of double sluice, equal to 144 square feet, about 9 tons of stone are required for paving.

The sluice-boxes should be lined above the stone pavement with 2-inch planks or 2-inch blocks, for a height of 10 or 12 inches, to protect the real sluice against the wear and tear of the swift gravel-stream.

The single sluice in the tunnel must be paved with square pine blocks, about 10 inches deep. These blocks are laid across the flume, close together, and a piece of plank $1\frac{1}{2}$ by 6 inches is nailed to the lower part of the blocks with headless nails. These headless nails are not driven home, but project about an inch on the face side. A new tier of blocks is inserted and driven on the projecting nails till the blocks touch the intervening board or plank, and are therefore within $1\frac{1}{2}$ inches of the first tier. Another piece of plank is put in position and the same process continued. The lining of the sluices is placed so low down that it touches the tops of the planks in the bottom, and keeps them in position. These spaces of $1\frac{1}{2}$ inches in width separate the different layers of block, and form the real riffles to catch gold or amalgam. The lining in those sluices which have rock pavements is, in many instances, placed so low that the rock pavement covers about 2 inches of it. This is done to prevent the wear of the rock pavement leaving a part of the sides of the flume, or sluice, unprotected. This, however, may be an unnecessary precaution, as the lining of the flume

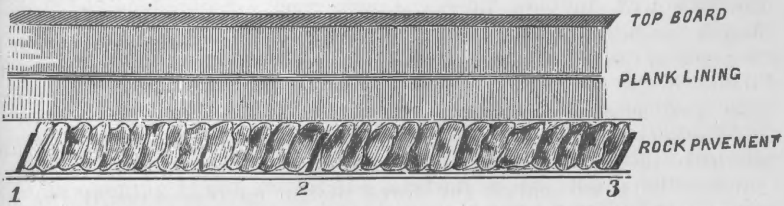


Fig. 19. Sluice-boxes; grade 6 inches per 12 feet; sides 36 inches high; 1, 2, 3, compartments. (See p. 414.)

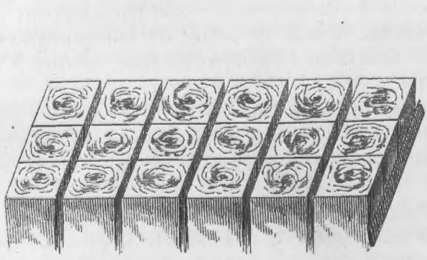


Fig. 20. Block-pavement for sluices. (See p. 414.)

[illegible]

wears out much faster than the rocks, and can, when it has to be renewed, always be placed close to the rock pavement.

The expense of constructing a double sluice of the above dimensions depends both on the cost of the material used and the difficulty of establishing the proper grade. In localities where lumber can be furnished for $20 per M, and where the grading can be done without blasting, double sluices have been laid and paved in the most substantial way for $2 per foot. A single sluice, 6 feet in width and 3 feet high, can be constructed, under similar favorable circumstances, for about $1.25 per foot.

Under-currents.—These are large flat boxes, or platforms, placed beside and a little below the main sluice-boxes. Their size and shape depend, to some extent, on the facilities which the place offers where they shall be constructed. Triangles, irregular oblongs, and parallelograms, containing a surface of from 500 to 1,000 square feet, are the forms often resorted to. The under-current is destined to receive from the main sluice-boxes a certain portion of the finer gravel-wash, black sand, quicksilver, and amalgam, and to afford to the particles of gold and amalgam a better chance to settle permanently in the riffles, which are evenly distributed over the whole surface of the platform. For this purpose an opening is cut across the bottom of the main sluice-boxes from 15 to 18 inches in width. In this opening are inserted steel bars, 1 inch square and 1 inch apart, generally fixed in a cast-iron frame. The small particles of gravel, sand, gold, &c., which pass through this grating are caught in a box placed below the sluice-boxes, on a pitch of about 1 inch per foot, whence they are carried upon the large platform provided with riffles.

This platform is placed on a grade of from 10 to 12 inches per 12 feet, and is provided with an opening at the lower end to return the bulk of the material received to the main sluice-boxes below.

To distribute evenly the water and gravel received from the main sluices a number of check-boards are placed at the upper part of the platform, in a direct line with the box under the grating of the main sluice, which receives the discharged matter. As the water, &c., rushes out of this box part of it strikes against the nearest check-board and is turned down the platform; the remainder, rushing on, is diminished by each succeeding check-board, and an even distribution over the whole platform is gained. At the lower end of the platform the discharge of the water, &c., into the main sluice below may be arrested by the insertion of a small box, on a grade, into which the material drops from the riffles. These riffles can be made either of 2 by 3 inch scantlings, laid down lengthways and 2 inches apart, or of common blocks or stone pavement.

The under-current and main sluice-boxes discharge their contents into a deep and strongly-built box, provided with a heavy stone pavement. From the upper part of this box a continuation of the main flume leads the gravel-stream to other under-currents, drops, &c., and to a final discharge. The lower part of this box must be 4 or 5 feet deeper than the point from which the main-sluices are continued—and will be found of great service in catching amalgam, &c.

The gratings in the main-sluices deprive the latter of a quantity of water. To counteract this loss the main-sluices are narrowed about 6 inches to condense the current of water till both streams, that of the under-current and that of the main sluice-boxes, re-unite as described above.

When there is sufficient room under-currents may be placed on each side of the main sluice. This plan is recommended in all localities where great care has to be taken in the distribution of a limited grade. An under-current of 50 feet length will absorb about 8 feet of grade, and for this reason the plan of establishing two under-currents opposite each other is highly economical, when practicable.

These under-currents are of the greatest service in catching rusty gold, which cannot be touched by quicksilver, and which, lessened in specific gravity by the foreign matter clinging to it, is very liable to be carried entirely through a long line of sluices to the final discharge. The gentle and shallower place on the platform of the under-current gives to this rusty gold more chances to be caught by the extensive riffles.

The grizzly.—This word in the strange nomenclature of the California miner means a grate or frame-work of parallel iron bars, with interstices, which is used here and there in the line of sluice-boxes to throw large pebbles or stones out, and to permit such particles only as can pass easily through the interstices between the iron bars to be carried further along in the sluice-boxes. Wherever a grizzly is applied, a drop of a few feet is necessary; since the material which can pass through must be collected in a box below and thence carried away by a lower section of sluice-boxes. The construction of grizzlies is of use only where the stones to be discharged over the grizzly can be thrown down a steep embankment. When this is the case, the sluice-boxes can thus be relieved of a great quantity of useless material.

To illustrate, we will suppose that a precipice of 40 or 50 feet exists close to drop-box H, represented in the accompanying sketch, so that any material thrown outside of this box would tumble down the precipice. This would give a favorable chance to apply a grizzly, which would have to be done by attaching a frame-work of strong iron bars (condemned iron rails are excellent) to the bottom of the sluice-box, which discharges its contents into drop-box H, and to lead this grate with a fall of about 30 degrees across the drop-box H and towards the precipice.

The iron bars or rails would have to run the full width of the sluice-box, 6 inches apart and parallel with each other, towards the precipice, and all bowlders larger than 6 inches in diameter would be discharged. On both sides of this grating planks must be fixed to prevent any of the stones from escaping sideways.

Hydraulic nozzles.—The observant miner early perceived that if a certain amount of gravel could be washed with a certain quantity of water, double the quantity of water would wash from three to four times as much gravel without increasing the expense for labor in proportion. Greater quantities of water and enlarged hydraulic nozzles were therefore introduced, and the latter became very soon the objects of inventive speculation, which resulted in the successful production of very ingenious hydraulic machines.

The first improvement was a flexible iron joint, formed of two elbows working one over the other, with a coupling joint between them. These elbows were called goose-necks.

This invention was a decided improvement, though it showed some serious defects. The abrupt turn of the elbow broke the force of the water to a great extent; the upward pressure made the joint *c* hard to move, and when the pipe was turned horizontally the hose part would often bend a little too far and the re-action would cause the pipe to "buck" or fly around in a contrary direction. The same re-action would also often occur in elevating or depressing the pipe.

The next improvement was Craig's globe monitor. This invention consists of a hollow ball or globe, with an opening on one side, into which enters the main supply-pipe, and one on top, out of which an elbow-joint protrudes. One end of this elbow is attached to a socket which revolves on the interior of the globe, and at the same time creates a water-tight joint. This joint enables the operator to change the direction of the stream from point to point at pleasure. To the other end of the elbow is attached the discharge-pipe, which may be of any size desired. The ball revolves entirely round horizontally, and up or down at an angle of about 40 degrees.

The next machine introduced was Hoskin's dictator, in which the parts constituting the joint work with an external instead of an internal connection; that is, the pressure of the water, instead of forcing the parts of the joints together, tends to force them apart, and the joint, to keep it from leaking, is provided with an elastic packing. Both rotary and vertical motions are facilitated by the peculiar construction, wheels reducing the friction on the former, and the latter turning on pivots. This joint is still much used; the only objection to it is the unnecessary loss of power, on account of the elbows being too abrupt.

Another machine, under the name of Watson's champion, similar in design to the last mentioned, was introduced, but denounced as an infringement on the dictator, and put under injunction.

Another new machine entered the field under the name of the knuckle-joint and nozzle, invented by Mr. F. Fisher, of Nevada County, California, consisting of two elbows, placed in reversed position when standing in right line, but made to revolve by a ring in which there is a series of anti-friction rolls, the ring being slipped down over the top of the lower elbow, and then held in its place by a flange bolted to the top of the lower elbow. The ring is then bolted to a flange on the top elbow, thereby connecting the two, and at the same time leaving the top elbow free to move around in a complete circle. When the water is let into the elbow the pressure brings the rolls in the ring up against the flange on top of the bottom elbow, allowing the top elbow to move around easily and without any friction, except that of the rolls themselves. A piece of rubber packing placed between the flanges of top and bottom elbows, makes the joint tight by the pressure of the water against the ring. In the outlet or top elbow is a knuckle-joint, which permits the up-and-down motion of the discharge-pipe. It is a concave surface fitted to a convex one; the concave has an opening for the pipe to pass through. The pipe is screwed into the convex surfaces and will move up and down, while the concave one is bolted firmly to the flange on the top elbow.

The elbow and knuckle-joint are made of cast iron from $\frac{5}{8}$ to $\frac{3}{4}$ inch thick. The discharge-pipe is made of No. 16 iron, 8 feet long, with cast-iron nozzle. The machine is operated by a lever 10 or 12 feet long, with two arms, and attached to the top elbow by trunnions. A lever is pivoted to the top of the upper elbow and attached on one end to the discharge-pipe by a strap inclosing the pipe, and provided with two rolls on the top for the lever to slip on. At the other end it is connected with the operating lever by a short upright lever, made to work loose on its joints. Thus the up-and-down motion is imparted to the discharge-pipe by the rise and fall of the operating lever. By moving it to the right or left the whole machine, except the bottom elbow, is moved. A little device is attached to the lever to hold the discharge-pipe in position when the water is off. It is a catch working in a ratchet on the top elbow, attached by a rod running out on the lever, so that the operator can put it in or out as the case may be.

The pipe stands firmly in place when the water is on; the operator, standing at the end of the lever, can easily direct the stream to any point—good execution being done at a distance of 200 feet from the bank, thus securing safety of life from caves, which are so frequent and so often fatal, where small streams are used against high banks. These machines are made to throw streams of from 4 to 7 inches in diameter.

The Little Giant, invented by Mr. R. Hoskin, of Dutch Flat, Placer County, is claimed to combine all the requisites of the hydraulic nozzle. Simple in its arrangement, it is easily managed, and an additional pressure of water does not interfere with its motion, as the connections, or joints, instead of being forced together, are forced apart by such a pressure. The avoidance of abrupt angles in its construction makes the Little Giant approach nearer to the straight line than any other hydraulic machine so far introduced. Upon the strength of this fact, it is claimed, and apparently with good reason, that less resistance is offered to the flow of water by the Little Giant than by any other hydraulic apparatus, and that by it, therefore, not only a greater quantity of water, but also a far more powerful stream can be discharged.

The joints, being packed with leather, are dependent on the packing for tightness, and are thus preserved from wearing or grinding off. To prevent this rotary motion of the water, produced whenever the elbows are turned different ways, the "rifle," composed of radial plates, is inserted in the discharge-pipe. These plates force the water to issue in a straight line from the discharge-pipe, and prevent thus the scattering or breaking up of the stream, on the solid and columnar shape of which so much of its effectiveness depends.

The Little Giant has been worked with 6-inch nozzle under a pressure of 435 feet.

Distributer.—This is a strong cast-iron box, receiving directly from the supply-pipe all the water to be used by means of hydraulic machines in the mines. It is provided with two or more openings, to which the pipes, directly connected with the hydraulic nozzles, are attached. These openings can be closed by strong iron gates, raised or lowered by means of a screw. To change the water from one hydraulic nozzle to another the gate for the latter is opened by turning the screw. At this point two streams of equal power will issue from the two nozzles. Now, the screw of the first hydraulic nozzle is turned, the gate closes slowly, and the whole of the water is changed from one nozzle to the other.

These distributers are provided with as many as four gates, so that four hydraulic nozzles could be supplied from one of them, provided the supply of water and the feed-pipe were large enough to furnish the four nozzles at the same time. The distributer must be firmly fixed to the ground.

The supply or feed pipe.—The size of this pipe must necessarily depend on the supply of water. In mines which use from 1,500 to 2,000 inches of water, feed-pipes of 22 inches diameter are generally used. When the supply of water is higher than that, and rises to 3,000 inches or more, it is advisable to use a pipe of 30 inches diameter, since the friction is lessened to a great extent by the large size.

The feed-pipe should descend from a strong bulk-head in as direct a line as possible, and with the least angles, to the mine. It should not be permitted to *fall* and *rise* again, unless this is unavoidable; and then it should be provided with an extra number of air-valves, with *brass* floats. (The depressed portion of the pipe would retain the water all the time, and might be at any moment the cause of a collapse, unless efficient air-valves could supply air quick enough to prevent a vacuum.

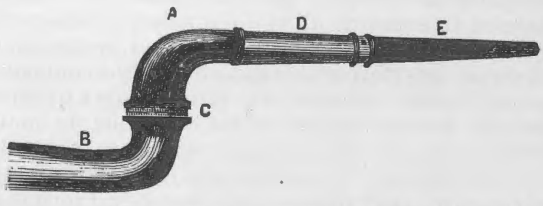


Fig. 22. Goose-neck. A B, elbow; C, joint; D, piece of hose; E, discharge-pipe. (See p. 416.)

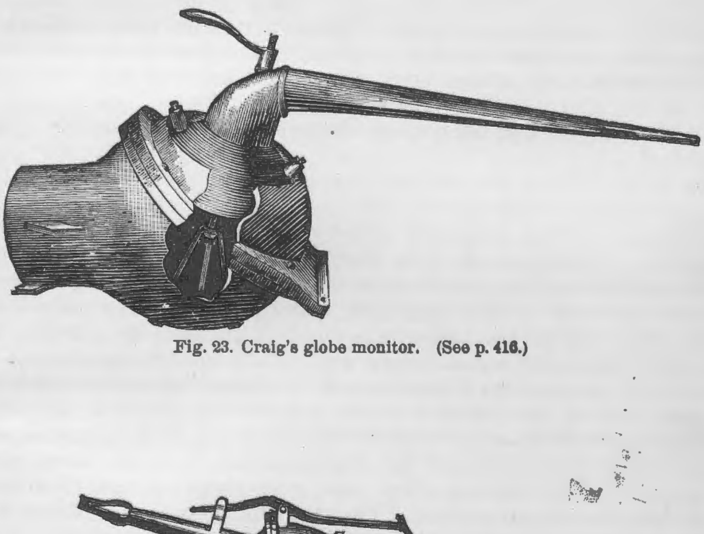


Fig. 23. Craig's globe monitor. (See p. 416.)

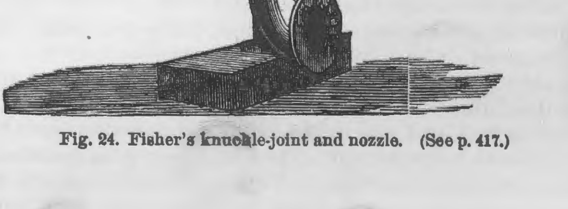


Fig. 24. Fisher's knuckle-joint and nozzle. (See p. 417.)

[illegible]

[illegible] the valve that the [illegible] of pressure [illegible] A [illegible] of the [illegible] of the pipe [illegible] of air [illegible] will enter with the water. [illegible] part of the pipe which [illegible] and the [illegible] carefully [illegible] be placed in [illegible] that it is [illegible] boxes and [illegible] weighted down with stones [illegible] at intervals. [illegible] to the [illegible] pipe, or near the [illegible] (Fig. 13[illegible]).

The iron used for [illegible] pipe, varies from No. 18 to No. 14, [illegible] according to the [illegible] pressure [illegible] should be taken not only to [illegible] but also [illegible] it strong enough [illegible].

For [illegible] pipe, No. 16 iron was used for pressure up to 175 feet; No. 14 from [illegible]; No. 12 from 250 to 400 feet. For [illegible] pipe No. 14 iron was used for pressure up to 150 feet; No. 12 from 15[illegible] feet.

The pipe [illegible] the hydraulic [illegible] from the [illegible] will [illegible] from 10 to 15 inches [illegible] be made of No. 14 or [illegible]

[illegible]

[illegible] with sand, gravel, [illegible], etc.

This [illegible] for a day, and [illegible]

After the [illegible] so as to [illegible] may be applied [illegible] with a [illegible] from 300 to 400 pounds are used for [illegible]. The upper [illegible] of the [illegible] the lower [illegible] a portion of the [illegible] the stream.

The quicksilver [illegible] light [illegible] along the [illegible] with good [illegible]. The [illegible] of the [illegible] is [illegible] to twice a day, but it must be [illegible]. The daily [illegible] of quicksilver [illegible] pounds [illegible] one hundred [illegible] pounds per day [illegible] quicksilver required [illegible] in the upper part of the [illegible]

These air-valves ought to be provided with brass, *not wooden*, floats, since the swelling of the latter will, under some circumstances, wedge them so tightly in the valve that the atmospheric pressure is unable to remove them; a collapse is the consequence.)

The water at the bulk-head must cover the mouth of the pipe for a depth of 3 or 4 feet, to lessen the amount of air, some of which, under all circumstances, will enter with the water. Where the feed-pipe has a permanent position, it is the best plan to have joints riveted together; that part of the pipe which is liable to be shifted must be connected by hooks and wire, and the joints must be calked carefully. The pipe must be placed in such a position that it is immovable; on precipitous ground, braces and frame-works, weighted down with stones, ought to be used at intervals. An air-pipe must be attached to the feed-pipe at or near its upper end. (See Fig. 18.)

The iron used for these feed-pipes varies from No. 16 to No. 11, and lower, according to the greater or less pressure; however, care should always be taken not only to employ the best charcoal-iron, but also to have it strong enough against all chances.

For a 22-inch pipe No. 16 iron was used for pressure up to 150 feet; No. 14 from 150 to 250 feet; No. 12 from 250 to 310 feet. For a 30-inch pipe No. 14 iron was used for pressure up to 150 feet; No. 12 from 150 to 275 feet.

The pipes supplying the hydraulic nozzle from the distributer will differ in size, say from 10 to 15 inches; must be made of No. 14 or No. 12 iron, and must be connected either by flanges or by hooks and wire; well calked and firmly secured in their position.

All the pipes should be protected by immersion in Dr. Angus Smith's preparation of coal-tar.

THE EXTRACTION OF GOLD.

The use of quicksilver.—Quicksilver is used to collect and combine small particles of gold, in the form of amalgam. To facilitate this action it is necessary to use it in such a way that it may be constantly exposed to a contact with these minute particles of gold. For this reason the washing through the sluice-boxes must commence before any quicksilver is used, so as to get the interstices between the riffles filled with small gravel, sand, clay, &c.

This washing without quicksilver may be carried on for a day, and light top-gravel will be the best material to use.

After the openings in the different riffles are thus filled, so as to prevent the quicksilver from dropping clear to the bottom of the sluices, it may be applied, for the first charge, with a liberal hand. From 500 to 600 pounds are used for a sluice of 5,000 feet length. The upper parts of the sluice are generally charged more profusely than the lower parts, as a portion of the quicksilver is carried down by the stream.

The quicksilver must be scattered in a light spray all along the sluices; iron sprinkling-pots, made for the purpose, are used with good effect. The charging of the sluices is generally attended to twice a day; but it must be admitted that a more liberal and more frequent application of quicksilver would be only beneficial. The daily charges of quicksilver are reduced to about 100 pounds, so that a supply of one hundred flasks of quicksilver (about 74 pounds per flask) will last for a six months' run, allowing for the quicksilver regained by the semi-monthly cleaning up of the upper part of the sluice-boxes.

Cleaning up.—The upper part of the sluice, provided with either scantling-riffles or block-riffles, is generally cleaned up once or twice per month. Whenever this is resolved upon the sluices are gradually emptied of their gravel contents down to the riffles, and these are removed successively, commencing with the upper riffle.

A small stream of water is applied to move gently the black sand, or fine gravel, which may remain in the sluices. The amalgam or quicksilver is scooped up and put in wooden or iron buckets. Here and there pieces of scantling are placed across the sluice to check the flow of the quicksilver. Brooms, scrapers, and knives are used to collect the amalgam which may hide in small fissures of the wood. A general cleaning up takes place once or twice a year, when the whole line of sluices is deprived of its gold and quicksilver.

The riffles, whatever they may be, are put alongside the sluices, ready to be replaced for new service.

Cleaning the amalgam.—The amalgam must be placed in a quicksilver-bath to separate the gold from any baser metal, particularly lead, which has been scattered by the hundred pounds over the hill-sides of California by quail and rabbit hunters. The amalgam must be well broken up, and rubbed and washed repeatedly. In this way the gold, as the heaviest part, will settle to the bottom, and all the other metallic substances will float on the top of the quicksilver. After this washing the amalgam is deprived of the free quicksilver by straining through a filter of canvas, and afterwards put in a bath of water and sulphuric acid (one-third acid and two-thirds water) and bailed and stirred over a slow fire for about forty minutes. By this process the remaining lead is generally removed, and the amalgam, after further washing in pure water, may be considered clean.

The residue (skimmings) of lead, &c., is put in pure nitric acid, which destroys the lead, forming a nitrate of lead; the amalgam remains and is cleaned by a water-wash.

Retorting.—After the amalgam has been purified it is ready for retorting. The retort is covered on the inside with a thin layer of moist clay to prevent the gold from sticking to the sides, after which the amalgam is packed tightly into the retort and the latter placed on the fire. A pipe leading from the retort into an iron bucket, filled with clean water, conducts the vaporized quicksilver into the water where a condensation takes place immediately. Five or ten minutes after the flow of quicksilver has stopped, provided the retort has been all the time exposed to a brisk fire, the retort may be removed from the furnace, and the amalgam has been changed into a cone of pure gold.

Great care must be taken to close hermetically the retort containing the amalgam, as the escaping quicksilver-vapors are very poisonous.

Smelting.—The retorted gold is broken in fine pieces, placed in a crucible, and, after some flux is added, exposed in the furnace to a hot charcoal fire. After a perfect fusion has taken place, the liquid gold is cast in a mold, generally the shape of a small brick. After cooling, the bar is stamped with the name of the mining company and the weight, and is ready for the mint or assay office.

LOSS OF GOLD AND QUICKSILVER.

It is difficult to arrive at a correct estimate of the loss of gold in hydraulic washings. In mines where coarse gold predominates the loss cannot be so great as where gold in fine particles, commonly called flour-gold, constitutes the principal yield. Hydraulic mines, however, must

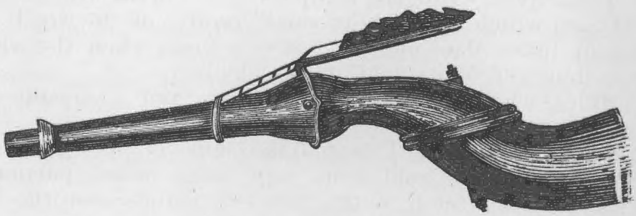


Fig. 25. Hoskin's Little Giant. (See p. 418.)

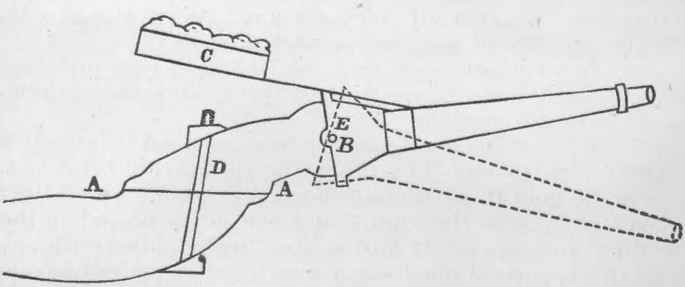


Fig. 26. Little Giant, section. A, joint for horizontal motion; B, ditto for depression or elevation; C, balance-box to keep pipe in place; D, E, bolts. (See p. 418.)

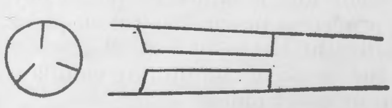


Fig. 26 *a*. Little Giant, rifle or radial plates. (See p. 418.)

[illegible]

chiefly depend on the latter gold, which is diffused through the hills and mountain-sides.

The loss of quicksilver in the best-conducted hydraulic mines is from 12½ to 15 per cent., and the loss of gold, in many cases, can hardly be less. Even if almost all the heavier particles of bright gold are saved, still there is in all mines a proportion of rusty gold, which is not attacked by quicksilver, and is very liable, on account of the reduction of its specific gravity by the adherence of foreign matter, to be carried off in the sluice-stream.

In most cases the tailings of a hydraulic mine become public property, and are therefore a total loss to their original owners. How great this loss is may be evidenced by the yield of only a small portion of these tailings under subsequent working.

There can be no doubt whatever that generally too much gravel is washed for the supply of water. We need only to argue from the most primitive mode of gold-washing, namely, the washing with the pan, to gain the strongest proof that by the washing of enormous quantities of gravel in a stream of thick and muddy water great quantities of the finer particles of gold are lost. To save such gold in a pan requires not only a skillful hand, but a change of water, so as to offer the least resistance to the settling of the particles at the bottom of the pan. Considering, then, how easy it is to carry on certain mechanical operations on a small scale, which are altogether impracticable on a large one, we must conclude that the difficulties of saving the flour-gold in enormous sluices, running rapid streams of thick and muddy water, must be increased, though not, perhaps, in direct proportion to the difference between the quality of material washed. That it is desirable to extract the gold as completely as possible from the gravel-deposits, which, though immense, are nevertheless exhaustible, needs no demonstration; the only means will be a greater supply of water. With an ample supply of water a system of sluices could be introduced which would separate the finer gravel, black sand, &c., from the main stream and carry this finer stuff, with a new supply of pure water, alongside the main sluice. A medium grade of 6 inches to 12 feet of the main sluices would suffice not only to carry out such a system of separation, but to establish under-currents and drops for finer gravel, even to a greater extent than the present system of sluice-washing permits.

We will suppose that sluice-boxes on a grade of 6 inches per 12 feet and for a distance of 5,000 feet are established; that, furthermore, the natural fall of the main outlet permits no higher grade.

At the point where main sluices leave the tunnel, (the length of which is immaterial,) a grating, such as described under the heading of under-currents, is inserted in the bottom, flush with the pavement of the sluices. The bottom of the main sluice, below this grating, which may be from 15 to 18 inches in width, forms the bottom of the box which receives the water, fine gravel, &c., falling through the grating. To give fall to this box, a false bottom on a grade of ½ inch per foot is inserted. This box leads into (or is continued in the form of) a smaller sluice-box, running alongside the main sluice and on a grade of only 4 inches per 12 feet.

To facilitate the flow of this strained material, and to make up for the loss of grade, a jet of pure water is injected by a small pipe into the receiving-box below the grating, assisting thus in keeping this box clear and in washing the strained gravel, &c., in a pure stream of water.

Figure 28 represents the sluices running on a higher grade than 6 inches to 12 feet, to make the difference in grade which exists between the two sluice-boxes more prominent and perceptible.

A represents the rock pavement in the main sluice-boxes flush with the grating.

B is an iron pipe, large enough to supply streams of pure water in sufficient quantities, when necessary.

C is a smaller pipe, leading a jet of water into the box below the grating.

The small sluices, containing the strained gravel-wash, will gain, in a run of 250 feet, about 3 feet and 6 inches height over the main sluice-boxes, the former running on 4 inches and the latter on 6 inches grade to the 12 feet. At this point—250 feet from the first tap—another grating and small sluice-box is established as before. At the same point the platform of an under-current, 36 feet long and of any desirable width, running on a grade of 12 inches per 12 feet, or 1 inch per foot, can be constructed. This platform connects at its lower end with the second smaller sluice-box, and empties its contents into that box, which needs to be enlarged sufficiently to carry, in a shallow stream, all the gravel and water received. It is supposed that another jet of pure water has been tapped from pipe B, and applied as before mentioned.

It will hardly be necessary to say that all these arrangements should be carried on far enough from the main sluices not to interfere with them except at those places where the tapping takes place.

Fig. 29. A. First tap, running 250 ft. and gaining 3 ft. 6 in. over grade of main sluices.

B. Second tap from main sluices, 3 feet 6 inches lower than the first.

C. Platform of under-current, on 1 inch per foot grade, and 36 feet long.

D. Widened boxes, running on 4 inch per 12 feet grade.

E. Main sluice.

We have here, then, in a distance of 250 feet, and without loss to the grade or elevated position of the main sluices, an under-current of 36 feet length and 1 inch per foot grade; and we can repeat the arrangement for every similar distance, and without losing control of the strained gravel, &c., which is carried onward independent of the mass of material in the main sluices.

The finer gravel, which is gradually extracted from the main sluices, must be collected into one box, increased in size as new tributaries empty into it. Considering that only very fine gravel, with an increased supply of water, is carried by these boxes, they may be made very wide, so as to permit the gravel and sand to spread and run in a thin stream.

To regulate the overflow, triangular checks, as represented in the platform C in the last sketch, may be used, one of the angles turned toward the stream.

If a drop is preferred, from time to time, instead of an under-current or its platform, a very strong and tight box should be placed below, and a few feet lower than the actual drop.

To the bottom of this box a strong iron pipe, 1 or 2 inches in diameter, may be adjusted, being, at the same time, connected with the supply-pipe which furnishes the water along the line of sluices.

This water is supposed to be subject to any desirable pressure and might be used at these drop-boxes under enough pressure to keep the quicksilver and other matter in the drop-box in perpetual motion, and thus assist in the liberation and amalgamation of the gold.

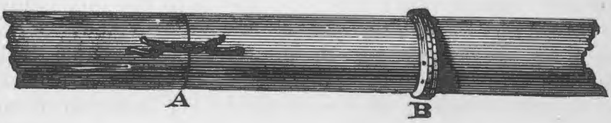


Fig. 27. A, hook and wire connection; B, flanges. (See p. 419.)

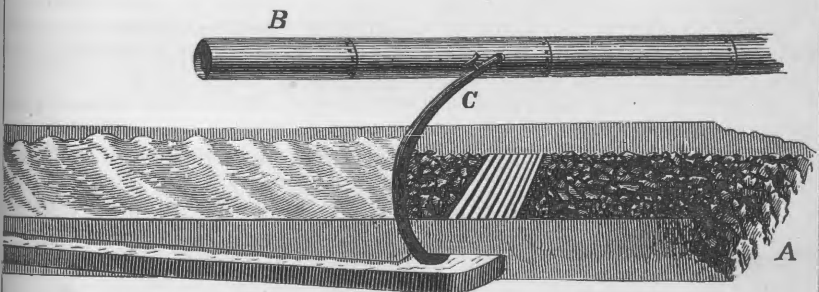


Fig. 28. Main and auxiliary sluice-boxes. A, rock-pavement; B, large iron pipe; C, small pipe. (See pp. 421, 422.)

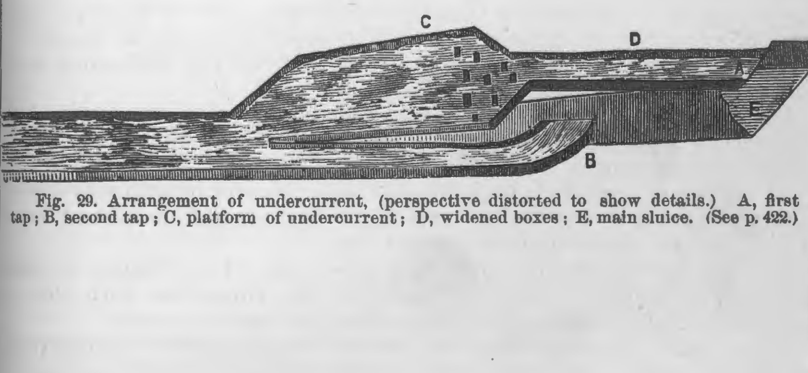


Fig. 29. Arrangement of undercurrent, (perspective distorted to show details.) A, first tap; B, second tap; C, platform of undercurrent; D, widened boxes; E, main sluice. (See p. 422.)

[illegible] the gold-[illegible] the [illegible]
[illegible] through a grating with a mesh [illegible] matter [illegible] the abundance of water [illegible] of alluvial deposits, should [illegible] the same [illegible] gravels of the [illegible] in the [illegible] means of [illegible].

The water [illegible] the [illegible] by the [illegible] pipes. The [illegible] and [illegible].

It would be advisable to [illegible] the sluices for the [illegible] which are considered the best [illegible] and durable enough for the washing of large areas.

In the history of gold mining [illegible] gold was found in the [illegible] of the [illegible] was [illegible] water, and [illegible] while the lighter sand [illegible] the water.

The platforms of our [illegible] only a [illegible] larger scale of the [illegible] greater [illegible]

[illegible]

[illegible], therefore, a [illegible] of the [illegible] would [illegible] of the [illegible] water [illegible]

The practicability of [illegible] application in gold washing [illegible]

The distance between [illegible] would, therefore, be [illegible] between [illegible]. The platforms [illegible] grade [illegible] would be [illegible] gravels of [illegible] When the gravel and water [illegible] a deep, strong box [illegible] of this box an iron pipe is led, which discharges a stream of water under a regulated hydrostatic pressure and an adjustable [illegible].

In this way the [illegible] would be [illegible]

A further sifting or reduction in size of the gravel can be accomplished by straining it through a grating with ½ inch interstices between the bars; the refuse matter may either be thrown at once into the main sluices, or, in case an abundance of water is at hand, carried in a separate box to the place of general deposit. Should the refuse pebbles be thrown back into the main sluice all future gratings in the latter must be fine enough to retain these refuse pebbles in the main sluices, and thus to prevent useless shifting of material.

The water which the main sluice loses by the repeated tapping must be supplied by pure water from the supply-pipe. The size of the main flume or sluice must also be reduced as the water stream and solid material lessens.

It would be advisable to supply all the sluices for the finer or sifted gravel with riffles made of 2 by 3 inch scantlings, which are not only considered the best gold-catchers, but are easily removed and replaced, and durable enough for the washing of fine gravel.

In the history of gold-mining the *washing process* can claim priority over all others, no matter whether the gold was found in the sands of a river or in a solid ledge of quartz. If in the latter, the solid quartz was first reduced to sand, and then treated like river-sand by washing over sloping platforms covered with blankets or skins, in which the small particles of gold settled, while the lighter sand flowed off with the water.

The platforms of our under-currents are only a repetition on a far larger scale of the above-mentioned primitive mode of gold-washing, and they illustrate well the soundness of the principle: *to pour the gold-bearing matter in a shallow stream over an inclined platform, provided with a rough surface, on which the small particles of gold can be caught.*

Being then forced to acknowledge that a broad and shallow stream facilitates the catching of gold, we must ask, *why are all our sluice-boxes not constructed on the principle of under-currents, wide and shallow?* The answer is, that the heavy and large material, (bowlders and pieces of hard clay or cement,) needs a deep current of water to carry it along.

If, therefore, a separation of the finer gravel from these bowlders, &c., were effected, no reasonable obstacle would remain to the application of that principle in gold-washing which has been sanctioned by the practice of thousands of years, and which our modern time, with all its advances in science, cannot improve, but only imitate.

The practicability of such an application in gold-washing, even for the largest hydraulic operations, may be illustrated by the subjoined sketch, which, though not executed with regard to proper proportions, represents, with sufficient clearness, a section of main flumes, or sluices, running on a grade of 6 inches per 12 feet, and tapped every 250 feet for its whole length.

The distance between tap I and tap II would, therefore, be 250 feet, and between tap I and tap III 500 feet. The platforms have only a grade of 4 inches per 12 feet, and the gain in height by this lessened grade would be for a distance of 250 feet about 3½ feet, which gain is spent in a drop at tap II, where a larger platform receives the strained gravels of taps I and II. Where the gravel and water drop off is inserted a deep, strong box, well charged with quicksilver. To the bottom of this box an iron pipe is led, which discharges a stream of water under a regulated hydrostatic pressure and in adjustable quantities.

In this way the quicksilver would be kept always in motion, and the gravel itself would be subjected to an excellent crushing process. (See sketch, pipe 1.) Pipes 2 and 3 inject streams of pure water under the grating to keep the box clear, and to supply also more water to wash the gravel over the widened platforms.

This process may be repeated for the whole length of the sluice-boxes. The size of the gravel may be reduced by repeated straining, as described above.

The undeniable advantages of this mode of working can be stated in a few words:

First. All the fine gravel and sand, in which most of the fine or rusty gold is carried off, will be submitted to a continuous washing over under-current platforms, without ever being returned to the main sluices. The reduced grade on these platforms is equalized by an addition of pure water, which will permit an easier settling of the gold than a swift and muddy stream.

Secondly. Repeated drops, connected with a strong hydraulic jet, will do a great deal for the scouring of rusty gold, and the general breaking up of the washed material.

Thirdly. A reduction of the gravel to the smallest size can be easily attained by repeated straining, as mentioned before, so that the largest pebble would only equal a pea in size.

To prevent this fine-gravel wash from "baking," requires only a very simple arrangement. A frame-work, resembling a common harrow, can be placed on the top of the platform, the teeth downward, and touching with their points the riffles of the platform. This arrangement would secure the breaking of the stream at a hundred or more points, and could be removed and replaced at a moment's warning. (See Fig. 30.)

Where motive power can be procured as easily as on large sluice-boxes running a large and rapid stream of water, this harrow might be put in slow motion by an undershot-wheel, the frame of the harrow running on rollers upon the sides of the platform.

This sort of machinery is the simplest in construction, and could be used, perhaps, with great beneficial effect, and without that wear and tear which any more complicated machinery would suffer by the treatment of such an enormous quantity of material as continually passes over the long line of platforms.

The writer submits the foregoing suggestions, trusting not only to gain the favorable judgment, but also to arouse the inventive energy of those to whom we owe already the present advanced condition of the art of hydraulic mining.

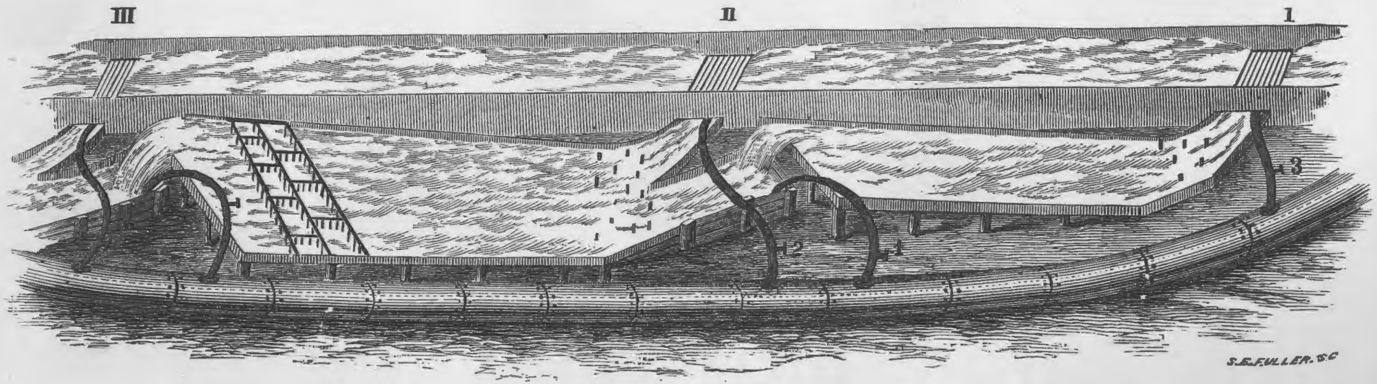


Fig. 30. Sluice-washing of the future. I, II, III, taps; 1, 2, 3, auxiliary jets. (See pp. 423, 424.)

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CHAPTER XVIII.

ORE-DRESSING.

[illegible] [illegible]pter was furnished for my last report by Mr. Willard P. [illegible]w of Salt Lake City, Utah, and formerly one of the editors of the Engineering and Mining Journal. As it arrived too late to be included in the volume for which it was intended, I retained it, and have since revised and somewhat enlarged it, preserving, however, in the main, Mr. Ward's arrangement and views. The object of the chapter is to give, for persons to whom the large and thorough works of Gaetzockmann and Rittinger are inaccessible or unintelligible, a general and simple statement of the principles on which the art of separating and concentrating ores is based, together with a brief notice of the leading machines for this purpose, in which water is used as a medium.

All ores as they come from the mines consist of two, and may consist of three, portions. There are always a valuable and a worthless portion, [illegible]e may be an injurious portion, the presence of which causes loss [illegible] subsequent treatment of the ore. It is purely an economical ques[illegible]ether the worthless and inert and the active and injurious por[illegible]ould be removed by mechanical means from smelting-ores before [illegible] subjected to chemical treatment in the furnace. To separate [illegible]ortions by mechanical means is the province of ore-dressing.

[illegible]early mining operations in the Territories consisted almost exclu[illegible]n the extraction and amalgamation of ores containing the pre[illegible]etals in a free state, and the high cost of labor, fuel, and trans[illegible]on entirely precluded the adoption of the processes of metallurgy [illegible]ich the base metals could be extracted, and the loss of the precious metals themselves could, as a rule, be materially lessened. Smelting-ores were then but little sought after, and veins containing ore that could not be amalgamated without being previously subjected to a metallurgical process were practically valueless.

But at the present day the ores of some of the richest mining districts are and must be worked by smelting alone, and in other places smelting-works could be profitably carried on were the proper means at hand for preparing the ore for the furnaces. It is also claimed that in certain districts at the present time ores are smelted at a profit which could much more profitably be worked by a previous dressing, and this is undoubtedly the case when the ore consists of argentiferous galena without tetrahedrite, or any of the exceedingly rich silver-ores, the cleavage of which causes them to break up into pieces of a shape ill-suited for dressing.

The cost of transportation is still generally so high at the West that the smelting of lead-ores, which do not contain from 30 to 50 ounces of silver to the ton, can hardly be thought of. The value of the lead obtained from the smelting of argentiferous galena may often be sufficient to pay something more than the cost of transporting the base bullion to market, and the same may be said more frequently of the copper contained in ores, mattes, or black-copper, but only in exceptional cases will the base metal also cover a portion of the mining and smelting expenses. The accompanying base metal renders the payment of the heavy insurance rates on fine bullion unnecessary, and the saving thus effected will go far towards paying the freight on the base metals.

Dressing-works are properly adjuncts to smelting-works and *vice versa.* In some localities silver-ores are found of sufficient richness to be smelted without previous preparation, but instances in which a proper dressing would not be advantageous are rare. Even in rich ores there is usually much more earthy matter than is necessary for the formation of sufficient slag to protect the metal in the furnace, and the removal of this excess by dressing before the ore comes to the furnace would always be found economical.

For example, the ores generally smelted in Utah contain a very much larger percentage of silica than can be used in slagging the oxide of iron and the alkaline bases which they contain, and in order to work these ores, fluxes, consisting of iron-stone or limestone, or a mixture of the two, must be employed in the furnace. The removal of a portion of the silica by mechanical dressing would save not only the cost of the fluxes, but the expense of smelting a much larger quantity of slag than is required.

It is claimed by some that decomposed ores, such as the carbonates of lead found in the Emma, Miller, and many other leading mines near Salt Lake, might also be dressed to advantage. This would entail the loss of almost all of the oxide of iron which they contain, but proportionally much more silica could be removed.

Another, and a not less important function of dressing, is the removal of substances which act injuriously in the smelting process, causing irregularity in the working of the furnace, and loss, by volatilization or otherwise, of both base and precious metals. In this respect we see the difference between a true dressing of an ore and a simple concentration, which aims merely at removing a portion of the worthless gangue, and which divides the ore from the mines into but two portions, headings and tailings. By means of a rational and comprehensive system of dressing, however, the galena, the pyrites, and the blende, which may have been intimately associated in the ore as it came from the mine, may be separated cleanly enough for all practical purposes, and each subsequently treated for itself. The advantage of making a complete separation of this kind will be apparent when we consider that the blende, which is so commonly associated with silver-bearing galena, is often poor in silver, and when put in the lead furnace not only consumes a considerable quantity of heat in being volatilized or smelted into the slag, but carries with it up the chimney or into the slag a much greater amount of silver than was contained in it when it was put in the furnace. If, however, this zinc-blende can, with only a small percentage of galena, be treated by itself, it can be used for the preparation of zinc white, (Bartlett's process,) and a large proportion of its contents of silver saved, or by different treatment metallic zinc may be made from it.

It is apparent, however, that the loss arising from the presence of zinc in the lead furnace, added to the value of the zinc and silver which may be saved, might not always be sufficient to pay the cost of dressing the ore, and as the question is purely an economical one, it will be necessary for every one working such an ore to decide in his individual case as to whether dressing would be pecuniarily advantageous to him or not. In deciding this question the best method of separation must be first determined, and the cost of dressing the ore by that process ascertained; then the loss of silver in the furnace caused by the volatilization of the zinc must be estimated with all possible care from assays and from comparison with other cases in which similar ores have been smelted with and without previous dressing. Hence it will be seen that the question is by no means a simple one after all. Technical knowledge, experience, and sound business judgment are necessary for its proper solution, and all that can reasonably be expected from a dissertation on the subject of ore-dressing is that the cheapest and most approved methods of dressing shall be given, together with descriptions and illustrations of machinery which have not appeared in previous reports of the Commissioner, and as far as possible the data from which the cost of constructing and operating such machines may be reckoned with tolerable accuracy in different districts and under different circumstances. It is evidently impracticable to give, in the limits of the present chapter, either the exact cost of dressing in any particular case or the metallurgical losses which are caused by the presence of the injurious substance. The aid of skilled metallurgists should be called to solve the question, which is both too complicated and too important to be decided by any one esle.

From what precedes it is clear that, before we reach the final product of the mining and smelting operations, the metal itself, the earthy portions of the ore must be got rid of. The economical question is, whether it is cheaper to wash away a considerable portion of this dead mass, or to put it in the furnace and smelt it up along with the productive portion. Any *concentration* will remove a portion of the unproductive part, and no economical system will perfectly separate every trace of it. We are compelled, therefore, to resort to a partial separation, if we resort to any, and the question, how far it will pay to go, becomes the important one. It would not usually be desirable to separate every trace of gangue from the ore, even if we could. What is left in the ore forms a slag which protects the metal in the hearth of the furnace from the oxidizing influences of the blast; and, were no earthy material present in the ore, it would be necessary to add some for the purpose alluded to. If the ore is to be transported for great distances, the cost of transporting worthless material should be taken into account; but, under other circumstances, it is not desirable to pass a certain limit in the concentration, which must be determined, as before, by actual study and experiment.

It will be noticed that no allusion has been made to the dressing of ores which are to be merely amalgamated, or roasted and amalgamated. When amalgamation alone is employed, previous concentration would be worse than useless, and, even when the ore is to be roasted and amalgamated, the loss in concentration would generally be greater than the cost of passing the inert matter through the roasting-furnace. In the present chapter, therefore, only smelting-ores are regarded as proper subjects for dressing. Tailings from amalgamation, from which the pyrites or other minerals are to be dressed out, are here classed under the denomination of smelting-ores, though in reality they are often treated by chlorination, or by a peculiar amalgamation, including the use of chemicals.

The theory of separation.—The most favorable possible conditions under which ore could be dressed would be to have the valuable portion of the ore possessed of a specific gravity greater than the liquid in which the dressing is to be performed, and the worthless portion of a specific gravity less than that of the liquid. For example, let us suppose an ore consisting of galena, the specific gravity of which is 7.5, and quartz of the specific gravity 2.5, so finely crushed that each particle consisted of one of the minerals alone, to be located first in a liquid of a specific gravity 5. It is evident that the quartz would remain floating on the surface, while the galena would be found at the bottom of the vessel containing the liquid. Practically, however, it would be found that pieces consisting partly of galena and partly of quartz, and whose specific gravity was less than that of the liquid, would remain floating, because it would be practically impossible to separate the minerals entirely by crushing, and fulfill one condition of our problem. It is evident, therefore, that if, even in the most favorable condition we can possibly imagine, the mechanical mixture of the ore is such that we can never divide it into pieces consisting entirely of one mineral, we cannot hope, by the ordinary appliances for dressing ore, to be able to achieve perfect results. Worthless and valuable minerals can never be entirely separated when they occur mixed together in an ore.

We may, however, by passing an ore once through a single machine, obtain one portion which shall contain, practically, none of the accompanying gangue, but we must do it at the loss of a considerable portion of valuable material; or we may obtain a portion which shall, to all intents and purposes, be free from the valuable constituent of the ore, but this can only be done by leaving a considerable portion of worthless material mixed with the valuable portion. It is not more difficult to make the separation in one way than in the other, but the question of economy must be again considered in determining which of the two limits we will most nearly approach. When the ore is very valuable for the precious metal it contains, and at the same time consists mainly of gangue, it would probably be found advantageous to remove only so much of the worthless portion as could be separated with but very slight loss of the valuable mineral. On the contrary, when the cost of smelting was high as compared with the value of the ore, it would be economical to carry the removal of the worthless part much further, though, for reasons given above, it would probably never be found economical to go to the limit of removing all the gangue.

The question of an economical concentration where the ore is to be separated into only two portions is much less complicated than that of dressing an ore composed of several minerals, which it is desirable to separate as cleanly as possible.

Ore cannot be dressed except in some medium which offers a resistance to the force of gravity. An old and familiar physical experiment consists in placing a feather and a piece of lead in a long, thick glass tube provided with a stop-cock at each end. If the tube is held vertically, and suddenly turned upside down when it is full of air, the difference in the times required for the lead and the feather to reach the bottom is very perceptible; but if the air is exhausted by means of an air-pump, the difference in the times will be so slight as to be imperceptible, notwithstanding that some air is always left in the tube, showing that a separation of bodies according to their specific gravity in a vacuum would be impossible.

Water and air are the most convenient and the cheapest media in which the separation of ores can be made, and both of them have been employed for the purpose.

The specific gravity of water, however, approaches more nearly to a mean between the specific gravities of ore and the accompanying gangue, and offers much more resistance to the action of gravity, and for these reasons it has generally been preferred to air, except for the dressing of certain ores. The use of water as a medium is so much more common, that I shall consider wet dressing first, and then take up the discussion of the dry method. I shall make use of many principles and formulæ developed in the excellent German works of Rittinger and Gaetzschmann.

Since all ore-dressing is founded on the different behavior of substances of different specific gravities, the study of the action of the laws of gravity will not be out of place here.

If a mixture of particles of different sizes and different specific gravities were allowed to fall a certain distance through water, (supposing all the particles to start together,) they would form a deposit on the bottom of the vessel, separate horizontal layers of which would consist of particles which reached the bottom at about the same time. It is evident that the undermost layer would consist of coarse and very dense particles, together with coarser particles of less specific gravity. The uppermost layer would consist of the finest particles of the densest substances, with larger particles of the less dense substances. If each layer is separately removed, the different sized particles can be easily separated by sieves of different sized meshes into parcels of the same, or nearly the same, specific gravity. The smallest grains will, of course, be the densest, and the largest the least dense in each layer.

If, however, the separation of the grains according to size be undertaken previously, and only sized material be thrown into the water, the layers of the deposit at the bottom will be composed of particles of the same specific gravity. It is important, therefore, that the laws which govern the falling in water of bodies of different sizes and densities should be well understood, for upon them is founded the practice of wet dressing of ores.

It has been already remarked that the action of the water is to afford a resistance to the operation of the force of gravity, and to cause bodies heavier than water to fall more slowly through it than they would through a vacuum, or through air.

This effect may be augmented by placing the bodies in a column of water which is in motion upward. The fall of a body would then be opposed by a force arising from the positive motion of the water in the contrary direction, which must be added to the resistance due to the density of the water, in order to find the total resistance to gravity.

Before proceeding to show how this resistance may be calculated, let me briefly demonstrate some of the principles governing the free fall of bodies through a vacuum and through air. The motion acquired by a falling body is of the kind known in mechanics as *uniformly varied motion*, in distinction from *uniform motion*.

Uniform motion is that in which the moving point describes equal spaces in equal portions of time. If we denote the space passed over in one second by v, and in t seconds by s, we have from the definition—

$$s = vt; \therefore v = \frac{s}{t}$$

From the first of these equations we see that the space described in any time is equal to the product of the velocity and time; and from the second that the velocity is equal to the space described in any time divided by that time.

Uniformly varied motion is that in which the velocity increases or diminishes uniformly. In the former case, the motion is accelerated, and in the latter retarded. In both the moving force is constant.

To find the relation between the spaces passed over and the velocities generated in any time, let the acceleration due to the moving force be denoted by p, and the velocity generated in t seconds by v. The acceleration is the velocity generated in one second, and since the velocity is proportional to the time, we have, from the definition—

$$v = p\,t \ldots\ldots\ldots\ldots\ldots (1)$$

Since the velocity increases uniformly, the distance traveled in any time is the same as though the body had moved uniformly during that time, with its mean or average velocity. At the beginning of the time t the velocity is zero; at the end of the time it is $p\,t$; hence the average velocity during the time t is $\frac{1}{2}\,p\,t$: multiplying this by the time t we have for the distance traversed $\frac{1}{2}\,p\,t \times t$; or denoting the distance by s,

$$s = \tfrac{1}{2}\,p\,t^2 \ldots\ldots\ldots\ldots\ldots (2)$$

Equations (1) and (2) express the conditions of motion of a body moving from a state of rest under the action of a constant force. From the former we see that *the velocities are proportional to the times;* and from the latter that *the spaces are proportional to the squares of the times.*

If in equation (2) we make t equal to 1, we find—

$$s = \tfrac{1}{2}\,p; \text{ or } p = 2\,s$$

That is, if a body moves from rest, under the action of a constant force, the acceleration is measured by twice the space passed over in the first second.

The force of gravity is directed toward the center of the earth, and its intensity varies as the square of the distance from the center. If we denote the acceleration due to gravity by g, and the space fallen through by h, both being regarded as positive downward, we have from equations (1) and (2)—

$$v = g\,t \ldots\ldots\ldots\ldots\ldots (3)$$

$$h = \tfrac{1}{2}\,g\,t^2 \ldots\ldots\ldots\ldots\ldots (4)$$

That is, the velocities are proportional to the times, and the spaces to the squares of the times.

The value of g in the latitude of New York is about $32\frac{1}{6}$ feet, or 9,809 meters, and by substituting this value in equations (3) and (4) and giving to t the values 1, 2, 3, &c., we can easily form a table showing the velocity acquired by a falling body, and the spaces described at the end of 1, 2, 3, &c., seconds.

Solving equation (4) with respect to t, we have—

$$t = \sqrt{\frac{2\,h}{g}} \ldots\ldots\ldots\ldots\ldots (5)$$

That is, the number of seconds required for a body to fall through a given height is equal to the square root of the quotient obtained by dividing twice the height in feet by $32\frac{1}{6}$.

Substituting the value of t in equation (3) we find—

$$v = g\sqrt{\frac{2\,h}{g}} \text{ or } v^2 = 2\,g\,h$$

whence, by solving with respect to v and h,

$$v = \sqrt{2gh} \text{ and } h = \frac{v^2}{2g} \ldots\ldots\ldots\ldots (6)$$

In these equations v is called the velocity due to the height h, and h the height due to the velocity v.

A column of water rising with a velocity v exerts upon a flat, horizontal plate placed in its current a force which is equal to the weight of a column of water with a base equal to the surface of the plate presented to the action of the stream, and of the height $\frac{v^2}{2g}$; the height due to the velocity. If we designate the surface of the plate opposed to the action of the current by f, we shall have for the vertical force the expression

$$W = f \frac{v^2}{2g} \gamma$$

in which γ represents the weight of a cubic meter of water, (1,000 kilograms,) and g the acceleration due to gravity, from which we have—

$$W = 51\, f\, v^2 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (7)$$

The pressure, therefore, increases in direct proportion to the opposed surface, f, and the square of the velocity, v, of the ascending water column.

If the surface f presented to the action of the stream is equal to one square meter, the pressure will be

$$W = 51\, v^2 \text{ kilograms} \; . \; . \; . \; . \; (8)$$

and if the velocity of the water column is one meter per second the pressure will be

$$\alpha = 51 \text{ kilograms} \; . \; . \; . \; . \; . \; . \; (9)$$

and we may hereafter designate by α the force exerted against the surface of a square meter by a column of water moving with the velocity of one meter per second.

We obtain, therefore, by substituting α for its equivalent in equation (8)

$$w = \alpha\, v^2 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (10)$$

and in equation (7)

$$W = \alpha f\, v^2 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (11)$$

I have already spoken of the fact that larger bodies of less specific gravity fall in water with smaller bodies of greater specific gravity. Of course the actual weight of two such bodies will not be equal. The only condition which must be fulfilled is that the proportion between the actual weight and the surface opposed to the action of the stream shall be the same in each case.

If we suppose the bodies to be spherical, it is easy to demonstrate mathematically, that while the surfaces would vary as the squares of the radii, the contents would vary as the cubes of the radii. As the size of the sphere increases, its cubic contents, and hence its weight, would increase more rapidly than the surface. If we take, for example, a sphere of galena and a sphere of quartz which would fall through a column of water in equal times, we find that the quartz sphere must be more than twenty-three times as heavy as the galena sphere, and the volumes of the spheres must differ still more, that of the quartz being sixty-eight times that of the galena sphere. If we represent the volumes of two equal-falling spheres of galena and quartz by V and V^1, their diameters by d and d^1, and their densities by I and I^1 we shall have—

$$\text{(galena) } I = 7.5$$
$$\text{(quartz) } I^1 = 2.6$$

And if the bodies are to fall through water the density of which is unity, it is evident that if we subtract unity from I and I^1, and cube the remainders, we shall have the corresponding values of V^1 and V, and hence we may write—

$$V^1 = 6.5^3 = 275$$
$$\text{and } V = 1.6^3 = 4$$
$$V : V^1 :: 1 : 68$$

If we designate the absolute weights of the spheres by P and P^1 we shall have—

$$P : P^1 :: IV : I^1 V^1$$

Substituting for V and V^1, and I and I^1, the values already found, we have—

$$P : P^1 :: (7.5 \times 4) : (275 \times 2.6) \text{ or } 30 : 715 \text{ or } 1 : 23.8.$$

In order to find the relation between volumes and weights of equal-falling bodies in air, the density of which is so small (0.00125) that it may be practically neglected, we need only to make—

$$V = 2.6^3 = 17.5 \text{ and}$$
$$V^1 = 7.5^3 = 421.8$$

Substituting these values in the proportion

$$P : P^1 :: I V : I^1 V^1$$

we shall have the absolute weights of equal-falling spheres of galena and quartz—

$$P : P^1 :: (7.5 \times 17.5) : (2.6 \times 421.8) \text{ or } 131 : 1096.6 \text{ or } 1 : 8.37$$

The volumes will vary in this instance as—

$$(2.6)^3 : (7.5)^3 \text{ or } 17.5 : 421.8 \text{ or } 1 : 24$$

From a comparison of the ratios between the volumes and absolute weights of equal-falling spheres of galena and quartz in water and in air, it will be seen that in order to do good work with any machine, for either wet or dry concentration, a previous accurate sizing of the stuff to be treated is necessary. More particularly is this the case in the dry process, for the difference in the size of equal-falling bodies of different densities in air is much less than in water. A quartz sphere must be four times as large in diameter, contain sixty-eight times the volume, and weigh twenty-three times as much as a galena sphere that behaves in similar manner in falling through a column of water; but in air the quartz sphere would only have to be two and eight-tenths times as large in diameter, contain twenty-four times the volume, and weigh eight and thirty-seven hundredths times as much. In either case, however, the importance of a careful sizing is at once apparent.

Much less importance has been attached, in this country, to the sizing operation than the facts of the case warrant. If we had a pulverized ore, the particles of which were exclusively composed of either galena or quartz, and all of the same size and shape, the separation of the minerals would not be difficult. In practice, however, these conditions are probably never fulfilled. The finely-divided ore will contain particles composed partly of quartz and partly of galena, and as the proportions of the two minerals will vary very greatly in the numerous compound particles, we shall have in effect grains of all specific gravities between galena and quartz, so that no matter if the particles were all of equal size and similar in shape, the absolute separation of the minerals would be impracticable. But it is, moreover, practically impossible to obtain grains of galena and quartz of the same shape. Galena has a distinct cleavage along cubic faces, and naturally breaks up into more or less perfect cubes. Quartz, on the other hand, breaks up into pieces of all possible shapes, but mainly into those of triangular section in at least one direction. Hence it is evident that a perfect sizing process is an impossibility, though it is none the less important on that account that some such process should be employed, where the best possible work is required. Though it cannot accomplish everything, it is nevertheless an important auxiliary in ore-dressing, which can only be omitted with a loss of valuable material or the retention of more worthless material than should be put into the furnace.

If we imagine a body hung by means of a thread in an ascending column of water, it is apparent that the force exerted by the motion of the water operates against the force of gravity, and lessens the tension of the thread. If the column of water moves with exactly the proper velocity, it is evident that the force exerted may be such as to exactly counterbalance the force of gravity, and cause the body to float without exerting any strain upon the thread. This velocity will depend upon the size and density of the body. The following table gives the velocity of the stream required to keep spherical bodies of different sizes and densities in the condition described:

Substance.	Specific gravity.	Diameter in millimeters.							
		10	8	6	4	3	2	1	½
		Velocity in meters per second.							
	15.	1.93	1.72	1.50	1.22	1.05	0.86	0.61	0.32
Galena	7.5	1.31	1.17	1.02	0.83	0.72	0.59	0.41	0.29
Iron pyrites	5.	1.03	0.92	0.79	0.65	0.56	0.46	0.32	0.23
Quartz	2.6	0.63	0.56	0.49	0.40	0.35	0.24	0.20	0.14
Coal	1.3	0.28	0.25	0.22	0.17	0.15	0.12	0.08	0.06

A class of machines known as jigs or jiggers operate upon the principle above described. They will be discussed hereafter.

The action of a stream of water passing over an inclined plane upon solid particles forms the basis upon which a number of dressing-machines have been constructed.

It is evident that two forces act at the same time upon a body thus constituted: first the force of gravity, and, secondly, a force due to the current of water. If the inclination of the plane is not too great, the friction of the body against the plane will retard the motion imparted to the body by the current.

The particles may either roll on the plane or they may slide along over its surface. In the former case the retardation of the particle would be due to rolling friction, and in the latter case to sliding friction. The kind of motion depends upon the shape of the particles and the thickness of the stream of water. Round particles, and those nearly approaching that shape, would naturally roll, while flat, or nearly flat particles, would slide. When the particles are very small, and the stream of water is very thin, the friction of the water on the plane is proportionally so great that the lower portion of the stream will have a much slower motion than the upper. Hence, if equal falling particles of different specific gravities and of a proper size are treated on such a plane, the larger particles will be affected much more by the current than the smaller ones, and in this way a separation will be effected according to the size of the particles.

Among the machines in which ore is separated by means of a thin stream of water passing over an inclined surface, I may mention the buddle, the plane-table, and the rotary table. In the percussion table this principle is also employed.

If grains of different sizes and specific gravities be thrown into a round vessel containing water, in rapid rotation, which is kept up for some little time after their introduction and then allowed to come to rest, the heaviest particles will be found near to the circumference, the lightest near the center, and those of intermediate weight in intermediate positions. In other words, the grains will be separated into concentric rings of equal-falling particles.

Jigs.—The foregoing discussion of the fundamental principles of ore-dressing will be sufficient for the comprehension of the chief machines now used for the purpose. Before treatment by the machines now to be described, a careful sizing of the stuff is, as I have said, necessary in order to obtain good results. The different arrangements of screws, trommels, &c., which have been employed for this purpose, are generally simple and well known to most persons who are ever likely to be called upon to use them. Without dwelling, therefore, on the machines of sizing, I shall proceed at once to the description of apparatus for treating sized stuff.

Perhaps the most universally serviceable machine for ore-dressing is the jigger, a machine which was originally of exceedingly simple construction and operated entirely by hand. It has, however, now been brought to a great degree of perfection; and a large number of machines, all resting upon the same general principle, and differing only in minor points, have been invented. It would be impossible within the limits of this chapter to describe the various patterns which have been built, but as there are only three main varieties of them, a general description will not be difficult.

The idea of a jig was originally derived from the treatment by hand of ore on a sieve under water. By plunging the sieve down suddenly in the water, and allowing the particles to come again to rest upon it, a separation is effected, and if the stuff has been sized, and the operation has been sufficiently often repeated, the denser particles are found in strata under the less dense. If the mass on the sieve is then divided into horizontal layers, ore and gangue may be separated. The first mechanical jig had contrivances for imparting motion to the sieve; but it was afterward found that the same results could be obtained by using a submerged stationary sieve and imparting a vertical oscillatory motion to the water. This is done either by means of pistons or elastic, pliable plates, of rubber cloth or some such material, placed in the sides of the box or on the top of a lower chamber full of water and communicating with the box containing the sieve. An additional feature of recent mechanical jigs is the continuous discharge.

Piston-jigs may be divided into two classes: those in which the piston is placed below the sieve, and those in which it is situated at the side or behind the sieve, in a box communicating freely below with the box containing the sieve.

The jig with a piston under the sieve operates as a pump, and is known in Germany, where such machines are most used, as a *setz-pumpe*. It is preferred at many of the best ore-dressing works to those with a side-piston, on account of simplicity of construction and economy of working. An excellent machine of this class has been invented and tested by Dr. F. M. Stapff, an engineer in the service of the Swedish government. This gentleman, wishing only to further the introduction of good dressing-machinery, refused to take a patent on his machine, so that any one is at liberty to construct a jigger after his pattern.*

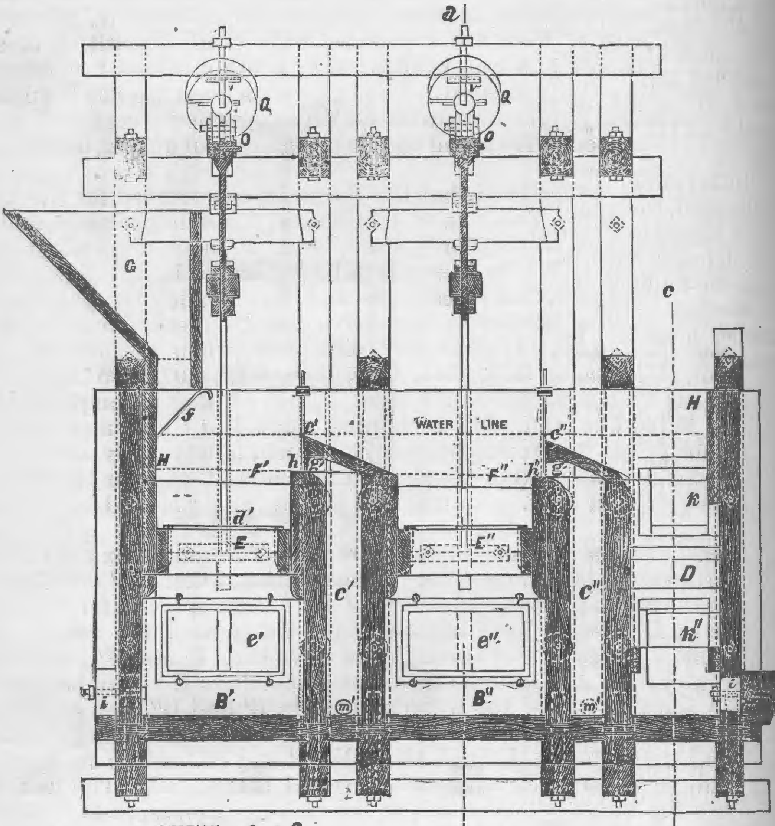
The cut subjoined represents a machine built in full accordance with Dr. Stapff's designs, which was constructed at Bethlehem, Pennsylvania, for the Dolores lead-mine, Mexico. The ores from this mine, galena and black carbonate of lead, are associated with small quantities of zinc-blende, and copper and iron pyrites; they contain calcspar as essential gangue, and are easily dressed. But in Sweden good use has been made of quite similar jigging-apparatus for dressing copper-ores, containing copper pyrites, iron pyrites, and blende in a gangue of quartz, hornblende, and other silicates.

It should be understood that the jigger is constructed for the treatment of sized stuff. The size of meshes in the sizing-screens, and the number of screens subsequently used, must be made dependent upon the specific gravity of the minerals to be separated by the jigging process. For the separation of calcspar and zinc-blende from galena, (Dolores,) the width of meshes in successive sizing-screens should be about 1.00, 0.64, 0.41, 0.26, 0.17, 0.11, 0.07, 0.04 inch, when perforated plates with round holes, or 0.70, 0.44, 0.29, 0.18, 0.12, 0.07, 0.05 inch, when wire gauze with square holes is used. Stuff passing through 0.04-inch meshes is too fine, and stuff remaining upon $\frac{3}{4}$ to 1 inch meshes is too coarse for proper treatment by this jig, which, however, by some slight alterations in constructive details, can be made fit also for the working of coarser or finer stuff. All material fed on the jig should be free from dust.

General arrangement and modus operandi.—The main box contains six compartments, viz: A, open for the circulating water; B′ and B″, containing the pump-pistons E and E″; C′ and C″, receptacles for the jigged products; D, a space for filtration of the water from the refuse. The rising pistons press water through the sieve-beds F′ and F″, while they draw water from A, through the valves *e*′ and *e*″, to the chambers B′ and B″. A consequence of the water's rising in B′ and B″, and of its sinking at the same time in A, is a current from left to right along the sieve-beds to D, and thence through the holes *k*′ and *k*″ back to A, by which the medium water-level in the whole vessel is restored. The valves *d*″ *d*″ allow the water to pass through the sinking pistons, so that there is no suction against the sieve-beds, and no current from right to left is effected by the back-stroke of pistons. Sized stuff fed upon the sieve-bed F′, from hopper G, is jigged by the thrusts of water from below; but at the same time being exposed to the horizontal water-current, its lighter particles are carried across the ridge *c*′, and after being exposed to a new jigging operation on sieve-bed F″, the refuse is carried across the ridge *c*″ to the chamber D. The heaviest parts of the jigged ore move close along the sieve-beds F′ and F″, and enter the receptacles C″ and C″, through the gates *g*′ and *g*″, respectively. Screens of woven wire, attached before the holes *k*′ and *k*″, prevent the refuse from being carried to chamber A. Along the inclined screen *l*″, the refuse is led to a discharge-opening, *m*″. Continual feeding from hopper G is regulated by moving the plate *f*, which allows more or less stuff to be drawn from the hopper by the fluctuations of the water. The regular horizontal movement of the ore from left to right is promoted by a slope of sieve-beds of 1 to 36. By slides *h*′ and *h*″, in front of the openings *g*′ and *g*″,

* Stapff's continuous jig was described at length in my fourth annual report, (1872, p. 493.) The drawings and the essential parts of the description are here repeated.—R. W. R.

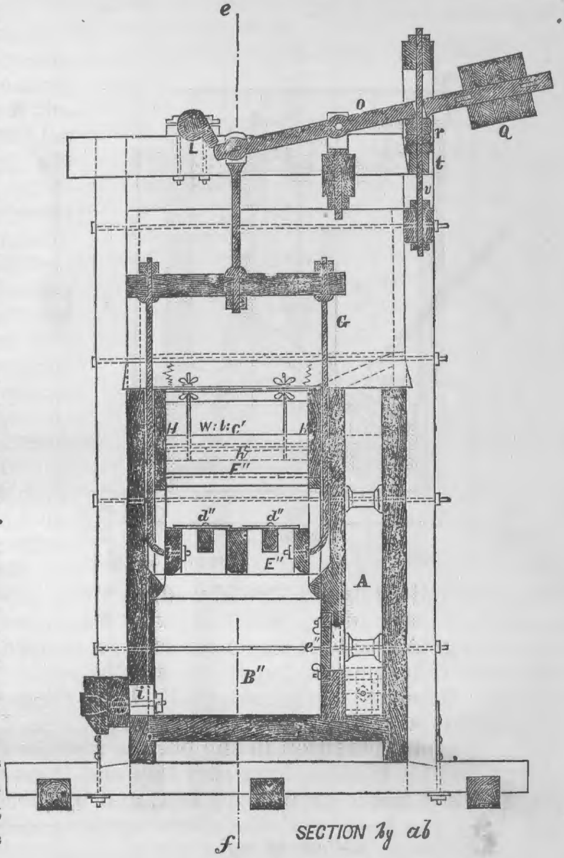
the quantity of products entering the receptacles C′ and C″, is so regulated that the upper surface of the ore in process of treatment is about level with the ridges C′ and C″. If plenty of water (one cubic foot per



SECTION of *ef*

second) can be disposed of, the discharge through the holes *m′*, *m″*, *m‴*, from the chambers C′, C″, and D, should be continual; but if water is scarce, the receptacles C′ and C″ are emptied periodically. The refuse hole *m‴* should never be wholly closed, in order to allow the refuse to escape continually with a certain quantity of water, which has to be replaced from above.

The pistons, by through-rods and cross-heads connected with levers O, receive their movement from cams L, working against the lever. It being favorable for the jigging process that the pistons sink slowly, but rise rapidly, the down-stroke is caused directly by cam, and the up-stroke effected by a counterpoise Q, on the end of lever O. By alteration of the weight of this counterpoise, the velocity of the rising pistons may be changed at pleasure. Fine ore must be jigged by short strokes, coarse ore by long ones. For changing the length of stroke at pleasure, a set-screw, *t*, is placed over the guide-bar *v* of the lever O. By this means the back-arm of lever O can be raised so much that the cam L does not catch the head of the other level-arm at all. Then the piston will rest, though the cam-axle is rotating; or it can be lowered sufficiently to allow the cam to catch the lever-head 3 to 4 inches above the releasing points, and then the stroke will be about 3 inches. The set-screw can be moved along the guide-bar while the machine is in full motion. An elastic cushion of rubber, *r*, is applied above the set-screw, to moderate the shocks of the falling lever.

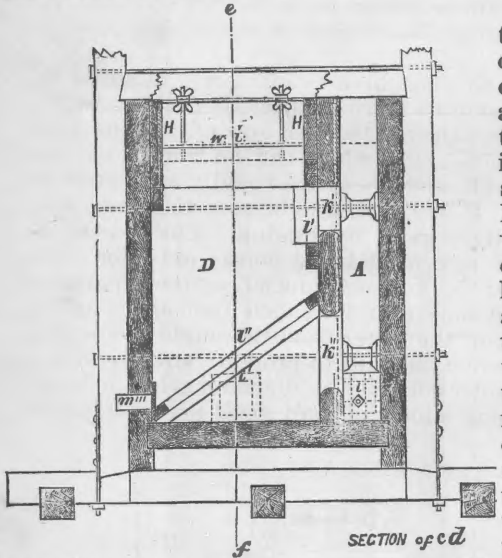


All other circumstances unchanged, the quantity of ore jigged in a certain time depends essentially upon the number of piston-strokes. But this number must not be increased so much that the ore on the bed has not time enough to settle between two strokes, consequently the jig should be run slowly, (about 60 strokes a minute,) if coarse ore is jigged by long strokes, and fast, (about 180 strokes a minute,) if the finest ore is jigged by very short strokes. The most favorable number of strokes in any case can easily be produced by running the driving-belt on one of the three pulleys of different diameter on the same cam-shaft.

From the preceding it is easy enough to see the wide applicability of this jig. If the hopper is regularly filled, and everything else regulated in accordance with the nature of the ore jigged, viz, supply of water, number and length of strokes, feeding (by regulator *f*,) discharge, (by regulators, *g' g''*,) outlet of water, products and refuse, (by holes, *m' m'' m'''*,) the receptacle C' will receive the heaviest ore, receptacle C'' an intermediate class of ore, box D gangue, or rock fit for the stamp-mill. The products of the jigging process, and the further operations they have to pass through, vary in accordance with the mineralogical character and the size of the treated material. Fine Dolores ore will give galena and lead carbonate in receptacle C', blende in receptacle C'', and calcspar in box D; coarse Dolores ore, galena and carbonate in C', blende, mixed with galena, carbonate and spar in C'', spar, with little blende, and traces of lead ore in D. In this case it is necessary to submit the crushed products from C'' and D to further dressing operations.

The power necessary to drive this jigger depends upon the area of pistons, and upon the number and length of piston-strokes. Half a horse-power is in all cases sufficient to work a jigger of 18 by 18 inches piston area.

The quantity of material worked in a certain time is greatest if the stuff is rich and of middle size. Of poor copper ore, 6 to 7 cubic feet are worked in an hour.



Most of the constructive details of a jigger built of wood can be seen from the cut, without further explanation. If acid water is to be used for the jigging operation, wood is the best material; and, besides, it is the cheapest. Leaks in a well-constructed wooden jigger-box are usually calked by dirt after the jigger has been used for some time, and besides it is of no practical account if a few drops of water leak from a vessel through which $\frac{1}{8}$ to 1 cubic foot is run per second. The outside walls of the jigger-box should be at least 3 inches thick, the interior partition walls 2 to $2\frac{1}{2}$ inches. The planks forming these walls should be united by hard-wood wedges filling grooves. It must be remembered that soft and dry wood expands transversely about $\frac{3}{4}$ inch per foot by soaking. A wooden box constructed in accordance with the cut remains not only tight enough, but it can also be easily taken apart and put together. Grooves in the side-walls hold the bottom, which is stiffened by transverse rails; the end walls are fastened in the bottom and side walls, the long partition in the bottom and the end walls, the short partitions in the bottom, long partition and front wall. Bottom rails and posts form a frame around the box, and by pieces between the rear wall and long partition wall the whole construction is secured. The discharge holes *m′ m″ m‴* should not be closed otherwise than by wooden plugs or exterior trap-doors, which by weights working on knee-levers are pressed against nozzles. Close above the bottom are gates *i* for cleaning the chambers A B′ B″ D′ when they become obstructed by dirt.

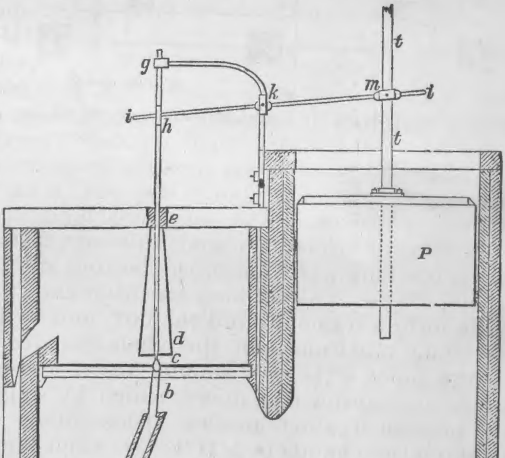
The pistons do not slide directly on the walls of partitions B′ and B″, but on hard-wood linings, which can be replaced, piece by piece, if necessary. The main valves *c′ c″*, of rubber, are stiffened by thin sheet-covers; their wooden valve seats are kept in place by buttons. Each piston is covered by four light rubber valves.

The meshes in sieve beds F,′ F″ and in screens *b′*, *bb″* must be fine enough to prevent the ore to pass through. But it is not necessary to use as many different sets of sieve beds and filtrating screens as there are sizes of ore. Two sets answer all practical wants. Wire-gauze with very fine meshes, which has to be used if the finest stuff is worked, should always be protected against too speedy abrasion by wrappers of coarser gauze. The frames covered with wire-cloth (F′, F″, *l′ l″*) rest loosely upon and behind wooden strips, and are kept in position by the large frame H, which is common for all compartments in the front part of the jigger. This frame contains the ridges *c′ c″* and the gates *f*, *h′*, *h,″* which move in grooves; *f* is kept in position by friction only, *h′* and *h″* by wing-screws besides.

Behind frame H and sieve beds F′ and F″ move the piston rods in spacious grooves. The lever-heads receiving the motion from cams L must be covered with steel; the counter-weights are disks of metal, kept in place by eye-bolts. By replacing one or more of those metal disks by wooden disks, and by moving them nearer to or farther from the fulcrum of lever *o*, it is easy to change the velocity of the rising pistons at pleasure.

There can be no doubt that this machine is admirably adapted for separating ores; and not the least of its merits, especially in this country, is the ease with which it can be adjusted to work ores of various sizes and kinds. The limits for the sized stuff which can be worked on this machine are given by Dr. Stapff, and these are equally applicable to other well-constructed jiggers. It will therefore be seen that only very fine stuff cannot be successfully worked by jigging. Pieces over an inch in diameter scarcely need any mechanical contrivance for their separation. They should either be further reduced, or the separation should be made by hand. Stuff finer than 0.04 inch diameter is apt to cake upon the sieve, and prevent the water from thoroughly loosening up the particles. It would also be difficult to properly size, by means of sieves or trommels, grains under 0.04 inch in diameter while in a wet condition, and it must be borne in mind that only sized material can be jigged to advantage.

I deem it unnecessary here to give any drawings or description of jiggers which can be worked only intermittently, or of those in which the water is stationary and the sieve is movable. Such machines are but little less expensive than the piston-jiggers, and are not capable of working more than about one-third the amount of ore per square foot of sieve in a given time. Only under very peculiar conditions would any well-informed engineer construct such a machine.



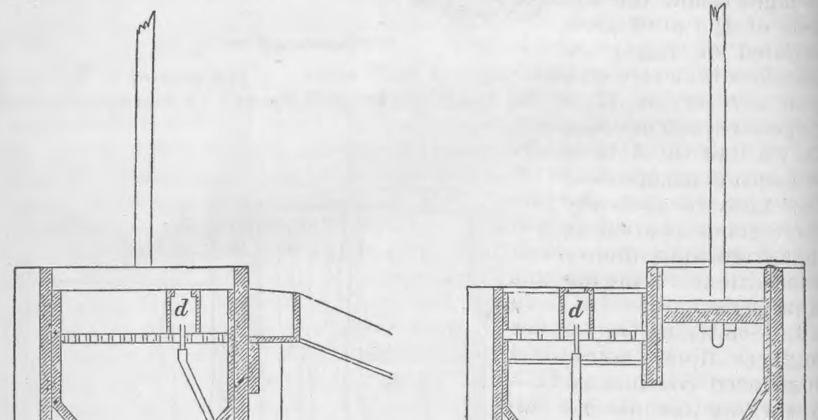
Wimmer's continuously working jig.

One of the simplest forms of the piston-jig is shown in the figure.* It is made of wood, with a piston or plunger P at one side, which, on being forced downward upon the water in the box, causes an upward flow through the grate in the direction *b* to *c*. The peculiarity of this construction, due to Mr. Vogel of Joachimsthal, and Mr. Wimmer of Clausthal, is a valve in the center of the sieve through which the concentrated stuff is delivered as it accumulates, while the refuse passes off

* This and the descriptions of jiggers immediately following are taken from my second annual report, (rendered in 1870,) pp. 702 *et seq.*—R. W. R.

over the partition in front. But it was found that the downward current of water, when this valve was opened, was sufficient to carry down some of the waste stuff from the top; and it became necessary to devise some means of preventing this flow. This was effected by covering the outlet with a conical tube, *d*, supported from a bar of wood above and reaching down through the layer of poor stuff so low that only the heavy and richer portions resting directly upon or near the sieve can pass downward into the discharge-pipe *b f*. This pipe is alternately opened and closed at the top by an iron stopper placed at the end of a vertical rod, the upper part of which slides through a supporting-ring. By means of an arm, *i*, supported on a pivot at *k*, the stopper is alternately raised and lowered as the piston P rises and falls. The opening in the discharge-pipe is thus opened when the piston descends, and is closed when it ascends. It has been found in practice, however, that this arrangement for opening and closing the discharge-pipe does not give satisfactory results.

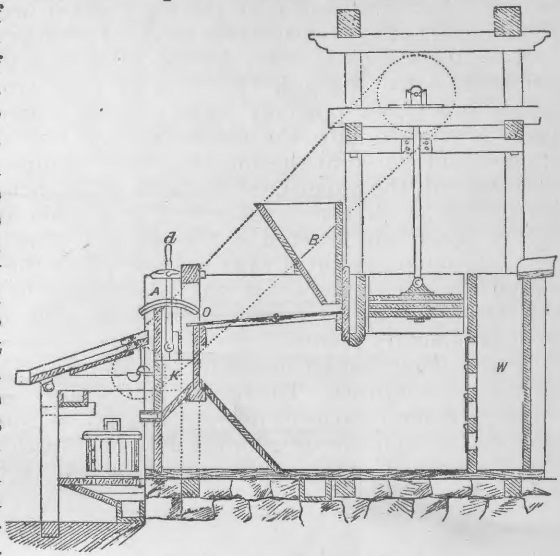
A somewhat similar machine, in use in the Harz, is shown in section by the next figures. The outlet in the sieve is surrounded by a perforated cylinder, *d*, so as to prevent the refuse from entering, while the ore escapes through the tube and is delivered at the side. From five to six cubic meters of stamp-stuff can be passed through this apparatus in twelve hours.



Self-discharging jig—Harz.

One of the best jigs of the continuously-working class is the invention of Rittinger, and was exhibited at the great exposition in Paris in 1867.

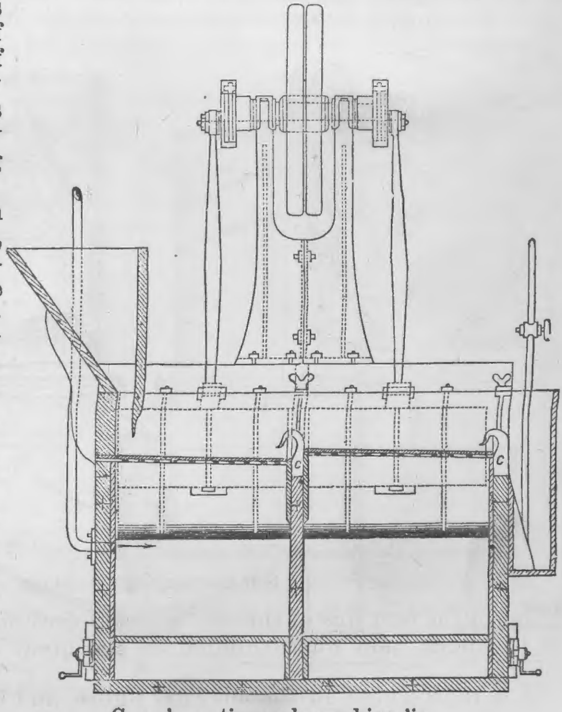
It is represented in the annexed figure, and is characterized by the inclination of the grates and the lowness of the front partition, over which the poor and lighter stuff falls continuously, and with very little water, while the heavier and richer portions fall through the opening or slit *o* at the base of the partition. This partition is the segment of a cylinder, and is supported upon the lever or arm *d*, so as to be movable back and forth in such a manner that the opening or slit *o* may be increased or diminished at pleasure. The heavy stuff, passing through the opening, falls into the box K, from which it is removed as required. The inclination of the grate in this machine is from five to eight degrees. It is fed through the hopper B, which plunges below the surface of the stuff accumulated on the grate.



Rittinger's self-acting jig.

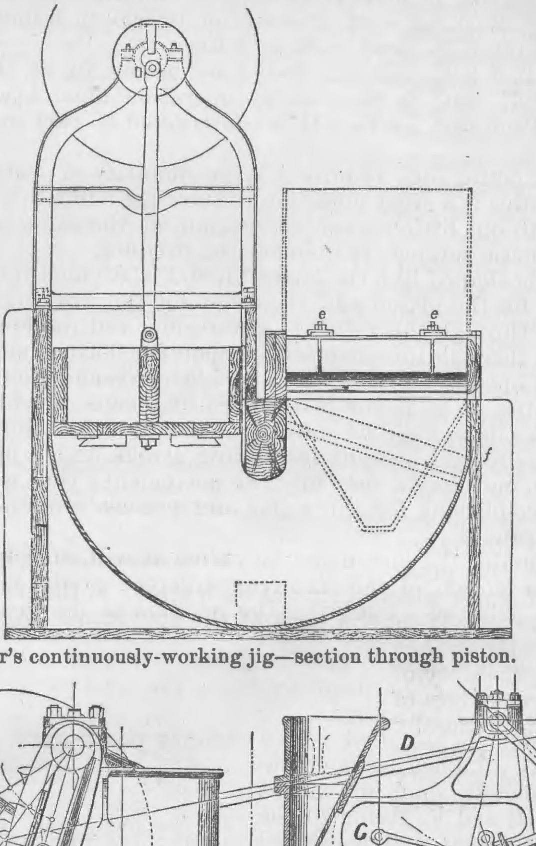
The loss of water which occurs at each stroke of the piston is replaced from a reservoir, W, at the back of the apparatus. According to Rittinger, experience has shown that the duty of self-acting machines of this kind is generally three times as great as that from the ordinary intermittent working apparatus.

In 1863 Mr. Geyer, an engineer from Baden, introduced continuously-working jigs into the great ore-dressing establishment erected by him on the banks of the Lahn. In the construction of these machines both wood and metal were employed. The arrangement of the parts is represented by the accompanying figures. It is a double machine, composed of two grates and two pistons, actuated simultaneously by means of cranks on a shaft above, the motion being communicated by two connecting rods. The grates are inclined forward, and are provided

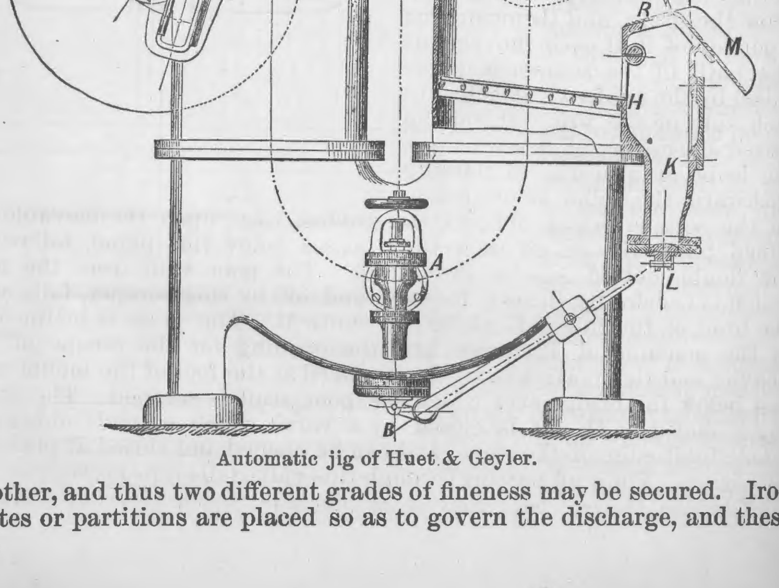


Geyer's continuously-working jig.

with a chink or gutter at the lower edge, through which the concentrated ore falls into inclined troughs *c*. The stuff passes from one grate to



Geyer's continuously-working jig—section through piston.



Automatic jig of Huet & Geyler.

another, and thus two different grades of fineness may be secured. Iron plates or partitions are placed so as to govern the discharge, and these

may be raised or lowered at pleasure by the thumb-screws *e e*. These machines, worked at seventy strokes per minute, will wash about nine cubic meters of stamp-stuff, diameter of $0^m.005$, in a day, and they require about three hundred liters of water.

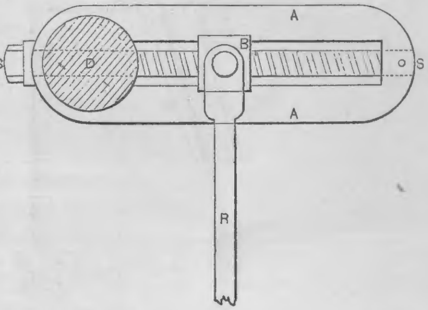
Messrs. Huet & Geyler exhibited a self-acting jig at the Paris exposition in 1867, and its satisfactory operation upon lead-ore was witnessed by Professor Blake. It is constructed of cast iron, and is very compact.

Most self-acting jigs require a large quantity of water, and this in many localities is a great objection to their use; but this jig is designed to work with but little loss of water, and, at the same time, by the aid of an automatic scraper, to increase the product.

The tub is shaped like the letter U, and is divided into two compartments, one for the piston and the other for the working-grate. Water is supplied through the valve A, at the side, and the fine stuff or slime which falls through the sieve settles upon the bottom, and is discharged through an opening, B, controlled by a lever reaching out to the front of the apparatus. The piston is operated by means of a shaft and crank, which works in an inclined slide, C, connected with a lever carrying the piston, so as to give a rapid descending stroke with a period of rest at the bottom, and then a slow upward movement; thus giving the most favorable conditions for the rapid and perfect separation of the stuff upon the grate.

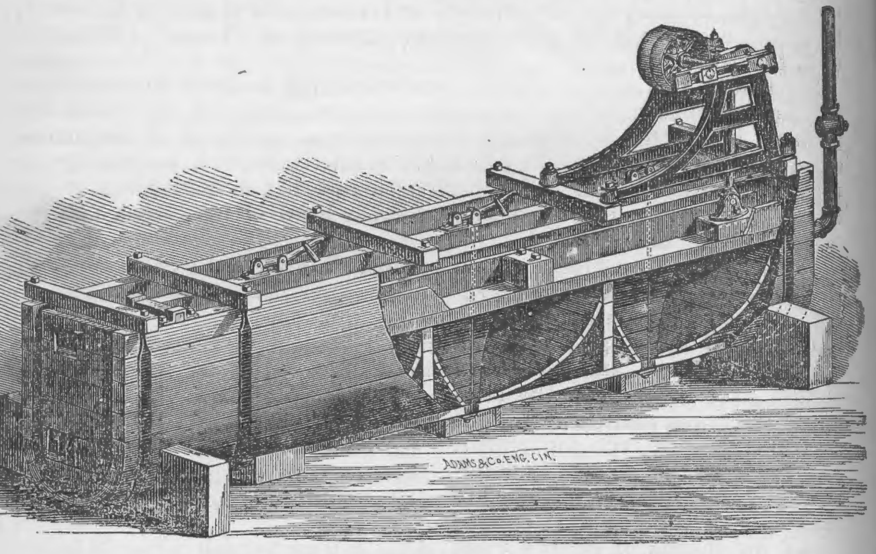
The motion of the piston may be varied at will, in order to secure the best flow or motion of the water for different grades of ore. This adjustment is effected by shifting the position of the head of the piston along the lever or arm, and by this means increasing or diminishing the amplitude of its motion. The construction of this slide is shown in the figure. By turning the fixed screw *s s*, the head of the piston may be moved forward or backward.

The machine is provided with a scraper R, actuated by the long rod D, which is attached to an eccentric on the main shaft and moves the levers E and F, giving to the scraper a forward and backward motion over the top of the stuff upon the grate, and throwing out a portion of it at each movement. The path of the scraper is determined by the guides G, attached to each side of the tub. It can be varied by means of screws upon the lever or arm F. In passing backward, the roller or projection on the scraper, which follows the guides, rises upon the movable inclined plane G, and on its return passes below this plane, following the double-dotted line in the figure. The poor stuff from the top, which is constantly thrown forward and off by this scraper, falls over the front of the tub at R, along the shute M. The grate is inclined as in the machine of Rittinger, and the opening for the escape of the heavier and rich portion is similarly placed at the foot of the incline and just below the bridge over which the poor stuff is scraped. The opening is shown at H. It is closed by a valve which extends along the whole front edge of the sieve, and can be opened and closed at pleasure by a lever. The stuff passing through this valve falls into a receptacle K, from which it may be removed at pleasure through the opening L.



The scraper is so made of perforated sheet-iron that it does not throw the water out together with the waste. These jigs are made with great care and accuracy.

Mr. F. Cazin, Rose Clare, Hardin County, Illinois, is the inventor, and Messrs. Morry & Sperry, of New York City, are the agents of a new ore-separator, which consists essentially of three jigs, arranged end to end. It is continuous in its action and has but one piston and piston rod, a disposition which, as all who have worked the ordinary machines know, saves a great deal of complication and permits a much simpler and cheaper construction than is possible when three separate pistons have to be actuated from a through shaft, or by connecting rods from the first piston. The peculiarity of this machine is that the piston is hinged at one end, opposite the last sieve, and the piston-rod is placed not in the center, but at the other end, opposite the first sieve. It lies the whole length of the machine, and at the side of the sieves. This peculiar arrangement gives each sieve a stroke of its own, entirely different in strength and length from that of the others. The undressed ore is run on the first sieve and receives the longest stroke, that is to say, the most thorough agitation the piston is capable of giving. On this sieve pure mineral and a mixture of middlings and poor are obtained.



Cazin's ore-separator.

Of course the middlings will be at or near the top when they arrive on the second sieve. There the action is less energetic; the middlings are taken off and the poor ore passes to the third sieve. This poor ore, though often thrown away, still contains some mineral, adhering in the form of fine particles to larger grains of rock. The difference in gravity between these grains and those which are composed of rock alone is very small, and in a violent stream the two sorts are constantly remixed, so that separation is not effected. But a quieter action will separate the absolutely worthless from that which has some value, so that on the third sieve a product which may still be worth reworking is obtained, while the gangue passes off to the tail-race.

Whether the machine will be equally effective in separating an ore containing two or three minerals of different specific gravities, is a question to be decided by trial. Each sieve would certainly afford one mineral separated from the other two, but with the peculiar action of the hinged piston it seems to be reasonable to expect that the pure mineral of each sieve would be mixed with the lighter particles from the sieve above. This, however, could be afterward separated by a repetition of the process. This is one of the great advantages of the continuous jig. Its work is so rapid that a repetition of the operation, especially when performed on concentrated mineral, does not involve the labor that a single run through other machines occasions.

I have already mentioned a machine in which the oscillations are imparted to the water by the movement of pliable plates of rubber-cloth, or some such material, against which the water under the sieve exerts a pressure. A very good machine of this sort has been constructed by Mr. Morton, of Jersey City, and I regret my failure to obtain drawings of this machine, which has done some very nice work. It is capable of being adjusted to treat ores of various specific gravities and sizes, and in one or two cases, where the results obtained by this machine were unfavorable, or at least not so favorable as had been expected, I have no doubt that the failure was due either to attempting to treat too finely pulverized ores, or to the lack of a proper previous sizing.

Jigs constructed on the principle of Dr. Stapff's possess one advantage over those built according to any other plan. There is a positive upward current passing through the sieve which ceases perhaps during the downward motion of the plunger, but which is never reversed, as in the case of the others. In this way a more regular sinking of the particles thrown up by the upward motion of the current is accomplished. A downward movement of the water tends to draw down the lighter particles and mix them with the heavier rather than to facilitate their separation. With any jig of good construction it is possible to obtain three or more products, according to the constituents of the ore. In Europe these machines are frequently used to separate galena, blende, and gangue, and sometimes copper or iron pyrites is also separated on the same machine. There is no other machine employed for the dressing of ores capable of performing so many various separations of ores, and at the same time of treating material of such a variety of sizes, the only necessary condition being the one which I have already alluded to, viz, that the grains treated at any one time must be of nearly the same size.

Rittinger gives the following general dimensions, derived from practical experience, as the best for the construction of jigs:

1st. The opening of the feed hopper should be of from $2\frac{1}{2}$ to 3 inches area, and about 4 inches above the sieve.

2d. The length of the sieve should be at least 24, and better 30 inches, and its inclination about a half an inch to the foot, in order to facilitate the discharge.

3d. The height of the material resting on the sieve should not be over 4 inches at the lower end.

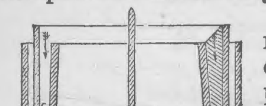
Settling-tubs.—A very simple machine for separating the particles of crushed ore, according to the rapidity with which they sink in water, consists of a cylindrical vessel full of water, kept in rotation by means of arms attached to a vertically revolving shaft. In many of the Cornish dressing-works this operation is performed by hand, a given portion of ore being placed in a tub, and the mixture violently rotated with a shovel. When the rotation has been maintained for a sufficient length of time, which varies with the quality and size of the material treated, the ore is allowed to settle, while the workman jars the tub by blows upon its side with an iron bar, in order to prevent the adhesion of fine particles to its inner surface.

In Germany mechanical means are employed for rotating the charge. The rotation is not so rapid as to prevent the sinking of the lightest particles, and is varied to suit the ore treated. By the application below the stirring apparatus, of concentric chambers, narrowing toward the bottom, and each terminating in a discharge-pipe, equal-falling grains may be separated into classes and caught in separate vessels. Thus the operation of the machine may be made continuous, no stops being necessary to remove the separated material. In order to prevent too great consumption of water, and to give the particles sufficient time for the operation of centrifugal force, the discharge-openings must be made as small as possible. The heaviest particles will of course be found nearest to the center. If a good separation of minerals, according to their specific gravity, is to be effected on this machine, a careful previous sizing is necessary, and the quality of the work done will depend to a great extent upon the accuracy with which this operation is carried out.

A regular rotation of the stirring apparatus is necessary, since, if it is run rapidly at one time and slowly at another, it is evident that the separation cannot be uniform. For this reason an independent motor, for example a small turbine-wheel, may be advantageously employed to drive it. The size of the stuff usually worked on these machines varies from $\frac{1}{40}$ to $\frac{4}{10}$ inches in diameter. Finer material can be worked, but not with equally good results. Machines are usually built large enough to work from 16 to 25 cubic feet of material per hour. They are usually from 2 to $2\frac{1}{2}$ feet in diameter.

The following varieties of settling-machines were described in the commissioner's report of 1870, in Professor Blake's treatise on mining machinery:

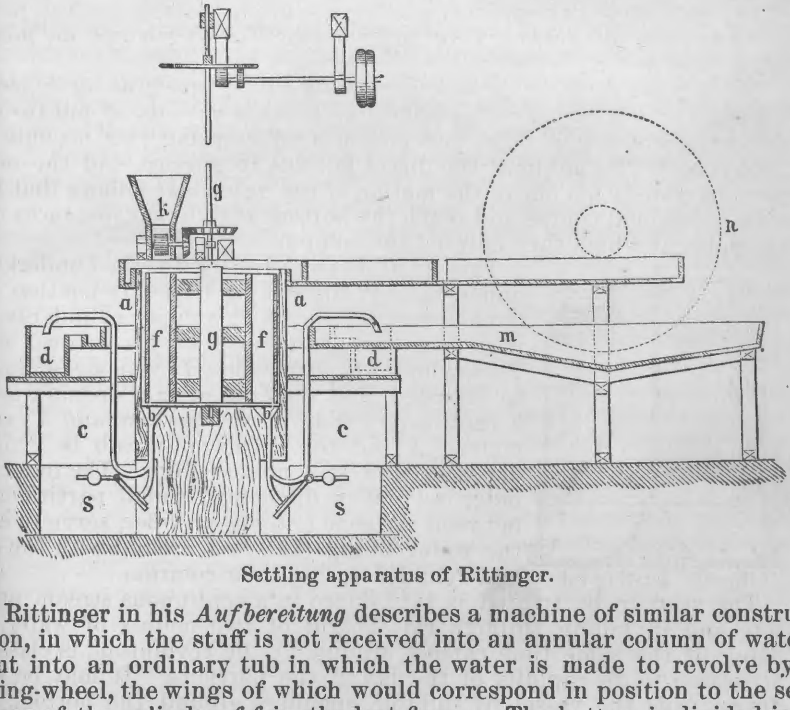
Hundt's settling-tub is a continuous-working machine, designed to separate or sort the particles according to their velocity of fall through the column of water. The particles of stuff entering this machine are subjected to two motions, the direct fall due to gravity, and the movement of translation due to the motion of the water. It follows that they take a diagonal course and reach the bottom at different distances from the point at which they entered the column.


Hundt's settling-tub.

This apparatus was first used at the Landerkrone mines, near Wilnsdorf, in 1854. It consists of a circular tub, within which an open cylinder is supported and made to revolve by a vertical shaft. This cylinder is partly closed by means of a cone, so adjusted that only an annular opening is left, 5 centimeters wide at the bottom, and 13 centimeters at the top. The outer tub is $1^m.75$ in diameter, and is 2 meters high. The inner cylinder is $1^m.60$ in diameter. Small partitions *s s*, between the cone and the cylinder, serve to carry the water filling the space around with the cone and cylinder during their rotation.

The stuff to be treated is introduced in a continuous stream at the top, and in falling through this height of two meters of water, and being at the same time carried around by the revolution, is classified according to the rapidity of the fall of the particles. It may be withdrawn from the vessel by suitable openings around the bottom. By careful management of these openings, very little water is lost; and this economy of water, and the very small quantity required for the proper working of the apparatus, renders it especially worthy of the attention of mill-men and metallurgists, in such regions in New Mexico, Arizona, Nevada, and Sonora, where water is scarce. The number of revolutions of the drum should range between 2 and 6 per minute, the diameter being 4 feet, and the size of the grain from $\frac{1}{32}$ to $\frac{1}{2}$ of an inch. Used with ore-stuff, particles of which differ in size, the machine sorts these particles according to their rate of fall. As the product in such a case would consist of small and dense particles mingled with larger ones of less specific gravity, the separation can readily be effected by the simple operation of sifting.

Rittinger's setz-rad is upon the same principle as Hundt's. It is a self-feeding continuous working-machine, and consists of a stationary wooden tub *a a*, the bottom of which is divided into eight conical compartments connecting with pipes *c*, which, after descending for a short distance into the foundation, turn upward and outward, and are curved at the end so as to deliver the water from the tub into an annular trough *d*. A double cylinder, *f f*, supported by a shaft, *g*, is made to turn in the tub *a*. The stuff to be separated is delivered in a constant stream through the hopper and distributor *k* into the revolving cylinder, and falling through the water in this space is sorted and collected in the conical reservoirs and tubes *b*. A branch tube, closed by valves *s s*, permits the removal of this concentrated stuff from time to time. The waste stuff, delivered through the tubes *b* into the annular trough *d*, flows into another trough or conduit *m*, whence it is lifted by the wheel *n*, and returned to the tub *a*.



Settling apparatus of Rittinger.

Rittinger in his *Aufbereitung* describes a machine of similar construction, in which the stuff is not received into an annular column of water, but into an ordinary tub in which the water is made to revolve by a wing-wheel, the wings of which would correspond in position to the sections of the cylinder *f f* in the last figure. The bottom is divided into eight radial compartments ending in funnel-like cavities, as shown.

With grains of lead ore $\frac{5}{32}$ of an inch in diameter, 91 per cent. of all the lead-ore contained in the stuff will be delivered into the second compartment at the bottom, and 8 per cent. in the next. But with grains $\frac{2}{32}$ of an inch in diameter, only 75 per cent. will be found in the second, and 20 per cent. in the third compartment.

Separation without sizing.—In the machines already described, the material to be worked must previously be carefully sized; but when very fine stuff is to be dressed, it is found impracticable to size it accurately and rapidly upon sieves or trommels; and for this reason an entirely different principle must be employed for treating it. It must, in the first place, be separated into *equal-falling* portions, the grains composing each portion being of such relative size and specific gravity that they will sink through a column of water of a given height in equal times. Each of these portions is then treated alone upon a machine capable of separating the particles according to their specific gravity.

Thus we see that, according to circumstances, ore may be dressed by a sizing operation, and a subsequent separation of the particles according to their specific gravity; or the separation, according to specific gravity, may be undertaken after a separation into portions consisting of equal-falling grains. In any case two distinct operations are necessary, and any method of dressing ores consisting of but one machine and one operation cannot possibly give as good results as machines worked upon long-known and thoroughly tested scientific principles.

When the stuff to be worked is not too fine to be separated on sieves or trommels, there can be no doubt that the most economical method is to size it first, and then separate it, according to specific gravity, on the machines already described.

Sometimes, however, the nature of the ore is such, (finely impregnated tin-ore, for example,) that it must be very minutely crushed in order to separate the valuable portion from the worthless gangue. Or, a considerable amount of fine "slimes" may be incidentally produced. In such cases the second system of dressing must be resorted to, and the fine stuff, mixed with sufficient water to hold the particles freely in suspension, is worked upon one of the three following principles in order to separate and classify the *equal-falling* particles:

1st. In a horizontal stream of water of decreasing rapidity of current, and of sufficient depth, the heavier particles will first sink to the bottom, then lighter particles, and if the rapidity of the stream is properly regulated, the finest slimes will settle in the almost still water at the end of the apparatus.

2d. A vertically-ascending column of water of decreasing rapidity of current may be so regulated that it will carry, at first, all but the heaviest particles with it; afterward lighter particles will come to rest, and finally even the lightest will be able to overcome the action of the current, and by this means the different sorts may be separated.

3d. A comparatively shallow, smooth stream of water will allow the heavier particles to rest on the bottom of the trough, and as the rapidity of the current decreases, the lighter particles will also come to rest.

On each of these principles various kinds of apparatus have been constructed. The most economical in point of labor is one constructed on the first mentioned, and called in German a *spitz-kasten*, or pointed box. These boxes are hopper-shaped, built of wood, and a number of them of different sizes are connected, so that the stuff which collects in the bottom of each box will consist of equal-falling particles, possessed of different properties from those in any other box. Four boxes usually constitute one apparatus. The water carrying the ore flows into and over the first box, the particles which are heavy or large enough settle in it, and the lighter or smaller ones flow on to the second, in which the heavier particles again settle, and so on to the third and fourth boxes. The rate at which the rapidity of the current diminishes is regulated mainly by the breadth of the boxes. Experience has shown that, for ordinary purposes, the relative breadth of the boxes should be in geometrical progression:

1, 2, 4, 8.

The first box, in which the heaviest and largest particles, about 0.04 inch in diameter, are to sink, must have one-tenth of a foot breadth for each cubic foot of the watery mixture to be dressed per minute. Hence when it is desired to dress 20 cubic feet per minute, the first box must be 2 feet wide. The relative widths of the boxes will then be—

2, 4, 8, 16 feet.

The length of the boxes varies usually in an arithmetical progression. To correspond with the above given widths the following lengths have been found by Rittinger to be most suitable:

6, 9, 12, 15 feet.

The sides of the boxes should have an inclination of at least 50° to the horizon. As the length of the boxes is usually greater than their width, care must be taken to have the least inclined side no nearer horizontal than the angle given, otherwise the fine stuff will sometimes collect in the corners, instead of sinking to the bottom, and cause irregularity in the discharge. On the other hand, it is unnecessary to make the sides steeper than 50°.

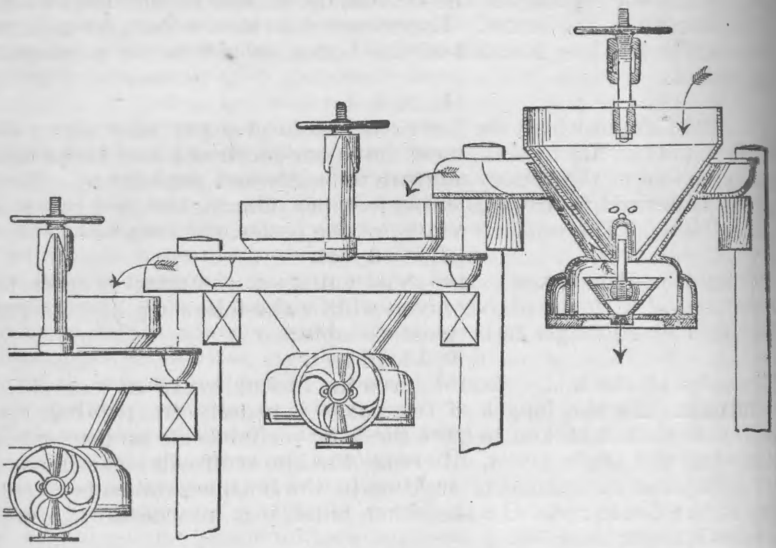
The size of the discharge opening must be regulated according to the height of the column of water in the box, so that only enough water passes to hold the solid particles in suspension. In case too much water escapes, a valve may be inserted in the discharge, and only opened at intervals.

The troughs to convey the water and ore to the apparatus should have 4 square inches sectional area for each cubic foot to be worked per minute, and they should be inclined from $\frac{1}{4}$ to $\frac{1}{24}$ of an inch per foot in length.

Considerable skill is necessary on the part of the builder of such an apparatus. The first box being the smallest is the easiest to construct. The apparatus requires but little attention after it is once in successful operation, the only things to be observed being the feed and discharge. The size of the material which can be advantageously worked in this way varies from 0.04 inch to the finest slimes.

The second principle, involving the employment of an ascending current, has led to various modifications of the spitz-kasten. The most complete (but the most complicated) is perhaps the *spitz-lutten apparat.* This I shall not discuss. The two following machines, described by Professor Blake in the report already referred to, may be classed under this head.

An apparatus of conical form is shown here on a scale of $\frac{1}{25}$, the upper cone in section. A complete series is usually composed of five or six, arranged in succession, one below another, as shown. The construction is very simple; and they can be made of cast iron, so as to be very durable, and at the same time exact in form. Each part consists of two cones, one inserted in the other, so as to leave an annular space in which water flows upward from a reservoir or chamber at the lower or pointed end. The stuff to be concentrated is conveyed by a launder into the upper cone, and, passing through holes, encounters the upward current. The largest of the stuff so fed should not exceed three-quarters of a millimeter in diameter. The lighter portions are at once car ried upward and over the upper edge of the inner cone, and fall with the escape-water into an annular trough, by which they are conducted away to the next lower cone, while the particles of sufficient weight to



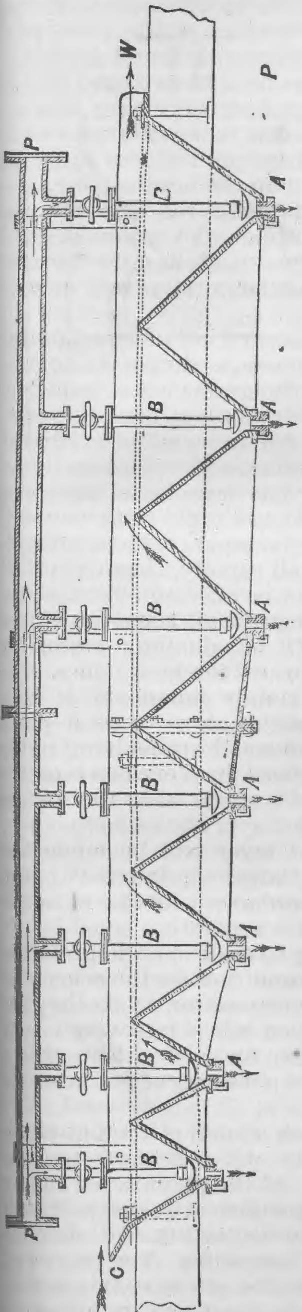
Conical separators.

resist the current fall through it, and accumulate in a small inverted cone, in the chamber below, from which they are allowed to drop by the small aperture at the apex in the direction indicated by the arrow. This orifice is controlled by a valve, and can be regulated at will, according to the rapidity of the accumulation. So, also, by means of a screw above the upper cone, the distance between the cones can be regulated according to the necessities of each case. The apparatus requires considerable water, and the overflow from one cone is carried to the next, and so on in succession.

Separating tubs with ascending currents (*Spitzgerinne*) combine the principle of the flowing with that of the ascending currents. The machine here illustrated seems to be the apparatus of Rittinger, as improved by M. Bilharz, director at Altenberg, near Aix.

This form consists of a succession of deep trough-like depressions placed edge to edge, and gradually increasing in size and depth. But as the ends and sides are the highest, the series forms, in reality, but one vessel, the water covering all of the intermediate edges, and thus permitting a continuous flow from one end to the other. This will be seen from the inspection of the figure. Seven compartments, B B, are shown, and the direction of the flow from C to W is indicated. The whole series is supported upon a frame at such a height that the attendant can pass under it, and reach the openings at the apex of the pyramidal tubs, at A A, where the concentrated stuff flows out. A supply pipe, P P, delivers clear water into each compartment through a branch pipe reaching nearly to the bottom. The stuff entering at C deposits the heaviest particles, and, aided by the ascending flow of water from the pipe, the lighter portions pass over into the next tub, and so on. The flow of water into each compartment must be carefully regulated. As the size of the compartments increases, the ascending current has less and less force, and finally only the very lightest and poorest portions are carried away.

The arrangement gives very satisfactory results. It requires from 120 to 150 quarts of water a minute, and will separate about a ton of battery-pulp in each hour. It may be constructed either of wood or of iron. The apparatus shown in the figure is made of iron.



Bittinger's separating-tubs with ascending currents.

On the third general principle above enumerated equal-falling particles may be separated in *inclined* troughs or sluices, through which the watery slimes are allowed to flow. The discharge of concentrated materials from such apparatus is not automatic, as American miners well know, being obliged to clean their sluices by hand. Launders with riffles, blankets, &c., and ordinary tail-sluices, come under this head. When practicable I would always prefer to use the pointed-boxes just described. When troughs or sluices are employed, however, the inclination of the trough, and the quantity of water flowing on it, should be so regulated that as much of the worthless portion of the ore as possible will flow over the end without carrying with it any of the valuable portion which remains in the trough, and may afterward be removed and treated by itself. By widening the trough from the upper toward the lower end, the velocity of the current may be diminished so that a more perfect separation will take place. Care must, however, be taken that the stream flowing through the trough is not too shallow, for in that case the effect of the current would be to classify the grains according to specific gravity, instead of separating them into portions consisting of equal-falling grains.

The riffle, which is so frequently used in all gold-diggings, is constructed on this principle: The gold and coarse gravel collect in the riffle, and these are easily separated by washing in a pan after picking out the large pebbles by hand. Small cross-ribs are frequently nailed in the bottom of the riffle-box, partly to break up the even surface of the water, upon which fine gold may be floated off, and partly to serve as receptacles for the gold which has already sunk to the bottom, and prevent its being carried off in case the current becomes more rapid than it was when the particles were deposited. The small pieces of gold, owing to their great specific gravity, soon work their way through the coarser pieces of rock or gravel, which are deposited along with them, and are found usually on the very bottom.

A sluice is essentially the same as the German troughs used for ore-dressing. In gold-diggings the sluices are sometimes made hundreds and even thousands, of feet long, and gold is frequently found deposited at the tail of the longest of them. Cases have been known of excellent profits being made by reworking the tailings from very long sluices which would go to prove how imperfect these contrivances are, even in gold-washing. When they are used for ore-dressing the loss must be much greater, since gold is so much heavier than the heaviest ore.

The foregoing are the principal machines used for the separation of grains of different sizes and densities into portions, the grains of each of which are equal-falling. The subsequent treatment, in order to separate these different portions according to specific gravity, will now be considered.

The sizing of equal-falling particles.—The separation of equal-falling grains according to specific gravity is, of course, a simple sizing, and can be effected by the use of sieves, when the grains are of sufficient size to permit treatment. In the practical dressing of ores, however, only those portions of the ore which are too fine to be sifted to advantage are first separated into equal-falling grains, and subsequently according to specific gravity. Previous sizing has been found more economical, because the sieve is the most simple and rapid contrivance to effect the result, and because sized ore can be separated according to specific gravity more easily, economically, and rapidly, than equal-falling grains. If sizing by means of sieves can be effected after the separation according to the falling power of the grains, it could have been effected to better advantage beforehand. Of equal-falling grains the smallest are of course the densest, and the largest the least dense. The smaller grains will be mainly ore, the larger mainly gangue.

A very thin, smooth stream of water, passing slowly over a plane surface, exerts different forces upon large and small grains lying in the current. The highest points of the small ones lie very close to the plane surface. The friction on the layer of water next to the surface over which it runs is much greater than on the layer above, so that very small grains which lie wholly in the lowest layer will be much less acted on by the force of the current than larger grains, the tops of which protrude into the layer above. In accordance with this principle numerous machines have been constructed for separating equal-falling *grains according to size, and hence according to their specific gravities.* The thinness of the stream is a necessary condition for the successful operation of any of these machines for the purpose for which they are intended. A thick or deep stream acts upon all points very nearly equally, so that the small particles are propelled forward with nearly the same velocity as larger ones. In such a stream a sizing of grains would be impossible.

Another requisite condition for the success of this method of sizing is that the stream shall have the right velocity, which depends upon the inclination of the plane over which it flows. If the plane is too nearly horizontal the force of the current will not be sufficient to carry off even the coarser particles, and if it is too steeply inclined the force will be sufficient to sweep away fine and coarse particles alike. The proper inclination of the plane is, however, not difficult to discover in practice, and when the angle can be altered by means of a screw or lever, the proper adjustment is easily made.

The number of grains held in suspension in a given quantity of the water allowed to run on the plane, or, in other words, the muddiness of the stream, must also be regulated. If the water is too muddy it will not be free to act on the separate grains in the manner described above. The grains will act on each other, and the resultant force acting on a given grain will be composed of the force of the water-current acting on the grain, and the force imparted by the grains lying around it. It may seem a good rule to follow, in working with such machines, to have the water as clear as possible, since the sizing of the grains would then be most nearly complete; but on the other hand less work would be done by the machine than if the water were muddier. The economical medium will be found by practical experiments; it is in fact impossible to lay down any universal rule on the subject. The proportion of sand to water may easily be determined by catching a bucketful of the mixture as it runs on the table, weighing it, allowing it to settle, pouring off the clear water on top, drying the residue, weighing the same, and subtracting the weight from that of the original mixture. This will give the weight of the water, the amount of which it is frequently desirable to express in cubic feet, which is easily done by dividing the weight in pounds by 62.5, the weight of one cubic foot of water in pounds.

Care must be taken that the fine ore is already wet when it is mixed with the water which is to effect the sizing on the table. If it is dry, the grains will be enveloped with an adhering coating of air, which will decrease their specific gravity when they come to be mixed with the water, and thus the sizing process will be seriously interfered with.

The plane-table.—In Germany, according to Rittinger, such tables are usually made about 12 feet long, inclosed by sides from 12 to 15 inches high, and for convenience in working, not more than about 5 feet in width.

The inclination of these tables varies, according to the size of the stuff to be dressed upon them, from 2½ degrees, for fine slimes, to 8 degrees for the coarsest stuff worked upon them. For dressing ores containing galena, a trifle more inclination may be given.

These tables are usually worked as follows: The water, carrying in suspension the ore to be dressed, is brought, by means of a pipe or trough, to within 4 or 5 feet of the head of the table, where it flows upon a board steeply inclined towards the table, but horizontal in the direction at right angles with the long axis of the table. By means of pegs fastened into the upper part of this board, or by some other convenient contrivance, the water is distributed uniformly over the board, and flows in a thin horizontal stream upon the table below. Soon a layer of ore will be deposited near the head of the table, and if no further care were taken, the water would in a short time cut furrows or channels in this ore-bed, and flow in a thick stream over the end of the table, carrying with it nearly or quite all of the solid matter held in suspension. In order to prevent this, a workman standing by the side, or on a board placed across the table and raised a few inches above it, smooths and consolidates the layer formed, by the use of a wire brush or piece of smooth plank, from 12 to 18 inches long, and about 3 inches broad, provided with a long handle. In this way he works over the whole table, always keeping a smooth, compact surface to the ore-bed, and taking care not to move the particles of ore up or down, but only to work with his brush or board straight across the table.

When the table is full, that is, when a layer of ore from 12 to 15 inches deep has been deposited over its surface, the water is shut off, and by means of a shovel the layer is divided into four parts, by lines crossing the table parallel with the head. The first line is drawn at a point from the head of the table where the ore in the layer is decidedly richer than that originally fed upon the table; the second division is of about the same richness as the original material; the third is poorer, but still rich enough to pay for reworking; and the fourth is too poor to bear this expense, and is consequently rejected as worthless. Minor subdivisions may sometimes be made to advantage, but this will depend upon the richness of the ore, cost of the process of working, &c.

The apparatus employed in this process is neither complicated nor expensive, yet considerable manual labor is required to maintain the even surface of the layer, and to shovel out the different portions of ore from the bed. For this reason other machines have been employed to accomplish the same result. The most common of these are the buddle, called in German "*Rundheerd*," and the percussion-table, "*Stossheerd*." In each of these the tedious operation of maintaining by hand an even surface to the ore-layer is supplanted by mechanical contrivances.

The buddle.—This may be regarded as consisting of a large number of plane-tables, placed radially around a central point. They may be arranged with their heads together, the feed being in the center, and the discharge on the circumference, in which case the surface of the buddle will form the frustrum of a cone, or they may be grouped with tails toward the center, the feed being on the circumference, and the discharge in the center, in which case the surface of the buddle will form an inverted frustrum of a cone.

A buddle of the first kind is shown in the accompanying figure. The watery slime coming through the trough *r*, enters the funnel-shaped receptacle *c*, and through suitable openings passes over the conical surface *h*, and thence up on the bed of the buddle *a a*. The vertical central shaft *s* receives, by means of bevel-gear *t*, a rotary motion from the shaft *s*.

The arms *d* and the receptacle *c* are in connection with the revolving shaft *s*. In the arms *d* are attached the rollers *n n* and *n' n'*, which are provided with cranks and catches.

To these are attached the brushes *f f* and *f' f'*, which serve to smooth and consolidate the ore on the buddle.

The circumference of the buddle is inclosed by the wooden partition *a'*, 12 inches high, which is provided with round holes at different heights. These holes are successively closed with wooden stoppers as the layer of ore rises on the surface of the buddle.

Instead of brushes attached to the pieces *f f* and *f' f'*, canvas cloths are frequently used with good effect for the same purpose.

The diameter of the outer circle of the buddle represented is 20 feet, and that of the conical table in the center 6 feet, so that the length of the conical surface over which flows the material to be dressed is 7 feet.

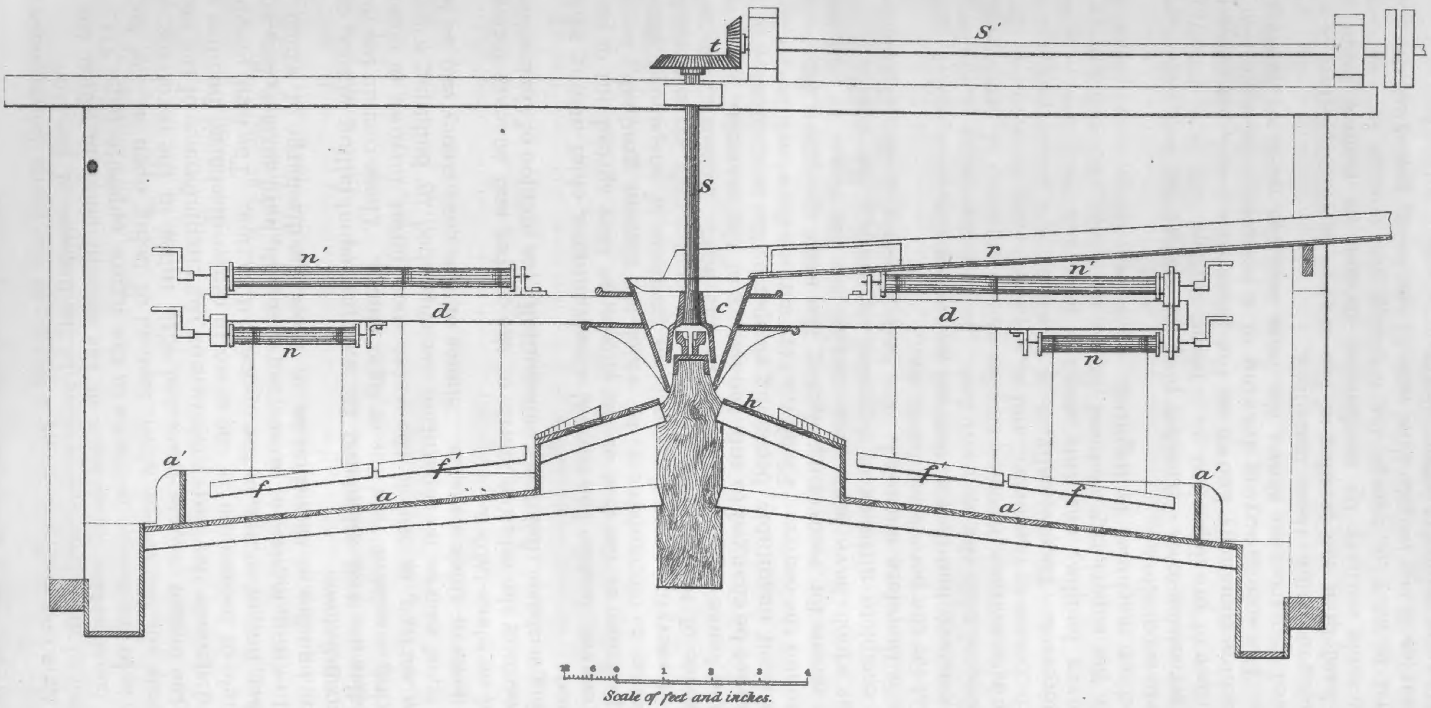
The central shaft should make from ten to twelve revolutions per minute. It requires but very little power to drive it. Rittinger estimates the force required at a twentieth of one horse-power.

The rollers *n n* and *n' n'* serve to regulate the position of the wooden bars *f f* and *f' f'* which carry the brushes or cloths.

The water flowing on the buddle should carry from 40 to 60 pounds of fine ore to the cubic foot, and from 2 to 3 cubic feet of it should be allowed to flow on the buddle per minute.

The inclination of the surface of the buddle should be such that the outer edge is from 4 to 8 inches lower than the inner circle, where it is fed. The inclination varies with the fineness of the ore treated, it being, of course, greater for coarse stuff than for fine.

THE CONVEX BUDDLE.



The time necessary for filling a buddle of the given dimensions varies from two to three hours, according to the fineness of the stuff.

The construction of buddles of the second class, in which the discharge is in the center, is shown in the figure opposite page 334. The receptacle on the center shaft, instead of being open at the bottom, as in the former case, is connected with tubes in the revolving arms, which distribute the watery mixture on the circumference of the buddle. The angle of inclination is the same in center-discharge buddles as in the other, but, of course, in the opposite direction. The feed, proportion of ore to water, method of preserving a smooth, hard surface, &c., are the same in buddles of this class as in those the discharge of which is on the circumference.

Buddles are well calculated for washing equal-falling grains, except when they consist of *very* fine or light slimes. These remain too loosely on the surface, in which the water soon forms furrows or channels. There is, of course, no separation accomplished by buddling when the water flows in thick streams. Slimes of this consistency can be better treated on plane-tables.

Concerning the relative merits of the convex and concave forms, the following criticism (following substantially the opinion of Gætzschmann) is offered:

The convex buddle has several disadvantages, chief among which is the retardation of the flow of the slimes, as they spread out in passing from center to circumference, by which the current gradually loses the power of carrying away the worthless portions of suspended material. The device of feeding farther from the center only gives a narrower ring, and hence a shorter distance for the flow. Moreover, the inclination cannot be changed to suit the nature of the material, yet is apt to change itself unsuitably, becoming steeper by the accumulation of headings around the center. Finally, a very serious drawback is the absence of any means for recovering, during the same operation, any valuable portions which have been once carried too far down by the stream. For a complete ultimate or repeated separation the ordinary convex buddle is therefore unsuited. Its best function is the preparation of material for the percussion-table, &c.

The concave buddle was devised to obviate the evils above referred to, connected with the outward flow. In this apparatus, it will be seen, the working-surface becomes smaller as the quantity of suspended material decreases in the water, and at the same time the force of the current increases. Theoretically, it is therefore the better machine than the convex buddle; and this much is generally confirmed in practice, though the superiority claimed for it over the percussion-table and some other machines is disputed. It is not likely to be suitable for complete separation.

The percussion-table.—Another plan for smoothing and consolidating the surface of ore deposited on a plane surface has been employed in the machine commonly known as the percussion-table, (German, *Stossheerd.*) The accompanying drawing of a percussion-table of the most approved construction shows the form and the mode of feeding and imparting motion to these machines.

The hardening and evening of the ore-bed is accomplished in a percussion-table entirely by mechanical means, no manual labor being required to work it, except for dividing the charge into sections at right angles to the longitudinal axis of the table, removing the old and preparing the table for a new charge.

In discussing the buddle, I have already alluded to the difficulty of consolidating the layer of ore, especially when the particles composing it are very small. In the percussion-table the shock given to the table is imparted to the particles, so that even the finer particles which remain loose on the buddle, and which have to be stamped or pressed down by hand on the plane table, are thoroughly shaken together and consolidated by mechanical means on the percussion-table.

The blow imparted to the percussion table could be caused by striking the movable table with a moving weight, but it is ordinarily given by suspending the table, swinging it from its position of equilibrium and allowing its backward swing to be stopped by striking against a stationary object. The blow may be imparted to the end or to the side of the table. In the present connection I shall only consider machines of the first class. Machines employing the side-blow will be mentioned under the head of continuous percussion tables. The heaping up of the ore on the side renders them unsuitable for use as intermittently working machines.

By reference to the drawing, the operation of sizing equal-falling grains on a percussion table will be easily understood. The ore is fed, in the first place, into the box *u*, at the head of the table, and thoroughly mixed with water, which flows upon it through the stop-cocks shown immediately above it. The water carrying the ore flows over the board *s*, and is evenly distributed in a thin stream over its surface by means of a row of stout wooden pegs. In this condition the water flows upon the board *h* attached to the head of the percussion table, and from which it flows upon the table itself, which is usually made 12 feet long and 5 feet broad. Three longitudinal and three cross pieces enter into the construction of the frame for the table. The boards composing the floor are not tongued and grooved, but simply driven up close with a hammer and nailed fast, after a strip of lamp-wick has been laid between them. The lumber need not be more than about half seasoned, as shrinkage is not to be feared when the table is wet, and the expansion of perfectly dry wood might be sufficient to twist and "buckle up" the floor.

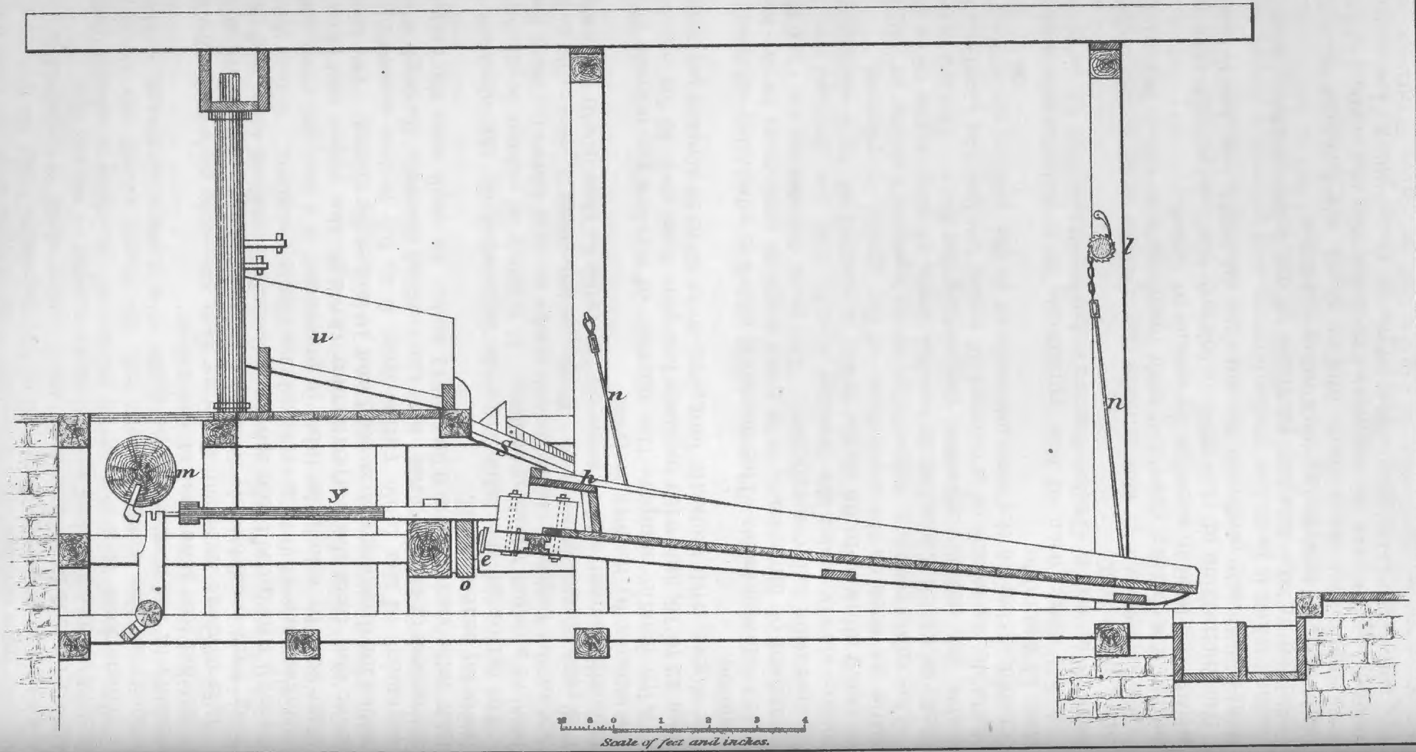
Motion is imparted to the table from the cam-shaft *m*, by means of the rod *y*. The table being hung by the rods *n n*, is swung out at each revolution of the shaft, and on returning the head *e* strikes against the bumper *o*, thereby giving a sudden jar to the table and its contents.

The swinging of the table, both out and back, must be slow enough to allow the stream passing over it to take part in the motion, and flow on over the surface of the table without being materially retarded by the outward, or accelerated by the backward swing. The momentary stoppage of so shallow a stream would permit the lighter particles to deposit themselves in the ore-layer at one time, and the accelerated current would carry heavy particles along with it at another time.

By means of a long lever and the roller *l*, the lower end of the table can be raised or lowered, so as to give it the proper inclination, and the current proper velocity, which must be determined practically according to the kind and size of the ore being dressed. It varies from 4 to 6 inches for slimes, and from 10 to 16 for coarse stuff, in a table 12 feet long.

In dressing coarse stuff from 0.5 to 0.7 cubic foot of the watery mixture of ore is fed on the table per minute; and of slimes not more than from 0.1 to 0.14 cubic foot. In the former case the water should contain from 20 to 40 pounds of ore per cubic foot, and in the latter, not more than from 5 to 10 pounds. A comparatively large number of small particles is required to make up the weight of one large particle. If the

THE PERCUSSION TABLE.



smaller ones are half the diameter of the larger ones, it takes four small ones to make one big one, and as the particles must be free to move in the current, it is evident that much more water is required for a given weight of fine ore than for the same weight of coarse ore.

When there is a fall of 12 inches in the length of the table, the velocity of the water current will be about a foot per second. The velocity of the motion of the table in a horizontal direction should be somewhat less than that of the water.

It is evident from the drawing that the rods by which the table is hung vary considerably from the perpendicular. The cord of the arc through which the table moves is therefore inclined also, and the table partakes somewhat of a vertically oscillating motion. When the length of the rods by which the table is suspended is 4 feet, the distance of the lower end from the perpendicular through the upper end should be 6 inches for dressing coarse stuff and 10 inches for slimes. The horizontal movement of the table varies from 5 to 0.5 inches according to the coarseness of the material; and the vertical distance through which the table falls varies from 0.90 to 0.11 inch. In each case the larger number is for coarser stuff.

The action of the table depends somewhat on the elasticity of the bumper against which it strikes. If a block of rubber is placed on the face of the bumper, the table will strike several blows for each time that it is pushed out by the cam. Rittinger considers it preferable to have an inelastic bumper and to suspend the table so that it will fall away from the bumper by its own weight.

With elastic bumpers the number of strokes per minute should be from 12 to 16, and with inelastic bumpers from 40 to 50 for coarser stuff. For slimes, with inelastic bumpers, from 60 to 80 strokes per minute are required.

The rotating table.—This machine, which is admirably adapted for the treatment of fine slimes, is in some respects analogous to the buddle in its operation and construction. The main differences are that the table rotates slowly under the feeding spouts, and the dressed ore, instead of being allowed to lie on the table, is washed off by a current of clean water as soon as the separation of the grains is effected.

The table consists, essentially, of an upright wooden or hollow iron shaft, to which a number of wooden arms, sloping either to or from the center, are radially attached supporting the floor. The ore is fed upon the table, by means of a current of water holding the particles in suspension, either on the circumference or in the center, according to the slope of the table.

A full description of this apparatus, in a considerably complicated form, is given in Gaetzschmann's Aufbereitung, Vol. II, page 522, and Atlas, plate LIX.

The attachment of the arms to the upright shaft is accomplished by means of a casting, provided with openings into which the arms are inserted, and held in position by means of screws.

The inclination of this table is toward the center, and this arrangement is generally preferred, because the feeding apparatus is more easily reached when it is on the circumference, and because a larger surface is presented to the heavier particles of ore, each of which may deposit itself without interfering with other particles.

To the radial arms short bits of plank are fastened by means of wooden pegs, which are employed in order that the surface of the table may afterward be planed. The edges of these planks are smooth, and the joints are made tight by laying a piece of string or lampwick between them, and driving them up tight together before securing them by the pegs. The exterior diameter of the table is 16 feet, and in the center a circular space, 5 feet in diameter, is left open. Around the circumference of this circle is the discharge.

For treating fine slimes the inclination of the table should be 6 inches in 5½ feet, or an angle of 5° 10′ with the horizontal plane. After a smooth surface has been obtained for the table, a number of small strips of wood (from 32 to 64) are nailed radially upon it, so as to divide the table into sections.

The watery mixture of ore is fed upon the table by means of feeding-boards, which are so constructed as to cause the mixture to flow in a thin even stream. These boards are inclined at an angle of 20° and their lower end is as broad as two of the sections on the table.

The table is revolved very slowly, making only about six revolutions per hour, or one revolution in ten minutes.

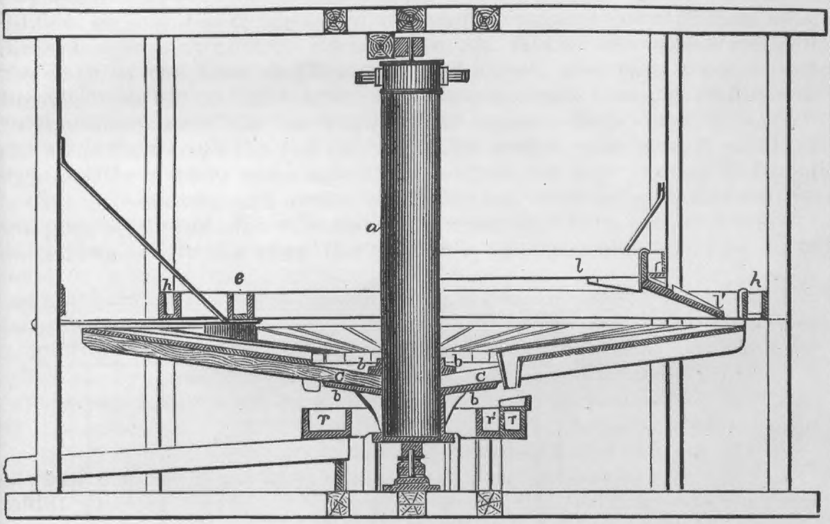
There are four feeding-boards, which are of course stationary, and from each of which flows a continuous stream. The motion of the table is so slow that by the time the sections which were fed from the first feeding-board come under the second, the larger and lighter particles have been washed over the table, and into the circular trough *r*, situated beneath it, whence they are conveyed by suitable conduits. The same operation is repeated at each of the other feeding-boards, and the heavy particles which were deposited upon the table from the first feeding-board, together with similar particles from the other boards remain upon it till it is revolved past the last board.

Clear water is added in a stream sufficiently strong to wash the table clear of everything except the heaviest particles, which are finally washed off from each section when it reaches a certain point by means of a small flat stream of water under considerable pressure. Rittinger claimed in 1867 the following advantages for this machine, as compared with the percussion-table:

1. The rotary-table furnishes at once a clean product.
2. The concentration of a given quantity of watery mixture of ore is more rapidly effected.
3. The yield is 5 to 6 per cent. greater.
4. The costs of tending and driving the rotating-table are less than for a percussion-table. The power required to drive a rotating-table is very small, not over $\frac{1}{10}$ of a horse-power. When the table is once in good operation, but very little attention is required to keep it in that condition. Rittinger says that one boy can be placed in charge of several such tables.

It should be added that Rittinger is rather enthusiastic upon the subject of this apparatus, and that later practice has not altogether confirmed the opinion above quoted, expressed by him in 1867. At Clausthal, Freiberg, and even at Przibram, the results of experiment with it have not been entirely satisfactory. The principal trouble appears to have been a choking of the compartments at their lower and narrow ends. An extra circular trough, delivering water at these points, was found necessary but not altogether effective; and other remedies complicated the machine. Moreover, the consumption of water is said to have been inevitably very great. Gaetzschmann praises the principle, but thinks further improvements in form necessary.

The continuous percussion table.—The working of the ordinary percussion table is necessarily intermitted, in order to remove from the table the ore which has accumulated upon it. Such tables had been used for

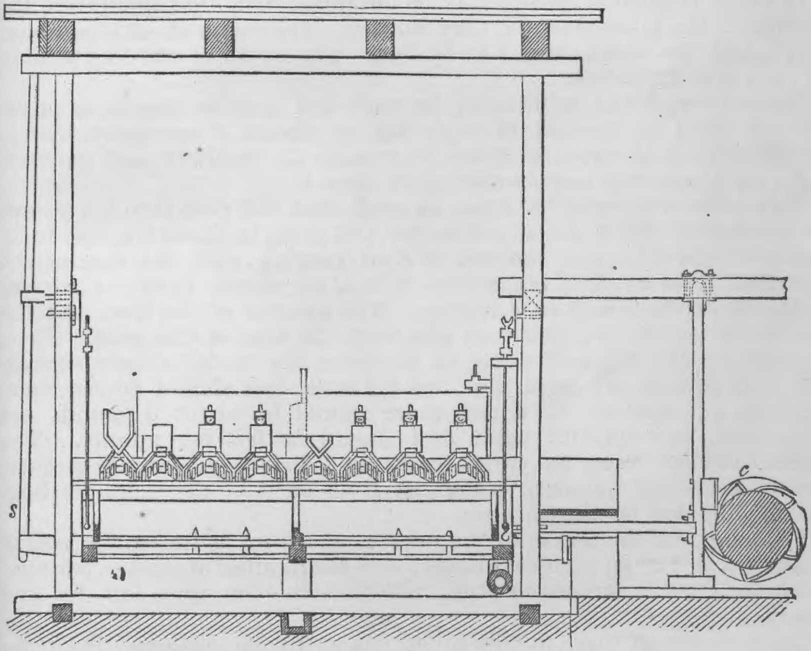


Rotating table. [See pp. 457, 458.]

many years before a continuous table was constructed, which presents the advantages of doing more work in a given time, furnishing a cleaner product, and requiring less attention and less manual labor than the old-fashioned machine.

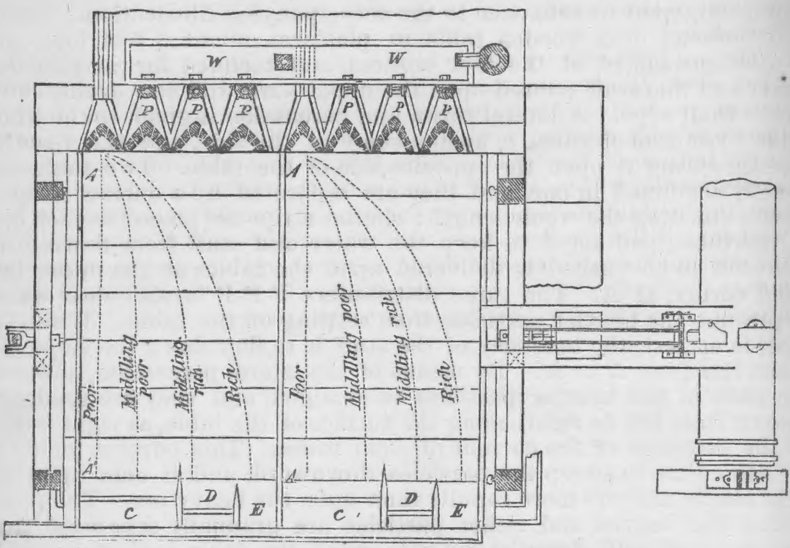
The construction and manner of operation of the continuous table will be apparent by reference to the accompanying illustration.

It consists of a wooden table or platform, about 8 feet long and 4 wide, suspended at the four corners, and inclined forward so that water and fine stuff poured upon the upper part will flow evenly down to the front edge. A lateral throw and percussion is given to the whole table by means of cams, *c*, upon a shaft at the side, and the reacting wooden spring S upon the opposite side of the table. Two tables are usually combined in one, and they are separated by a narrow strip of wood extending the whole length; similar strips are placed on each side of the table, and serve to keep the water and stuff from flowing off. The stuff to be washed is delivered upon the tables at the upper left-hand corner, at A. The three distributors P P P furnish clear water, to prevent the heavier particles from settling on the table. While the table is at rest, the tendency of the stuff is to flow down the slope in a direct line from A to A′. By means of the lateral percussion, however, the path of the heavier particles is changed, and they are gradually thrown from left to right, along the surface of the table, at right angles to the direction of the current of clear water. This current tends at the same time to sweep the particles downward, and it acts upon the light sterile matters more rapidly than upon the heavy ore. The result is that the heavier and richer particles are gradually separated from the poor stuff and describe the path upon the table indicated by the dotted lines. By the time the particles have reached the foot of the



Rittinger's Continuously-working Stossheerd—front view.

table, the richest portions have been transferred to the corner of the table diagonally opposite to that upon which the stuff entered, and they flow off into the compartment E. The "middlings" are dropped into the next compartment D, and the poor falls into C.



Rittinger's Continuously-working Stossheerd—view from above.

In order that good results may be obtained with this apparatus, the surface of the table must be very smooth. Its length should be about 8 feet, and the width from 4 to 4½ feet. The width of the feed should be from 8 to 12 inches.

The surface of the table must be made and kept as smooth as possible. It must be washed off every day, or oftener if necessary, with a strong current of water, in order to remove the smallest and heaviest particles which may remain stationary upon it.

This table is suitable for dressing stuff that will pass through a sieve the meshes of which are a millimeter (.04 inch) in diameter, the inclination of the table and amount of feed varying with the size of the particles. The angle of inclination is less for slimes than for coarser stuff. It varies from 3 to 6 degrees. The amount of the feed and the proportion of ore to water vary also with the size of the stuff. Thus, of particles about a millimeter in diameter the water should contain about 15 pounds per cubic foot, and 0.2 cubic foot should be fed upon the table per minute. Of slimes there should be about 6 pounds per cubic foot, and only 0.1 cubic foot should be fed per minute. The amount of clear water fed varies from 0.60 to 0.36 cubic foot per minute, one-third of that quantity being fed from each of the three feeding-boards intended for the purpose.

The length of the stroke of the table varies from 2½ inches for coarse stuff, to ½ or ¾ of an inch for slimes; and the number of strokes per minute from 70 to 80 for coarse stuff, to 90 or 100, even up to 140, for fine slimes.

The capacity of these double tables can easily be reckoned from the above data. It varies from 10 tons to 1 ton in twenty-four hours, according to the size of the stuff treated.

About a quarter of a horse-power is required to drive one of these tables.

When four tables, or a pair of double tables, are worked at the same time, the watery mixture of ore from the pointed boxes should be fed on three of the tables, while upon the fourth the product of the other tables too rich to throw away, and too poor to be sent to the smelting works, is reworked.

The ore produced by these tables is remarkably free from gangue. That which reaches the foot of the table at the extreme right hand is almost perfectly clean. Going to the left the proportion of gangue increases very rapidly, so that it is not at all difficult to adjust the strip at the bottom of the table in such a way that the ore from the right-hand division will be free from gangue; that from the left free from ore, and the middle division only furnish a product requiring to be re-worked. Rittinger says that in Germany the cost of dressing ore on the continuous table is only about half that of the same work on the ordinary percussion table. In this country the difference would be still greater, on account of the higher price of labor.

PART III.

MISCELLANEOUS.

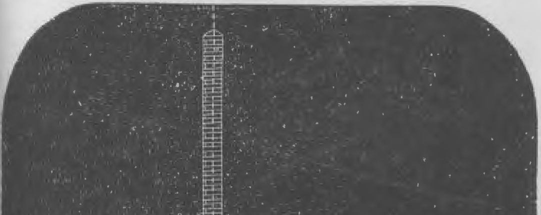
CHAPTER XIX.

MINING-MACHINERY.

The subject of the mechanical appliances of mining, so ably discussed by Professor Blake in a former report, cannot be further treated in detail within the compass of the present volume. I have thought it well, however, to insert in this chapter a series of engravings, illustrating the present approved patterns, in several important departments of mining and metallurgy, as developed in the practice of the Pacific States and Territories. The illustrations are taken from the very handsome pictorial catalogue of H. J. Booth & Co., of San Francisco, who have courteously placed the electrotypes at my disposal.

THE WHEELER PAN.

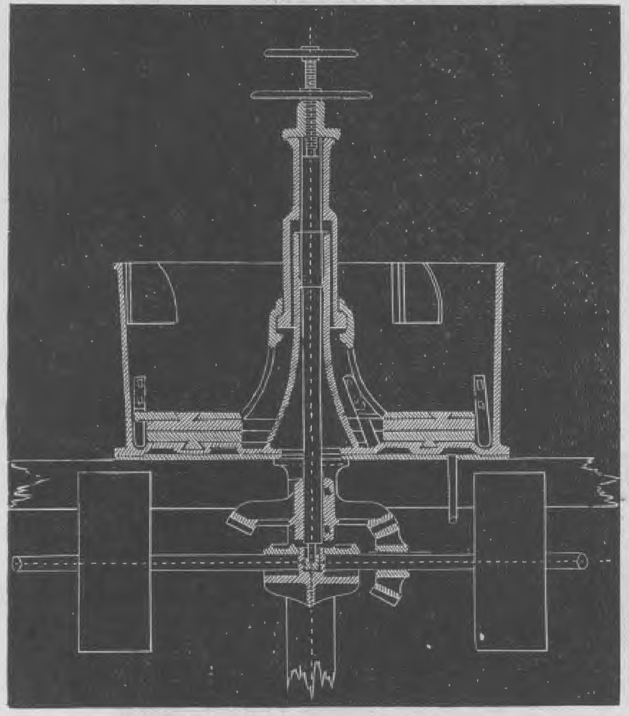
This pan is one of the oldest in use, having been first introduced in 1862. The cut shows an improved form. It is made with a flat bottom



to which the dies are secured by dove-tailed tongues and sockets. The shoes are attached to the muller-plate in a similar way. The muller is carried by a vertical shaft, passing up through the cone in the middle of the pan, and is raised up for the purpose of cleaning the pan by a screw cut on the shaft. In working the shaft is prevented by a key from turning in the nut of the muller. The regulation of the distance of the shoe and die from one another, in working, is accomplished by a hand wheel at the side of the pan, which, through a lever, raises or lowers the steel block, into which the toe of the upright shaft steps. Bevel-gearing transmits the motion to the vertical shaft, from the horizontal shaft, which has a pulley on its outer end. A steam-bottom is fastened to the bottom of the pan, so that the contents of the pan may be heated. The sides may be either of wood, cast-iron, or sheet-iron.

THE HORN PAN.

This pan, like the Wheeler, described above, has a flat bottom. The tendency of the western practice is to adopt the flat bottom, in preference to the conical or concave forms. The "tractory conoidal" form of the Wheeler and Randall pans is used by many operators where grinding as well as amalgamating is desired; but its alleged advantages are purchased at the cost of some drawbacks, among which may be named the smaller capacity for a given diameter.

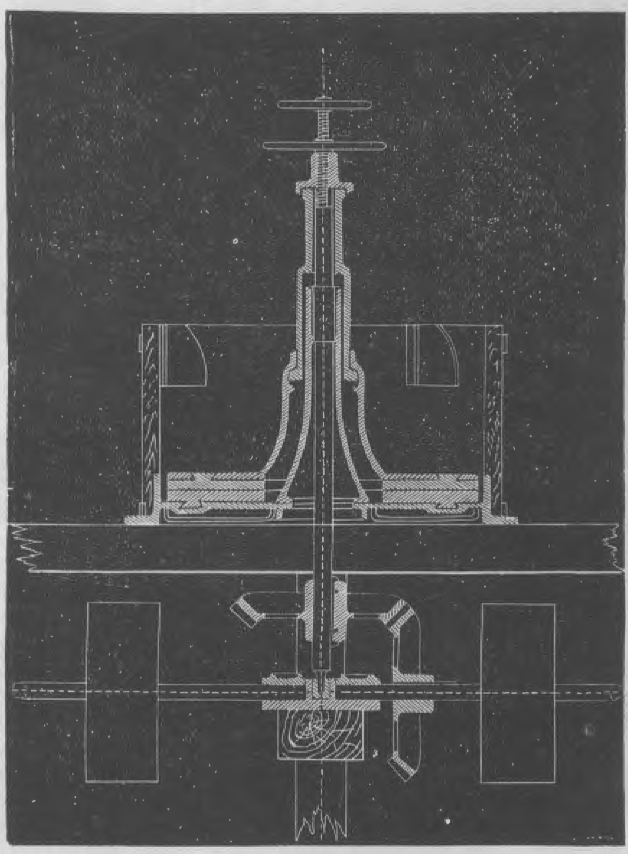


In the Horn pan, a flat plate serves the double purpose of a foundation and a steam-bottom. The body of the pan is set directly upon this, and the joint is made with cement. The shoes and dies are secured by dovetailed tongues and sockets. A groove runs around the pan, outside the circumference of the muller, which is traversed by a scraper, fastened to the muller. The gutter around the cone is also scraped in the same way. The muller is hung loose upon the driver, which is carried by the vertical shaft, and is regulated as to height by the screw at the top, the point of which rests upon the top of the shaft. A yoke is fastened to the bottom of the pan, which serves for a footstep, and also carries the bearing for the horizontal-motion shaft.

THE PATTON PAN.

This is in some respects a compound of the Wheeler and the Horn, resembling rather the second than the first. The steam-bottom is fastened beneath, as in the Wheeler pan, and the yoke, which in the Horn pan serves for a footstep and also carries the bearing for the horizontal driving-shaft, is here dispensed with, the footstep and shaft-bearings being set upon the wooden framing of the mill which carries the pans. The manner of hanging the muller loose upon the driver, which is carried by a vertical shaft and regulated in height by a screw at the top, is the same as in the Horn pan; and the attachment of the dies to the bottom, and of the shoes to the muller, by means of dovetailed tongues and sockets, is the same as in both the Wheeler and the Horn pans;

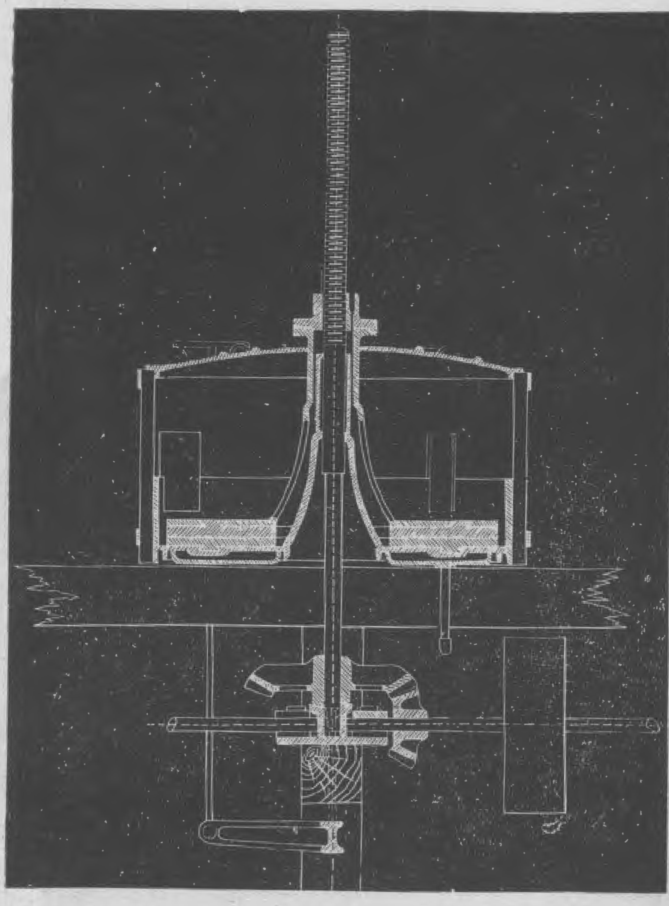
but in the Patton pan the sides, as may be seen from the illustration, are made of wood. It will be noticed that in all these pans, as manufac-



tured by the Union Iron-Works of San Francisco, there are curved flanges extending inward from the upper part of the side. The form of these, as shown in the drawings, is slightly different in the two latter pans from what it is in the former. They are intended to effect a circulation of the pulp, and it is claimed that the warped surface adopted in the pan herewith illustrated, does this most satisfactorily.

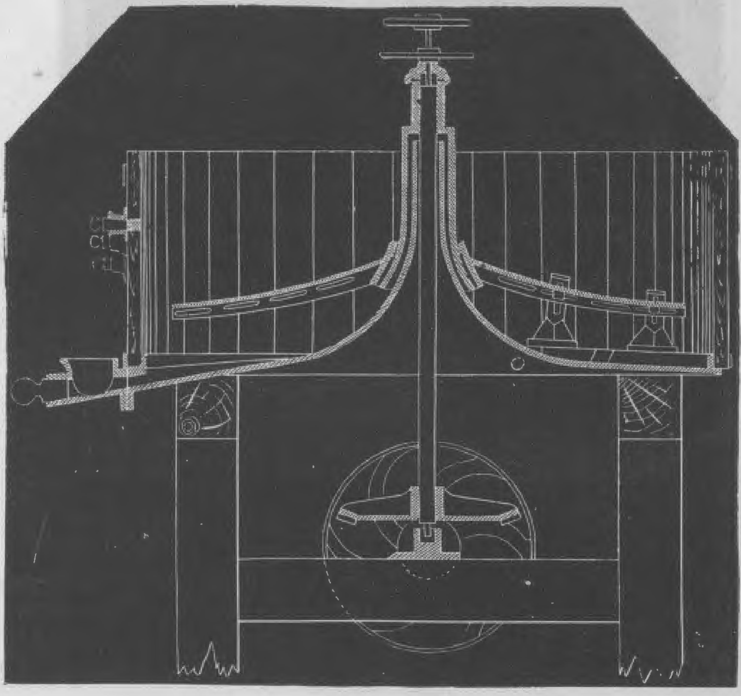
THE COMBINATION PAN.

This is the Wheeler pan with the Patton footstep, the only thing of its own being a cast-iron ring set in the pan to protect the wooden sides. This ring can be replaced when worn. This machine is one of the latest and most approved forms. It is noteworthy that the steady tendency of practice has been to discard the ingenious and complicated contrivances, and to adopt simple, large, and mechanically stable construction. Concerning the combination pan, see some remarks in a previous chapter, on Nevada, under the head of Lincoln County.



THE SETTLER.

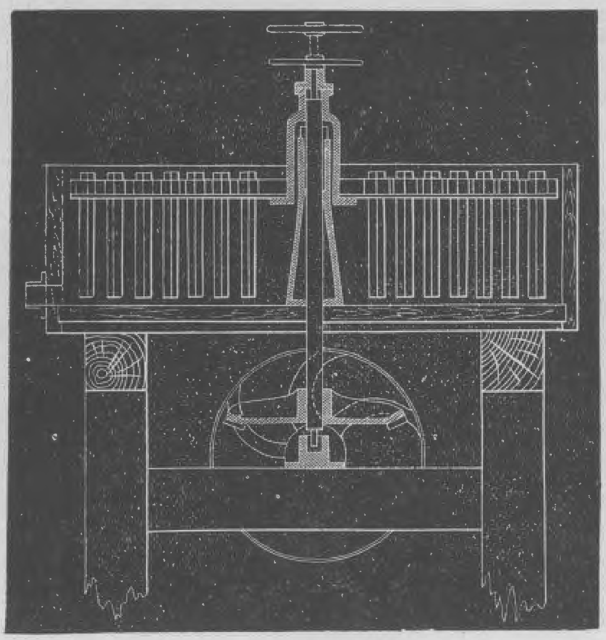
The work of the settler, in the system of amalgamation, is to separat the minute particles of mercury and amalgam from the pulp through which they are distributed. It resembles a pan in some respects, being made up of a circular box, in which revolves a central axis carrying arms, and to these arms are fixed shoes. These iron shoes, however, do not come in contact with the bottom of the settler, as no grindi action is desired. They are faced with wooden rubbers, which ke the heavier parts of the pulp thoroughly stirred up, while the revolv ing arms perform a similar service for the lighter portions floating above. The pulp is thinned by a stream of water during the operatio for which reason the settler has a larger capacity than the pan. It is formed of a conoidal iron casting, in the hollow axis of which works the upright to which the revolving arms are fastened. The sides of the settler are of wood, but sometimes sheet-iron is used instead. Holes stopped by plugs are pierced in the sides at different levels, through which the thinned pulp can be gradually drawn off. On one side is bolted an iron quicksilver bowl, communicating with a radial gutte cast in the iron bottom. The rotary part of the apparatus consists o the central shaft before mentioned, which carries on its lower end a beveled cog-wheel, and at its upper end an arrangement for adjusting the height of the wood rubbers so as to lower them as they gradually wear away. This arrangement, which is a duplicate of the devices for a similar purpose in the pans heretofore illustrated, consists in a deep collar embracing the vertical part of the conoidal iron bottom of the settler, and hung upon the shaft by a screw furnished with a hand-wheel. The revolving arms are carried out from this collar. All these details are plainly shown in the accompanying cut.



THE AGITATOR.

The battery-slimes, after being amalgamated in the pan and the amalgam collected in the settler, are run to a third receptacle resembling the pan and settler, but of larger dimensions and with different working apparatus. Some kinds of amalgam, such as those containing copper or antimony, are friable, and on account of their fineness cannot be recovered from the pulp while it is thick. It is therefore run into a circular tank or tub in which wooden stirrers revolve, a copious stream of water running constantly in at the top. Here the pulp is thoroughly beaten up and thinned, and while the lighter parts flow off with the current, the amalgam and floured mercury fall to the bottom and collect there. This amalgam is always both poorer and less pure than that from the settler.

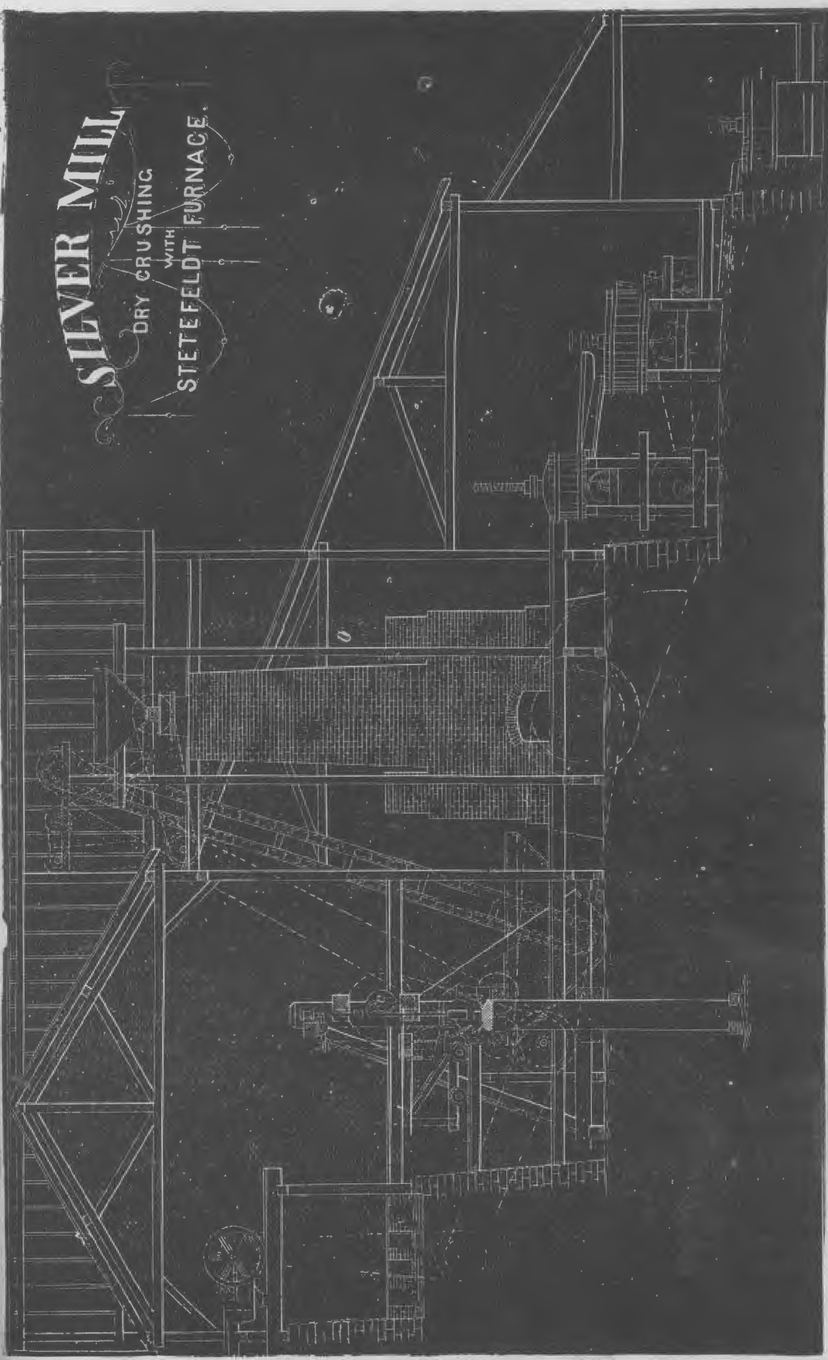
The illustration shows one of H. J. Booth & Company's agitators. It is formed of a round tub, the bottom and sides of which are made of wood. In the center a hollow cast-iron cone is bolted, through which rises the shaft, driven by a cog-wheel below. A cast iron cap or carrier rests on the top of the shaft, and from this project iron arms, in which are fastened the wood stirrers, hanging vertically and reaching down nearly to the bottom of the tub.



ARRANGEMENT OF A SILVER MILL.

The illustration shows the arrangement of a silver mill for dry crushing, provided with a Stetefeldt furnace for chloridizing the ores. The reduction of the ore to the proper size begins in nearly all cases with the Blake crusher. From that it passes to the stamping floor, in this case to a self-feeder, which supplies it to the stamps. When the ore is roasted a drying floor is placed between the rock-breaker and the self-feeder. This floor is made of cast-iron plates 3 by 3½ feet square and flanged on two contiguous sides. The plates overlap, and rest on walls forming a double flue under them. Heat is supplied by what would otherwise be the waste gas from the chloridizing furnace. The dried ore is shoveled to the stamps or to the self-feeder. From the stamps the powdered ore is conveyed by a traveler to a bucket-lift which raises it to a pulp-feeder on the top of the furnace. In the latter it immediately reaches a red heat, the extreme fineness of the particles making the process of heating almost an instantaneous one. It falls through an atmosphere of hot chlorine gas and by the time it has reached the sole of the furnace 85 to 96 per cent. of the silver has been thoroughly chloridized.

From the furnace the pulp is drawn on the cooling floor, from which it goes to the pans, the principal styles of which we have already described. From the pans to the settlers and thence to the agitators, the pulp passes until it has not only been thoroughly treated but has deposited the last obtainable portions of mercury. Its last work is to collect in the settling vats outside the mill, from which it is taken and


SILVER MILL
DRY CRUSHING
WITH
STETEFELDT FURNACE.

stored up in the hope that improved processes will one day make its remaining wealth available.

When no chloridizing furnace is employed, the pulp is sometimes received from the stamps in cars and taken direct to the pans. Other details are often altered to suit the circumstances of particular cases.

One of the main points in these mills is the disposition of the belting. It has received the closest attention of mill-builders, who have brought the system to a wonderful state of efficiency.

ARRANGEMENT OF A GOLD-MILL.

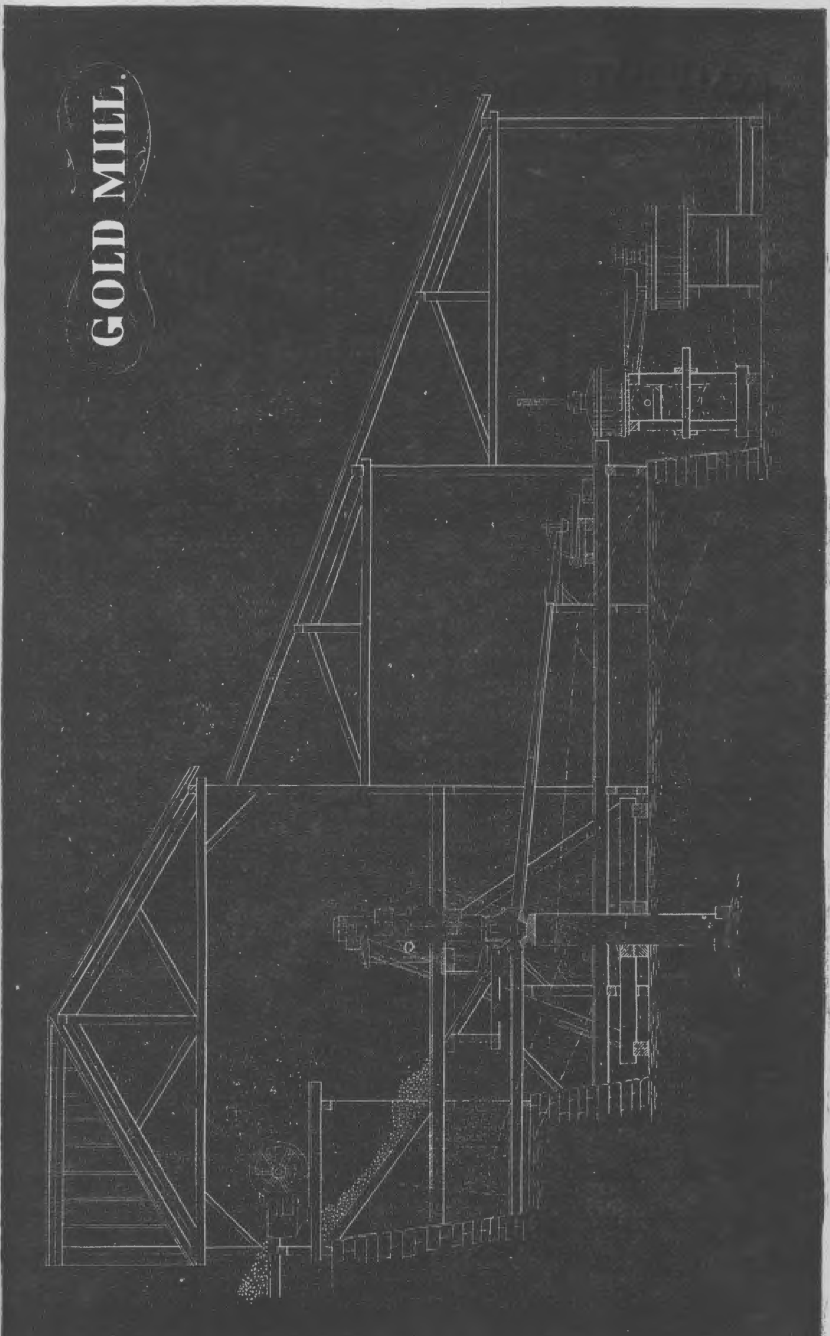
The engraving shows the ore from the mine thrown down before the Blake rock-breaker. From this machine the broken ore passes down an incline to the self-feeder, and thence to the stamps. Amalgamation often takes place, in the first instance, within the battery-box. Considerable gold is also gathered from the bottom of the box, not having been pounded fine enough to pass through the screens. In front of the latter is an apron of amalgamated plates, which is the second trap set to catch the metal. Beyond the apron come the blanket-tables, where the pulp undergoes mechanical separation, the resulting two qualities receiving different treatment.

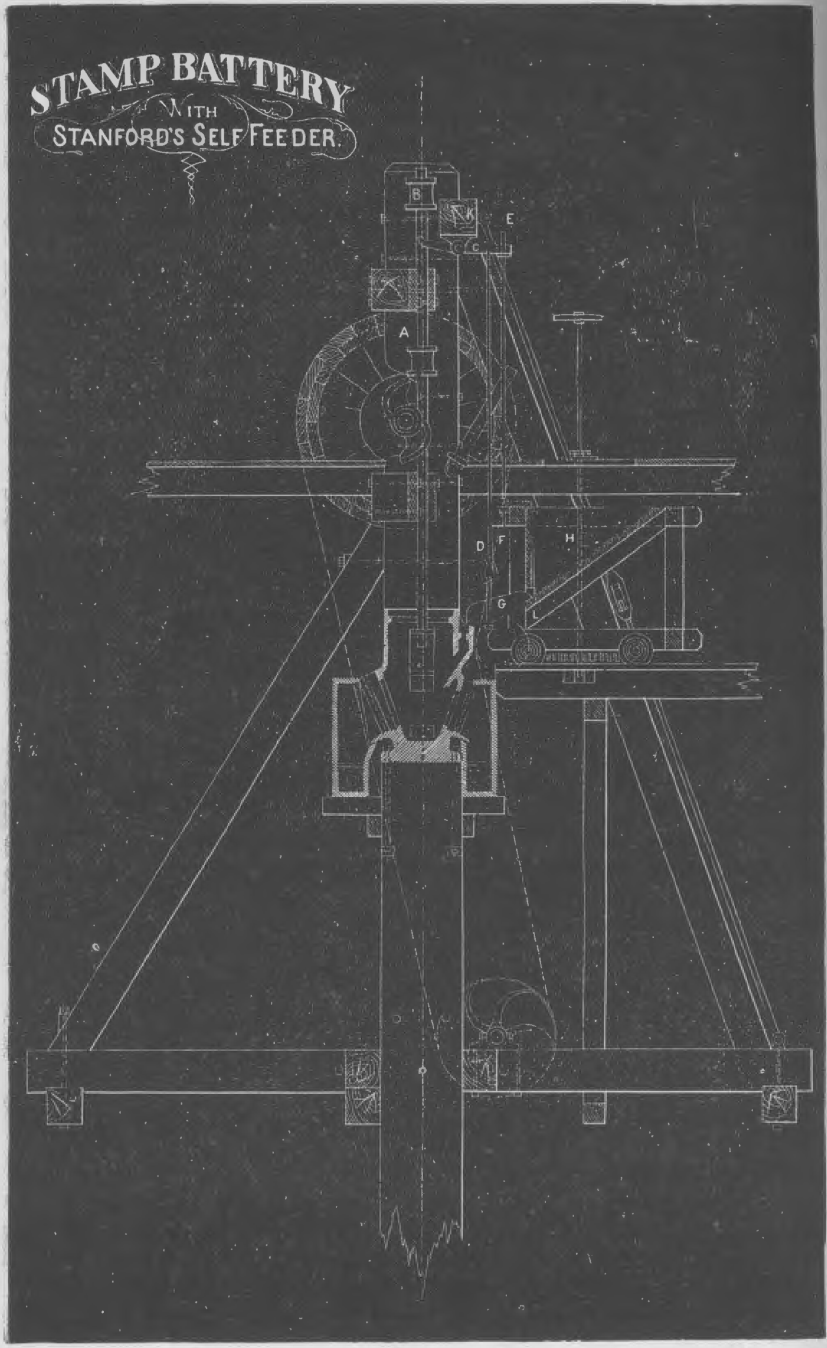
The sands which pass the blankets, and are therefore of second quality, are passed through the first concentrators, then through the second concentrators, and finally into the tail sluices outside the building. The sand which remains on the blankets is washed into tanks, then passed through Atwood vats and over copper riffles, after which it goes through the second concentrators and tail-sluices, like the second quality.

Other arrangements are followed, but they all obey one rule—to obtain as thorough a separation of the gold as is possible by repeated reworking of the sand. In the figure, the long blanket-table is seen reaching from the battery to the first concentrator. Below the latter are a Wheeler amalgamating-pan and a settler, the latter being a step interposed before the tailing-sluices. On the concentrators, pyrites, or, as it is generally called in the West, "sulphurets," is obtained more or less pure. It is usually roasted in reverberatory furnaces and treated by chlorination, but when the amount will not pay for this treatment the concentrated mineral is sometimes run through a good grinding-pan with mercury.

STANFORD'S SELF-FEEDER.

Were the importance of automatic battery feeders confined to the saving of labor, they would probably find no very extensive use, for although the business of milling is one that requires the closest scrutiny and economy, the one workman employed in each working shift for the feeding of fifteen or twenty stamps is not an item of expense sufficiently heavy to warrant in all cases the introduction of the large and somewhat cumbersome apparatus necessary when the machine is to do its own feeding. But it is claimed that these automatic arrangements work with a regularity, a precision, and an attention to duty which are matched only by the most faithful laborers.


GOLD MILL.

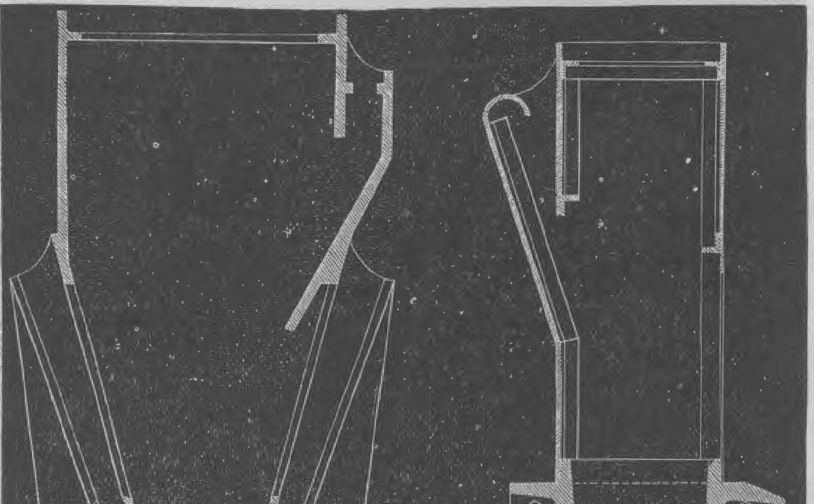

STAMP BATTERY
WITH
STANFORD'S SELF FEEDER.
B
K
E
C
A
D
F
H
G
L

Mr. C. P. Stanford has devised a feeder, which is now manufactured by the Union Iron Works of San Francisco. The removal of ore from under the stamps by powdering and washing through the screen, lets a tappet, B, on the stem, A, down on a lever, C. The motion is communicated to the feeding screen and a small quantity of ore is thrown into the battery, the action continuing until the ore on the die has accumulated to such a height that the tappet no longer falls far enough to touch the lever. This tappet is usually placed on only one stamp in a battery—generally the middle one. The tappet being adjustable, allows the rapid alteration of the quantity of ore thrown down by the feeder in a given time.

The illustration shows the application of this feeder to a battery for silver-ore, crushing dry. The powdered ore passing through the screens falls into side boxes, in which works a worm, or some similar device which conveys it to the proper receptacle.

MORTARS.

One of the most distinctive features of American stamp-mills, and also one of the most creditable improvements which have grown out of the application of American inventive genius to the machinery for treating ores, is the mortar or stamp-box used in California mills. Its particular advantages are durability and *completeness*, by which I mean



DRY MORTAR. SECTIONAL MORTAR.

not only that it fulfills all the functions desirable in a battery-box, but also that all parts which are not necessarily movable are combined in one casting, and the box is therefore ready for rapid setting up. Of the mortars for dry-crushing there are two sorts, one solid and one sectional, the latter being made in parts for convenience of transportation over mountain-roads. Both of these are herewith illustrated. In the dry mortar the die is set high, the screens are steeply inclined, and there is a double discharge. The peculiar requirements of American silver-milling make this dry mortar quite different from that in ordinary use in Europe for dry-crushing. Thus the discharge is at the side instead of in the bottom, as in those mortars which are used for very coarse crushing, a difference which is necessitated by the extreme fineness demanded in milling silver-ores. The mortar has a width of bottom of about 11 inches, suitable for a die of eight inches, and an outside length of 52 inches. Its material is cast-iron. The sectional mortar has a cast-iron bed, made in sections, and fitted with a wrought-iron top. These sections are held together endwise by strong bolts, and sidewise by a long bar fitted into a groove planed in the bottom and riveted to the sections. When set up it makes a perfectly firm mortar. Somewhat different is the form adopted in mortars for stamping gold and silver ores wet. In gold-milling the interior of the mortar forms the most effective amalgamating surface, and the stamp-box is therefore arranged in such a way that it can be lined with copper plates. A seat is formed on the inside of the die-step, at the foot of the screens, the purpose of which is to afford means for placing a copper plate at the point where more gold settles than in any other given spot in the entire system of battery and amalgamating plates. This small plate

GOLD MORTAR. SILVER MORTAR.

takes up the gold while it is still coarse, and places it beyond the possibility of loss by further powdering. A convenient arrangement for the ready placing of these interior copper plates is an essential requirement of mortars for gold-mills, for this is one of the most frequently recurring tasks connected with the treatment of auriferous ores. It is also a task that necessitates the stopping of the stamps and the loss of a certain amount of time.

The mortar for silver-ores is narrower than the above, and also has a deeper die-seat. As its use is confined to reducing the size of the ore and no other work goes on within it, the arrangements for the insertion of amalgamating surfaces are omitted. Here the main requirement is the speedy discharge of the slime after it has been formed. The screens are therefore set near the line of the stamps. All these mortars have a charging slit, one side of which is curved at the top, or narrowed by some similar device, in order to restrict the size of the ore charged, while the expansion of the opening below the top gives a ready fall to any ore that passes the mouth.

CHLORINATING WORKS.

Chlorination, though suited to every kind of gold-ore, is mainly confined in the West to the "sulphurets" which are obtained in treating the ordinary gold-ore. This ore contains a variable amount of iron pyrites, the average being, perhaps, 2 or 3 per cent. These sulphurets are in small works merely passed through a pan and subjected to long grinding, when a considerable proportion of the gold present will be taken up by the mercury. When, however, the richness of the concentrated pyrites, or the magnitude of the works will warrant the expense, chlorination is resorted to, and very excellent examples of these works are to be seen at Grass Valley, California.

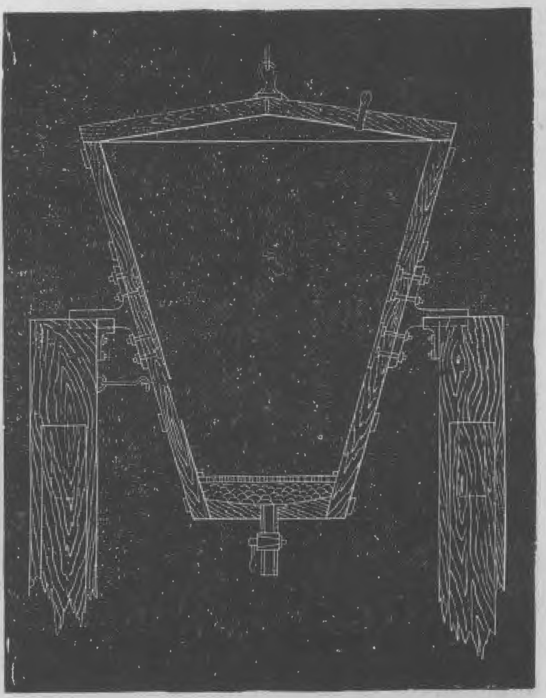


Fig. 1.

The process of chlorination has been described in former reports, and in a preceding chapter of the present report. So much only will be here repeated as may serve to explain the accompanying illustrations.

The process in general consists in passing dry chlorine through finely-powdered ore, which, however, must be free from sulphur, since this substance would cause a precipitation of the gold. The production of soluble perchloride of iron must also be avoided, for the reason that this precipitates gold from its solution. The theory of the process is the formation of a soluble salt of gold—the chloride—which is then removed by lixiviation, and the gold is obtained by adding a precipitating agent to the liquor. If any precipitation takes place within the dissolving cask, it is evident that so much of the gold will be lost. The precipitating agents most to be avoided are sulphur, antimony, arsenic, and iron, though the peroxide of this metal is not injurious. The first step is, therefore, complete roasting. This is done in reverberatory furnaces. Bruckner's cylinders, or Stetefeldt furnaces, might, perhaps, accomplish it, but have not, so far as I know, been so employed. The powdered and roasted ore is placed in the leaching vats, Fig. 1. These are merely wooden tubs swung on gudgeons, and with a filter on the bottom, made of pieces of quartz laid under a perforated earthenware cover. These vats are closed air-tight by rubber joints under the covers. Pipes in the covers connect the vats together, so that the gas which is introduced at the bottom passes through the whole row of vats. The ore is slightly dampened, but must not be wet.

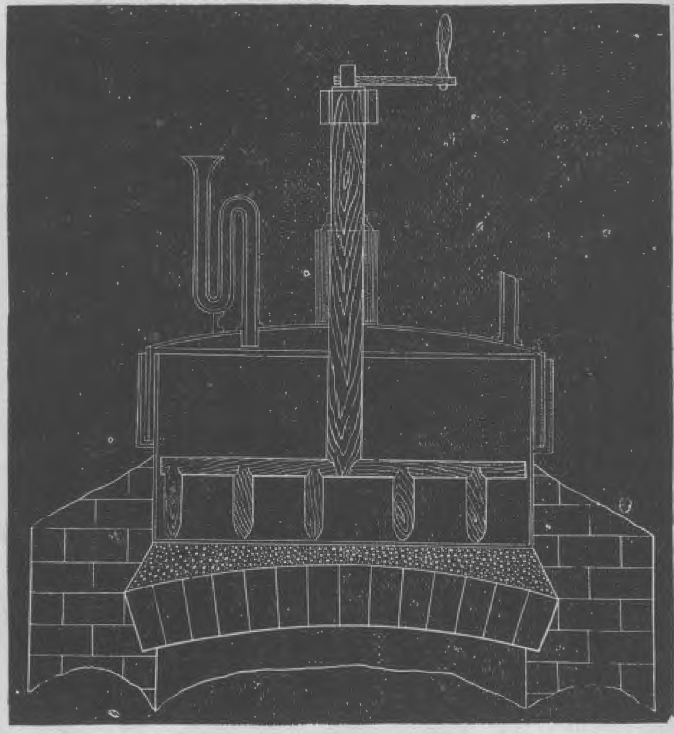


Fig. 2.

Fig. 2 shows the gas-generator. It consists merely of a lead chamber, containing an agitator of hard wood, and closed by a cover resting in a water-joint. The whole rests on a sand-bath. Between the generator and the leaching vats is placed a wash-bowl, where any hydrochloric acid in the gas is removed. When the operation is ended, the soluble chloride of gold is extracted by warm water, and the spent ore is tipped into dump-cars. The solution is run to precipitating tubs, where the gold is thrown down by solution of sulphate of iron, oxalic acid, &c.

With proper care the process is a very perfect one, yielding 97 per cent. of the gold, which is very fine. It ought not to cost in California, according to Messrs. Booth & Co., of San Francisco, more than $12 a ton.

In Fig. 3 is shown an arrangement of chlorination works designed by Messrs. Riotte & Luckhardt, of San Francisco. It includes the use of the Bruckner cylinder, which is seen at I, the starting-point of the operation. The leaching vats are placed at A, in a row, with the gas-generator D in the center. C is a rail-car for removing the spent ore from the building, while the precipitating tubs are seen at B. At E is seen the waste tub, where the water runs through sawdust before being finally discharged.

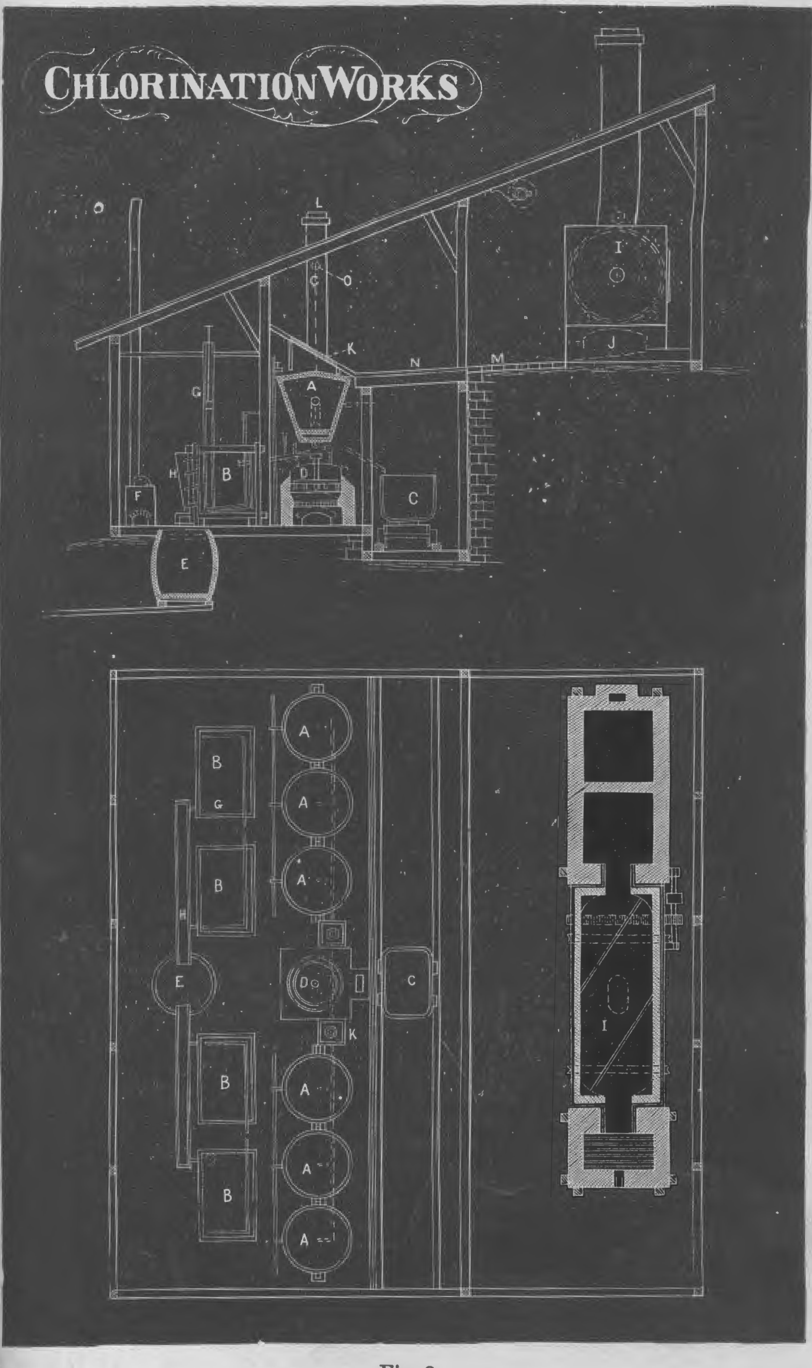


Fig. 3.

CHAPTER XX.

GENERAL GEOLOGICAL MAP OF THE UNITED STATES.

The colored lithograph-map, a copy of which accompanies this report, was prepared by Professor C. H. Hitchcock, with the assistance of Professor W. P. Blake, primarily for the Superintendent of the Census. I was able to render some advice and assistance in the execution of the plan, with the understanding that, if the requisite authority could be obtained from Congress, an edition of the map might be prepared for the report on mining statistics. I could not have undertaken, within the limits of my official instructions and of the usual appropriation made for my work, to carry out in such detail as would certainly be desirable the expensive and laborious undertaking of a complete geological map or atlas of the United States. The aim was, therefore, to obtain, at an expense so small as to permit its circulation as a public document, a map exhibiting the general geological features of the country, more comprehensively and accurately than any already before the public. The result has, I think, vindicated the wisdom of this attempt, and reflects credit upon the scientific gentlemen who generously gave themselves to the work. Certain severe criticisms of the map, in which it has been compared with very costly and elaborate charts issued in other countries, lose their force in the light of the foregoing explanation.

The map has been redrawn, with a few slight alterations, for the present edition. The following description of it is taken from the volume on Industry and Wealth of the Ninth Census, with a few additions and changes made on the authority of recent communications from Professor Hitchcock:

For the elaborate geological map of the States and Territories, which accompanies the present volume, the Census-Office is indebted to Professor C. H. Hitchcock, of Dartmouth College, Hanover, N. H., who has for many years been engaged in the collection of information, both printed and in manuscripts, from the best geologists, for the purpose of constructing a complete geological atlas of North America. The present effort is the first fruit of these labors. The information was designed primarily for the larger work, but, in consequence of unavoidable delays in the issue of the atlas, Professor Hitchcock has felt himself justified in compiling from it for the publications of the Ninth Census this preliminary map, which the Superintendent submits to the country, with a confidence derived from long knowledge of the scholarly care and conscientiousness which characterizes all of the author's works. The following notes from Professor Hitchcock contain all the explanatory or descriptive matter which it is deemed essential to present in this place.

In the work of compilation great assistance has been rendered by Professor William P. Blake, of Connecticut, who is responsible especially for the coloring of the western portion of the map. Professor Blake's knowledge of the Territories, both on account of personal observations and editorship of the results of other explorers' work in the reports of the Pacific Railroad surveys, enables us to present the best interpretation of the geological structure of the Territories yet offered to the public.

The following are the authorities used in the compilation of the map; only the maps employed in the compilation are cited. The special sources for the several primary maps will be given in the larger work to which reference has been made.

Maine.—Manuscript map prepared by C. H. Hitchcock for the State authorities in 1863.

New Hampshire.—Manuscript map prepared by C. H. Hitchcock, in 1872, as the result of the geological survey now in progress.

Vermont.—C. H. Hitchcock's map as published in the final report, corrected by the latest discoveries.

Massachusetts.—E. Hitchcock's map of 1844—an improvement over the one in final report, and not generally known to exist. This has been improved by his own later observations and those of C. H. Hitchcock.

Rhode Island.—C. T. Jackson's map in final report improved by C. H. Hitchcock.

Connecticut.—Essentially the map of J. G. Percival.

New York.—Official survey-map of 1843, improved by James Hall, in Logan's map of Canada, 1869, and by others.

New Jersey.—Latest map, by Professor George H. Cook.

Pennsylvania.—Map of geological survey, 1858.

Maryland.—Map of geological survey, improved by P. T. Tyson.

Delaware.—Geological report, (no map,) by J. C. Booth.

Virginia and West Virginia.—Map prepared by W. B. Rogers in 1844, from the observations of geological survey, never published. Professor Rogers's ill-health has prevented him from examining our copy, and any errors that may possibly exist must be ascribed to this circumstance.

North Carolina.—Manuscript map, by W. C. Kerr.

South Carolina.—Tuomey's and Lieber's maps, revised by F. S. Holmes.

Georgia.—Map in White's Statistics, with improvements, especially in northwest part of the State, by J. M. Safford.

Florida.—No map of this State has ever been made.

Bahama Islands.—Manuscript map of W. M. Gabb.

Alabama.—Manuscript map, by Dr. G. Little. Northern part, by J. M. Safford.

Mississippi and Louisiana.—Manuscript map, by E. W. Hilgard.

Tennessee.—Map of final report, improved by James M. Safford.

Kentucky.—Manuscript map, by S. S. Lyon, prepared from the results of geological survey, under the direction of D. D. Owen.

Ohio.—Latest map of J. S. Newberry.

Michigan.—Lower peninsula, from map of Alexander Winchell; upper peninsula, from map of Foster and Whitney, with improvements by Logan.

Minnesota.—Mostly from Logan's map, with suggestions from C. A. White, and a paper by James Hall.

Wisconsin.—Manuscript map by J. A. Lapham, expressly prepared for the purpose mentioned above; largely from J. D. Whitney's report.

Iowa.—C. A. White's latest map.

Illinois.—A. H. Worthen's manuscript, embodying results of his survey.

Indiana.—Manuscript map, by Richard Owen, former State geologist.

Missouri.—Manuscript map, by G. C. Swallow, former State geologist.

Kansas.—Compiled from information given by G. C. Swallow, Meek and Hayden, J. L. Leconte, J. S. Newberry, and W. P. Blake.

Arkansas.—Chiefly from manuscript map of Richard Owen, compiled from report of D. D. Owen.

Indian Territory.—Marcy's Red River Expedition, Jules Marcon's report, and other sources; revised by J. S. Newberry.

Texas.—S. B. Buckley's manuscript map for the eastern portion; maps of various Government expeditions, carefully considered, by W. P. Blake and J. S. Newberry.

New Mexico and Arizona.—Manuscript map, by J. S. Newberry.

Colorado.—Parts by J. S. Newberry, F. V. Hayden, and W. P. Blake.

Utah, Nevada, California, and Oregon.—Compiled by W. P. Blake, from personal observations; Pacific Railroad reports, both for United States and railroad corporations; California reports, by J. D. Whitney; geology of 40th parallel, by Clarence King, and other sources.

Dakota, Montana, Idaho, Wyoming, and Nebraska.—Maps by F. V. Hayden, (Raynolds expedition, and final report on Nebraska.)

Washington Territory.—Compiled by W. P. Blake, from manuscript notes of George Gibbs and other sources.

Canada.—Sir W. E. Logan's map, published in 1869.

The formations are arranged in nine groups, not in every respect the most natural, but the most convenient, from the material in existence. The first group of *Eozoic* includes the granites and other metamorphic rocks; both those older than Paleozoic and those more recent. In the Appalachian region there may be some Paleozoic crystalline schists. In the Territories and along the Pacific border there are many crystalline schists of Mesozoic age, a few patches of which are indicated; but their entire limits are unknown as yet. In this group is included the *Huronian system.* These are the talcose rocks of the eastern border region, referred to the Lower Silurian by W. E. Logan and others. They are largely developed in Maine.

The *Silurian system* is made to extend from the Paradoxides beds to the Lower Helderberg inclusive, in accordance with the general usage of American geologists. There is good reason to believe that the limits of the Silurian should be modified in accordance with the views of Professor Adam Sedgwick, of Cambridge, England. In the Silurian are included the "Calciferous mica-schist" of Vermont, the "Coös group" of New Hampshire, the "Merrimack group" of New Hampshire and Massachusetts, and some schists in North and South Carolina, whose precise position is not well determined.

The Paleozoic rocks in the western portion of the map are undivided, as is true, also of the Cenozoic, save a few post-tertiary lacustral areas and deltas. The lacustral areas will be much enlarged in the future, as our information shall be more precise.

COAL-MEASURES.

The most important division for giving accurate practical information is that of the "Coal Measures." With it is included in Nebraska, Kansas, and Indian Territory an inconsiderable area of Permian and Permo-carboniferous.

The following are the areas of the coal-measures in the United States:

New England basin, in Massachusetts and Rhode Island, estimated to cover 750 square miles. The coal is a plumbaginous anthracite, used to advantage in some smelting furnaces. Perhaps eleven beds may exist; best seen in Portsmouth, Rhode Island. The maximum thickness is 23 feet. The whole carboniferous system is supposed to be 6,500 feet thick, of which 2,500 pertain exclusively to the coal-measures.

Anthracite basins in Pennsylvania.—This is the most important coal district in the United States. There are four basins, having an area of 410 square miles, not including the Broad-Top semi-anthracite, which amounts to 24 more. The measures are from 2,000 to 3,000 feet thick. The number of distinct beds varies from two to twenty-five, according to the depth of the basin. The maximum amount near Pottsville is given at 207 feet, while the average cannot be far from 70 feet.—(H. D. Rogers.) Macfarlane estimates the area of the anthracite fields in Pennsylvania at 472 square miles, which is 62 square miles more than Rogers's estimate.

The *Appalachian field* embraces an area of 62,025 square miles, extending from Pennsylvania to Alabama.

In Pennsylvania the aggregate thickness of the measures is from 825 to 2,535 feet. The area of the bituminous coal is 12,222 square miles, with an average thickness of 40 feet of coal.—(H. D. Rogers.)

In Maryland the area is 550 square miles, in three separate basins. The strata are 1,500 feet thick. There are thirty-two beds in all—one of 14 feet, three of 6 feet each, others from 1 to 5 feet thick.—(P. T. Tyson.)

In Virginia (chiefly West Virginia) the coal area embraces 16,000 square miles. On the Kanawha the strata are 1,250 feet thick, with twenty-four beds of coal, of which eleven have an aggregate of 51 feet thickness. The coals seem best developed on this river.—(T. S. Ridgway.)

In Ohio, Dr. J. S. Newberry states the area to be more than 10,000 square miles, with a thickness of 1,500 feet, and 10 workable beds of coal, corresponding in number and thickness to those of Pennsylvania and West Virginia.

In Eastern Kentucky the area has been stated to be 10,000 square miles. Macfarlane puts it at 8,983 square miles, said to have been derived from actual measurement.

In Tennessee, Prof. J. M. Safford states the area of the measures to be 5,100 square miles. One characteristic section gives a thickness of 14 feet. The beds vary locally in their dimensions, some of them being 9 feet thick, but thinning out very rapidly.

In Georgia the area may be represented by 170 square miles.

In Alabama the area marked upon the map amounts to about 9,000 square miles.

The *Michigan basin* has an area of 6,700 square miles, with 123 feet of measures and 11 feet (maximum) of coal. In the center the coal is thickest, thinning out to nearly the thickness of paper around the edges.—(A. Winchell.)

The *Illinois basin*, including Indiana and Western Kentucky, covers an area of 47,188 square miles.

In Illinois the measures occupy 36,800 square miles, are 600 feet thick, and contain ten beds of coal, with an aggregate thickness of 35 feet.—(A. H. Worthen.)

In Indiana the measures occupy an area of 6,500 square miles, are 650 feet thick, and contain thirteen beds of coal, with an aggregate thickness of 31 feet.—(E. T. Cox.)

In Western Kentucky the measures are 612 feet thick, including the millstone grit, and carry eleven beds of coal.—(E. T. Cox.) Their area in Western Kentucky is 3,888 square miles.—(S. S. Lyon.)

The *Missouri basin* extends from Iowa to Texas.

In Iowa, Professor White's map shows an area of 18,000 square miles, which is divided into three parts, each about 200 feet thick. The two lower divisions contain the workable coal, which amounts to 8 feet in the second, but to only 20 inches in the upper. As the highest division is everywhere underlaid by the others, the whole area must be regarded as workable.

In Missouri, Prof. G. C. Swallow estimates the coal area at 27,000 square miles, and in Kansas at 17,000 square miles. The measures are 2,000 feet thick, with twenty coal-beds, from a few inches to 6 feet thick.

In Arkansas there seem to be only two beds of coal, which lie below the coal-measures proper, beneath the conglomerate.—(Lesquereux.) D. D. Owen speaks of some beds from 4 to 5 feet thick, and estimates the area occupied by productive beds at 12,000 square miles.

In the Indian Territory little is known of coal. The officers of the Missouri, Kansas and Texas Railway Company find good banks of coal at several places along their line, several feet thick. The area upon the map amounts to as much as 13,600 square miles. Since the completion of the map it has been ascertained that the coal-measures are covered by the cretaceous formation for a width of about thirty miles along the valley of the Red River in Texas and the Indian Territory; and also that the tertiary area, extending southerly from Preston, is probably of carboniferous age. These discoveries will enlarge rather than diminish the size of the Missouri basin, since the two fields are probably connected beneath the cretaceous beds.

In Texas, according to A. R. Roessler, in the "Almanac," the coal-measures occupy 6,000 square miles. A bed of coal has been reported near Fort Belknap as 4 feet thick. Estimating from Hayden's map the coal-area in Nebraska at 3,600 square miles, the total area of this great basin must be 97,200 square miles.

In Arizona, near Camp Apache, Mr. G. K. Gilbert, of the expedition under the immediate direction of Lieut. George M. Wheeler, reports a bed of coal belonging to the true carboniferous series. It is probable that future explorations may develop other coal-bearing areas in the Territories.

In this sketch no notice is taken of any coals which do not belong to the carboniferous system. Other coals of commercial importance exist, especially in Eastern Virginia, and near the Union Pacific Railway. They usually belong to the triassic or cretaceous formations, and there are lignites in the tertiary.

As I did not receive the necessary authority to publish this map, until after the present report had been transmitted to Congress, I have not had opportunity to prepare an extended discussion of the facts regarding the mineral resources of the country, and their relations to its geological structure. This subject is one of the deepest scientific and practical interest, and cannot be satisfactorily treated in a hastily-written chapter. I shall, at this time, merely make one or two general remarks as to great natural features of the country, which the map is adapted to illustrate.

The enormous extent of coal-deposits of the United States may be seen in the areas of the carboniferous formation on the map. The Rhode Island, Appalachian, Michigan, Illinois, Iowa, Kansas, Arkansas, and Texas fields are fully shown. In addition to these, we have the small triassic fields near Richmond and the vast area of coal-bearing cretaceous and tertiary strata, accompanying the Rocky Mountains from the British frontier to the borders of Mexico. In the cretaceous of the western coast in California and Oregon, we have still another source of mineral fuel, our supply of which is thus seen to be widely distributed, as well as abundant.

This map shows, also, with considerable clearness, the general geological structure of the country. There is no topography indicated in the engraving, but it is not difficult, by simple inspection of the colors, to infer the nature of the surface. The extent and trend of the leading upheavals determining the form of the continent; the Appalachian ranges on the east; the Rocky Mountains, with the Mississippi basin and the gold plains between; the vast corrugated table-land of the inland basin; the volcanic and granitic axis of the Sierra, with the enormous basaltic overflow of the northwest; the agricultural plain of California; the comparatively recent elevation of the Coast Range, are all made visible by the distribution of these colors representing different ages of rocks. The intimate relation between the geological structure and the topographical features of the country may thus be traced on a large scale, and to the initiated eye even the geological history of the country is graphically recorded.

As I have shown in a former report, the distribution of the mineral deposits and mining districts of the United States is also connected with the great features of continental structure. Thus, as was long ago pointed out by Blake, and has been more elaborately shown by Clarence King, the mineral deposits of the Pacific slope are characterized by an arrangement in parallel zones, running generally north and south. The quicksilver, chromic iron, copper ores, and coal of the cretaceous Coast Range; the gold and the auriferous slates of the west flank of the Sierra; the silver-ores of the subordinate ranges between the Sierra and the Wasatch; the galenas and carbonates of Utah and Montana; the gold of Montana, Wyoming, and Colorado, all follow more or less closely the law of distribution. East of the Rocky Mountains we have, on the other hand, a distribution in basins, rather than in zones, which has been happily described with regard to the relative positions of our coal and iron-ores in the well-known report of Mr. Abram S. Hewitt, a commissioner for the United States at the Paris Exposition. This distribution continues throughout the continental depression of the Mississippi basin, and eastward to the Appalachian formations, where the phenomenon of a zonal structure is repeated, east of the Paleozoic region. We have, extending from the Gulf of Saint Lawrence, through Vermont to Georgia, parallel series of rocks, carrying everywhere similar minerals and ore-deposits. In other words, the same great laws of folding have obtained here as on the Pacific slope, while between the two there exists a great basin, or group of basins, where the deposits lack the zonal character. The nature and causes of this distribution of our mineral deposits east and west can easily be inferred from inspection of this map, and this alone is a sufficient reason for its publication, both in reports of the census and those of mining statistics—documents, an important purpose of which is to display to our citizens and to the world the nature and extent of our resources.

CHAPTER XXI.

MISCELLANEOUS STATISTICS.

For the following statistics of the exportation of domestic gold and silver during 1872, I am indebted to the Bureau of Statistics, Treasury Department:

Amount of domestic gold and silver exported during the twelve months ended December 31, 1872.

Coin	$56,430,530
Bullion	35,864,706
Total	92,295,236

Statement of gold and silver of domestic production deposited at the mints and assay offices of the United States during the year 1872. *(Furnished by the courtesy of the Director of the Mint.)*

Gold.		Silver.	
Alabama	$910 72	Arizona	$1,141 19
Arizona	163,118 81	Colorado	300,048 99
California	7,521,369 35	California	31,825 30
Colorado	1,124,837 85	Lake Superior	392,060 24
Georgia	40,966 23	Montana	145,934 63
Idaho	1,240,489 19	Nevada	5,562,780 93
Montana	3,548,086 77	North Carolina	220 04
Nebraska	1,875 49	New Mexico	82,665 11
Nevada	4,895,855 01	Nebraska	342,463 51
Kansas	679 95	Utah	524,765 19
New Mexico	82,626 42	Parted from gold	154,044 98
Utah	38,540 43	Other sources	30,991 46
North Carolina	120,350 10		
Oregon	399,065 40		
South Carolina	2,955 06		
Virginia	1,468 23		
Washington	2,841 73		
Wyoming	11,186 44		
Parted from silver	236,543 99		
Other sources	30,074 82		
Total	19,473,841 99 7,568,941 57	Total	7,568,941 57
Aggregate	27,042,783 56		

It should be remarked, with reference to the foregoing table, that the States and Territories mentioned as the localities from which gold or silver has been received are not necessarily those in which the precious metals were mined or reduced. The parties depositing bullion for coinage give the locality sometimes of the smelting-works, sometimes of the mines. Occasionally, I believe, the officers of the mint infer, to the best of their knowledge, the locality. At all events, they are quite unable to ascertain the truth of statements made, particularly when mixed lots of bullion from various localities are deposited in the name of a single State or Territory, as a mere matter of form. Thus the silver from Nebraska may be the product of the Omaha reducing-works, or shipments made from points on the Pacific Railroad. The product of any mines in Nebraska it certainly is not. The silver credited to Lake Superior is doubtless wholly or chiefly the product of smelting-works at Wyandotte, Mich., treating mainly ores from the Silver Islet mine, which is not in the United States. The Denver branch mint, which does no coinage, received during the year $990,603.09 in gold, and $17,079.62 in silver, or, in all, $1,007,682.71. A portion of this bullion may have been re-deposited for coinage at Philadelphia, and hence it may be counted twice in the aggregates of the table. To obtain full information on this point was found impracticable, without an amount of correspondence and minute analysis of the books of the mints and assay offices, for which there was no opportunity.

The following comparative statement of the coinage at the United States branch mint, San Francisco, for 1869, 1870, 1871, and 1872, is taken from the Commercial Herald:

The coinage at the branch mint in this city for 1872, compares with that in 1869, 1870, and 1871, as follows:

	1869.	1870.	1871.	1872.
January	$467,000	$1,620,000	$1,570,000	$840,750
February	185,000	985,000	1,171,725	1,210,000
March	743,000	2,155,000	965,000	1,127,750
April	1,579,000	1,330,000	1,800,000	1,420,000
May	985,000	2,083,000	2,178,050	2,020,000
June	1,348,000	1,846,000	881,000	666,000
July	1,040,000	120,000	2,760,000	2,245,000
August	689,500	2,370,000	1,900,000	730,000
September	2,550,000	2,030,000	2,210,000	1,264,500
October	1,669,300	1,875,000	1,689,000	1,895,000
November	1,618,000	1,965,000	1,684,000	1,525,000
December	1,459,750	1,676,000	1,218,000	1,436,600
Totals	14,363,550	20,355,000	20,026,775	16,380,600

The description of coinage for the twelve months was as follows:

	1871.	1872.
Double eagles	$18,500,000	$15,600,000
Eagles	215,000	173,000
Half-eagles	115,000	202,000
Quarter-eagles	75,000	55,000
Dollars	....	9,000
Half-dollars	1,074,000	290,000
Quarter-dollars	7,725	26,250
Dimes	32,000	19,000
Half-dimes	8,050	36,350
Totals	20,026,775	16,380,600

TREASURE PRODUCT, IMPORTS, ETC.

The receipts of treasure from all sources, through Wells, Fargo & Co.'s Express, during the past twelve months, as compared with the same period in 1871, have been as follows:

	1871.	1872.
From northern and southern mines	$35,608,385	$28,000,270
Coastwise, north and south	3,245,431	2,477,978
Imports, foreign	4,108,724	8,060,412
Totals	42,962,540	38,538,660

MOVEMENT OF COIN IN THE INTERIOR.

The following has been the circulation of coin through Wells, Fargo & Co.'s Express, during 1872:

	To interior.	From interior and coastwise.
January	$1,015,300	$936,159
February	935,472	635,357
March	1,251,259	699,944
April	1,525,801	568,017
May	1,676,637	677,163
June	1,249,509	431,301
July	1,535,545	764,837

	To interior.	From interior and coastwise.
August	$2,044,643	$911,880
September	1,845,305	655,286
October	1,632,273	632,489
November	1,711,459	572,902
December	1,591,000	510,672
In 1872	18,014,203	7,996,007
In 1871	17,389,882	8,385,437
Increase	624,321	....
Decrease	....	389,430

RECEIPTS OF TREASURE.

The following tables comprise the receipts of treasure in this city, through Wells, Fargo, & Co.'s Express, during the year 1872:

From the northern and southern mines.

	Silver bullion.	Gold dust.	Coin.	Totals.
1872—January	$637,378	$1,136,459	$752,516	$2,526,353
February	1,083,408	1,138,847	539,205	2,761,460
March	458,656	1,438,603	614,388	2,511,647
April	379,780	1,440,487	498,018	2,318,285
May	368,720	1,666,974	608,400	2,644,094
June	692,502	1,501,744	360,616	2,554,862
July	267,454	1,760,855	640,821	2,669,130
August	453,357	1,384,807	835,554	2,673,718
September	866,402	1,147,603	561,570	2,575,645
October	524,698	742,028	532,584	1,799,310
November	321,148	665,862	418,748	1,405,758
December	333,221	819,566	407,221	1,560,008
Total 1872	6,386,794	14,843,835	6,769,641	28,000,270
Total 1871	14,609,809	13,872,648	7,125,928	35,608,385
Total 1870	14,152,984	17,762,131	6,487,037	38,402,152
Total 1869	(*)	(*)	11,572,594	44,045,445

* Not separated.

From the northern coast.

	Silver bullion.	Gold dust.	Coin.	Totals.
1872—January	....	$41,854	$131,602	$173,456
February	....	156,631	63,701	220,332
March	....	127,505	46,615	174,120
April	....	126,604	33,047	159,651
May	....	238,418	33,078	271,496
June	....	151,543	28,826	180,369
July	....	196,407	31,539	227,946
August	....	206,965	34,710	241,675
September	....	285,486	35,087	320,573
October	....	277,050	43,198	320,248
November	....	299,933	106,467	406,400
December	....	197,018	74,019	271,037
Total 1872	....	2,305,414	661,889	2,967,303
Total 1871	$9,785	2,552,668	708,096	3,270,549
Total 1870	....	3,380,566	532,901	3,913,467
Total 1869	(*)	(*)	300,397	2,958,458

* Not separated.

From the southern coast.

	Silver bullion.	Gold dust.	Coin.	Totals.
1872—January	....	$11,458	$52,041	$63,499
February	....	33,382	32,451	65,833
March	....	26,315	38,941	65,256
April	$44	21,544	36,952	58,540
May	....	47,773	35,685	83,458
June	....	14,583	41,859	56,442
July	1,000	19,287	92,477	112,764
August	....	43,024	41,616	84,640
September	1,400	6,830	58,629	66,859
October	....	24,592	56,707	81,299
November	....	10,895	47,687	58,582
December	1,440	14,566	29,432	45,438
Total 1872	3,884	274,249	564,477	842,610
Total 1871	5,750	347,627	551,413	904,790
Total 1870	....	399,888	844,548	1,244,436
Total 1869	(*)	(*)	227,000	2,282,571

* Not separated.

In the total receipts from the northern and southern mines for 1871 are included the amounts sent east from the Virginia office; for 1872 they are not. The following shows the comparisons for the twelve months ending December 31, 1871 and 1872:

1871.	Silver bars.
January	$638,966
February	708,885
March	611,226
April	713,450
May	826,607
June	741,467
July	604,905
August	554,711
September	542,676
October	667,179
November	723,190
December	767,516
Total	8,100,778

1872.	Silver bars.
January	$530,427
February	185,196
March	838,905
April	1,372,670
May	1,284,905
June	764,134
July	1,040,917
August	569,991
September	286,149
October	695,554
November	652,474
December	1,127,448
Total	9,348,770

The small amount sent in February, this year, is due to the snow-blockade on the railroads.

CURRENCY MOVEMENT.

The annexed table exhibits the interior and coastwise receipts, (Wells, Fargo & Co.,) imports foreign, and exports for the years 1870, 1871, and 1872:

	1870.	1871.	1872.
Interior receipts	$42, 874, 746	$38, 853, 816	$30, 478, 248
Imports, foreign	5, 466, 883	4, 108, 724	8, 060 412
Total	48, 341, 629	42, 962, 540	38, 538, 660
Exports	32, 983, 140	17, 253, 347	29, 330, 436
Currency movement	15, 358, 489	25, 709, 193	9, 208, 224

COMBINED EXPORTS.

The combined exports, treasure and merchandise, exclusive of overland railroad, during the past twelve months, as compared with the same time in 1870 and 1871, were as follows:

	1870.	1871.	1872.
Treasure exports	$32, 983, 140	$17, 253, 347	$29, 330, 436
Merchandise exports	17, 848, 160	13, 951, 149	23, 793, 530
Totals	50, 831, 300	31, 204, 496	53, 123, 966

TREASURE EXPORTS.

Our treasure exports for 1872 and the past two years, have been as follows, exclusive of shipments through United States mail:

	1870.	1871.	1872.
To New York	$13, 443, 295 02	$8, 057, 279 33	$4, 055, 565 46
To England	9, 790, 631 10	3, 184, 841 74	2, 262, 302 25
To France	190, 408 24	....	....
To China	5, 496, 856 22	3, 443, 208 72	7, 476, 862 72
To Japan	1, 383, 669 77	738, 412 67	10, 212, 949 63
To Panama	255, 497 20	115, 146 49	56, 679 82
To other countries	2, 422, 782 49	1, 714, 458 16	5, 266, 075 76
Totals	32, 983, 140 04	17, 253, 347 11	29, 330, 435 64

The comparative description of our exports of treasure by the above table was as follows:

	1870.	1871.	1872.
Gold bars	$8, 345, 549	$3, 566, 535	$11, 910, 565
Silver bars	11, 968, 477	8, 663, 944	7, 913, 391
Gold coin	9, 131, 923	3, 028, 100	7, 888, 620
Mexican dollars	3, 492, 606	1, 872, 184	1, 427, 441
Gold dust	30, 801	37, 514	37, 007
Legal tender	12, 284	....	....
Silver coin	500	85, 070	153, 412
Totals	32, 983, 140	17, 253, 347	29, 330, 436

The following table shows the value and destination of treasure-shipments from this port during the past sixteen years, from 1857 to 1872, inclusive:

Years.	Eastern ports.	England.	China.	Panama.	Other ports.	Totals.
1857	$35, 531, 778	$9, 347, 743	$2, 993, 264	$410, 929	$692, 978	$48, 976, 692
1858	35, 891, 236	9, 265, 739	1, 916, 007	299, 265	175, 779	47, 548, 026
1859	40, 146, 437	3, 910, 930	3, 100, 756	279, 949	203, 390	47, 640, 462
1860	35, 719, 296	2, 672, 936	3, 374, 680	300, 819	258, 185	42, 325, 916
1861	32, 628, 011	4, 061, 779	3, 541, 279	349, 769	95, 920	40, 676, 758
1862	26, 194, 035	12, 950, 140	2, 660, 754	434, 508	322, 324	42, 561, 761
1863	10, 389, 330	28, 467, 256	4, 206, 370	2, 503, 296	505, 667	46, 071, 920
1864	13, 316, 122	34, 436, 423	7, 888, 973	378, 795	686, 888	56, 707, 201
1865	20, 583, 390	15, 432, 639	6, 963, 522	1, 224, 845	1, 103, 832	45, 308, 227
1866	29, 244, 891	6, 532, 208	6, 527, 287	511, 550	1, 548, 457	44, 364, 393
1867	23, 355, 903	5, 841, 184	9, 031, 504	372, 752	3, 075, 149	41, 676, 722
1868	21, 468, 800	5, 212, 979	6, 193, 995	640, 000	1, 828, 621	35, 444, 395
1869	12, 459, 813	11, 841, 812	6, 487, 445	658, 182	5, 839, 865	37, 287, 117
1870	13, 443, 295	9, 790, 631	5, 496, 856	255, 497	3, 996, 861	32, 983, 140
1871	8, 057, 279	3, 184, 842	3, 443, 209	115, 146	2, 452, 871	17, 253, 347
1872	4, 055, 565	2, 262, 302	7, 476, 863	56, 680	15, 479, 026	29, 330, 436
Totals	362, 485, 181	165, 311, 543	81, 302, 764	8, 791, 782	38, 259, 813	656, 151, 083

EXPORTS OF TREASURE.

Statement of the amount of treasure exported from San Francisco, through public channels, to eastern domestic and foreign ports during the year 1872, exclusive of shipments through United States mail:

To New York.

January	$304, 960 42	
February	274, 014 61	
March	578, 040 53	
April	364, 661 09	
May	338, 241 44	
June	394, 712 06	
July	284, 001 04	
August	121, 845 94	
September	89, 385 29	
October	205, 267 01	
November	354, 685 78	
December	745, 750 25	
		$4, 055, 565 46

To England.

January	235, 746 69	
February	383, 365 89	
March	283, 130 55	
April	239, 235 55	
May	275, 997 48	
June	133, 906 66	
July	91, 647 96	
August	167, 350 65	
September	40, 845 67	
October	52, 839 43	
November	152, 680 68	
December	205, 555 04	
		2, 262, 302 25

To China.

January	428, 578 67	
February	485, 744 17	
March	778, 923 26	
April	573, 644 27	
May	692, 284 87	
June	524, 440 80	
July	379, 736 52	
August	1, 134, 049 52	
September	289, 685 84	
October	891, 548 69	
November	1, 018, 275 47	
December	279, 950 64	
		7, 476, 862 72

To Japan.

January	$637,588 99	
February	100,281 13	
March	653,887 31	
April	300,071 61	
May	1,837,657 68	
June	99,946 63	
July	1,400,707 52	
August	4,633,571 28	
September	256,581 66	
October	250,037 00	
November	42,618 82	
		$10,212,949 63

To Callao.

March	500,000 00	
April	1,000,000 00	
May	500,000 00	
June	1,000,000 00	
July	1,547,902 60	
		4,547,902 60

To Manila.

February		170,000 00

To Panama.

February	3,452 22	
March	5,000 00	
April	5,000 00	
May	15,000 00	
June	10,000 00	
November	658 72	
December	17,568 88	
		56,679 82

To Central America.

January	76,505 24	
February	86,783 00	
March	20,069 50	
April	30,000 00	
May	8,168 17	
July	15,000 00	
August	21,326 74	
September	8,720 00	
October	6,150 50	
November	3,540 00	
December	17,676 00	
		293,939 15

To Iloilo, (Philippine Islands.)

March		23,963 79

To Mexico.

June	5,000 00	
August	28,900 00	
October	15,000 00	
November	1,000 00	
December	5,000 00	
		54,900 00

To Valparaiso.

July	102,279 28	
August	50,090 94	
		152,370 22

To Honolulu.

November	20,000 00	
December	3,000 00	
		23,000 00

Total for 1872	29,330,435 64
Total for 1871	17,253,347 11
Increase this year	12,077,088 53

MINING DIVIDENDS FOR 1872.

[Compiled from San Francisco papers.]

During the year thirteen mining companies paid dividends amounting in the aggregate to $6,731,100, and distributed as follows:

Name of mining company.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Belcher	$104,000	$156,000	$156,000	$208,000	$312,000	$312,000	$312,000	$312,000	$312,000				$2,184,000
Cederberg										$12,000	$12,000	$12,000	36,000
Chollar Potosi	28,000	28,000											56,000
Crown Point	120,000	180,000	180,000	300,000	480,000	300,000	300,000						1,860,000
Eureka	20,000											20,000	40,000
Keystone Quartz		7,500	10,000	7,500			5,000						30,000
Mahogany								15,000					15,000
Meadow Valley			90,000	90,000	60,000	60,000						60,000	360,000
North Star	9,000	9,000	9,000										27,000
Pioche							20,000	20,000					40,000
Providence											3,100		3,100
Raymond & Ely	90,000		150,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	150,000	2,070,000
Yule Gravel				5,000	5,000								10,000
Total	371,000	380,500	595,000	820,500	1,067,000	882,000	847,000	557,000	522,000	222,000	225,100	242,000	6,731,100

The foregoing dividends compare as follows with the dividends paid by 18 mining companies during the previous year:

	1871.	1872.
January	$537,000	$371,000
February	587,000	380,000
March	554,500	595,000
April	517,600	820,500
May	407,550	1,067,000
June	308,300	882,000
July	363,300	847,000
August	359,300	557,000
September	344,400	522,000
October	298,000	222,000
November	280,500	225,100
December	280,500	242,000
Totals	4,837,950	6,731,100

San Francisco coal trade for 1871 *and* 1872.

[From the Commercial Herald of January 17, 1873.]

IMPORTS.

	1871. Tons.	1872. Tons.	Increase. Tons.	Decrease. Tons.
Foreign:				
Australian	38,942	115,332	76,390	......
English	54,191	29,190	......	25,001
Vancouver	15,621	26,008	10,387	......
Chili	4,164	3,682	......	482
Eastern:				
Anthracite	7,231	19,618	12,387	......
Cumberland	6,060	10,051	3,991	......
Domestic:				
Mt. Diablo	133,485	177,232	43,747	......
Coos Bay	28,690	32,562	3,872	......
Bellingham Bay	20,284	4,100	......	16,184
Seattle	4,918	14,830	9,912	......
Rocky Mountain	1,025	1,862	837	......
Total	314,611	434,467	161,523	41,667

Specified on the way from domestic Atlantic ports, December 31—

	1870.	1871.	1872.
Tons	2,464	3,679	3,799
Casks	890	885	819

We give above our imports and production for the past year in detail, with our usual biennial comparison of amounts, merely noting here that, from the receipts of 1871, we have eliminated some 583 tons from Queen Charlotte's Island and Sitka, being merely experimental shipments and not belonging to our regular sources of supply. In reviewing the operations of the year, it will be observed that the imports of foreign coal, as well as the production of our domestic varieties, have been altogether without precedent, and they seem to have shared to the fullest extent the remarkable impetus which has characterized all of our industrial and commercial pursuits during the period under review. And what perhaps is equally remarkable, prices have been maintained throughout the year with great firmness, and, indeed, all of our domestic varieties have been very materially advanced. The very heavy foreign import is doubtless due to some extent to the large fleet seeking our extraordinary grain crop, but in consequence of our increased ocean steamship service it has been mostly brought on orders, or taken to arrive at full prices, and, in view of the probable further increase in this element of our commerce, the consumption for the future must necessarily be large, and as both coal and freights have materially advanced in all parts of the world, we can scarcely look for much abatement here as to prices. As regards our domestic coals, we note also a very general increased production, Bellingham Bay being the only exception, in consequence of interruption of work at the mine for the first nine months of the year. We learn, however, that it is again in complete working order, and is sending its usual quota of coal to the market, and has considerably advanced the price. The increase of Mt. Diablo is especially noticeable, this increase alone being more than the entire production of this variety some eight years ago. And as the consumption of this coal is particularly identified with our coasting trade and inland navigation, as well as our various manufacturing pursuits, it indicates a very gratifying activity during the past year in all these branches of industry. Present price, $6.50 and $8.50 for fine and coarse, respectively. We give below our usual five year comparative statement, which will indicate at a glance the increased consumption of the several varieties:

	1868. Tons.	1869. Tons.	1870. Tons.	1871. Tons.	1872. Tons.	Totals.
Foreign	93,000	109,000	135,168	113,483	174,212	624,863
Eastern	32,700	38,600	30,820	13,291	29,669	145,080
Domestic	157,000	184,100	167,183	188,420	230,586	927,289
Total	382,700	331,700	333,171	315,194	434,467	1,697,232

As the import of foreign coals is, to a considerable extent, controlled by the course of tonnage and to some degree affects the consumption of other varieties, the comparative variations between consecutive years do not, perhaps, indicate so accurately the steady increase and average consumption as a statement of the annual consumption at given periods. We accordingly give below this consumption, at periods of five years, for the past fifteen years:

Year.	Foreign.	Eastern.	Domestic.	Total.
1858	29,071	30,753	3,755	63,579
1863	43,480	36,660	47,820	127,960
1867	63,700	62,230	124,320	250,250
1872	174,212	29,669	230,586	434,467

	Total tons increase of domestic coals.	Average annual incr'se of domestic.	Total tons increase of all kinds.	Average annual incr'se of all kinds.
1859 to 1863, inclusive	44,065	8,813	64,381	12,478
1864 to 1868, inclusive	76,500	15,300	122,290	24,458
1869 to 1872, inclusive	106,266	25,253	184,217	46,054

The sales of Coos Bay in this city from the Eastport mine during the past year were 20,000 tons. The mine is in complete order, mining 80 to 90 tons per day, but capable of turning out 200 tons every twenty-four hours with present machinery and facilities. The quality has steadily improved the farther the tunnels are extended and the deeper they go. The mine is situated (by railroad) three-quarters of a mile from the water, the grade is easy, discharging the coal directly on board vessels. Nearly the entire amount brought to market has been used for domestic purposes, being highly appreciated. The demand has been constantly in excess of the supply. The coal is of such a nature and so comes to market that it is all received from the wharf as discharged, nothing being rejected as screenings or wastage. The supply the past season was considerably curtailed by a strike of the miners, the owners prefer-ring to suspend operations until the strikers would accept their former rates of wages. The property of the company covers some 1,700 acres, and, judging from present indications, there is no limit to the supply. The deposit is very regular, with no indications of faults or dislocations in the seams, and the amount which this mine can be made to furnish is practically only dependent upon the demands of the market and the means of transporting it at remunerative rates. A steamer is now nearly completed for the purpose of bringing this coal to market, and of affording regular communication with Coos Bay, with the probability of others soon following in the same business, and with the same owners. This company has during 1872 paid regular monthly dividends of one per cent. on the par value of the capital stock. The average price of Coos Bay from ship's side during 1872 was $11; present cargo rate, $12. The supply of Seattle coal is steadily increasing, and is largely used for household purposes; present cargo price, $13 to the trade. The market for Australian, anthracite, Cumberland, and English is exceedingly quiet, and withal stocks are ample, dealers carrying more than their usual supplies, besides showing no disposition at this date to make further purchases, owing to the very considerable quantity *en route.* A cargo of Cumberland from Baltimore, per ship C. A. Farwell, has been stored.

Annual receipts of coal at San Francisco from 1860 to 1872.

Years.	Mount Diablo, tons.	Coos Bay, tons.	Bellingham Bay, tons.	Vancouver Island, tons.	Chili, tons.	Australia, tons.	English, tons.	Cumberland, tons.	Anthracite, tons.	Queen Charlotte Island, tons.	Sitka, tons.	Seattle, tons.	Rocky Mountain, tons.	Saghalien, tons.	Fuca Straits, tons.	Total tons.
1860	....	3, 145	5, 490	6, 655	1, 900	7, 850	6, 640	5, 970	39, 985	....	....	....	....	....	....	77, 635
1861	6, 620	4, 630	10, 055	6, 475	12, 495	23, 370	23, 565	2, 975	26, 060	....	....	....	....	....	....	116, 245
1862	23, 400	2, 815	10, 050	8, 870	5, 110	12, 590	16, 055	4, 970	36, 685	....	....	....	....	....	....	120, 545
1863	43, 200	1, 185	7, 750	5, 745	1, 790	16, 890	14, 660	5, 670	38, 660	....	....	....	....	....	....	135, 550
1864	50, 700	1, 200	11, 845	12, 785	2, 323	21, 160	18, 330	7, 275	41, 680	....	....	....	....	....	....	167, 298
1865	60, 530	1, 500	14, 446	18, 181	1, 410	17, 610	9, 655	4, 230	22, 585	....	....	....	....	....	....	150, 147
1866	84, 020	2, 120	11, 380	10, 852	1, 480	53, 700	7, 400	9, 524	12, 124	....	....	....	....	....	....	192, 601
1867	109, 490	5, 415	8, 899	14, 829	14, 949	26, 619	7, 302	12, 177	48, 518	....	....	....	....	218	509	248, 925
1868	132, 537	10, 524	13, 866	23, 348	8, 511	31, 590	29, 561	2, 292	29, 592	....	....	....	....	204	....	282, 025
1869	148, 722	14, 824	20, 552	14, 880	1, 114	75, 115	17, 386	11, 536	24, 844	....	....	....	....	....	....	328, 973
1870	129, 761	20, 567	14, 355	12, 640	7, 350	83, 982	31, 196	9, 322	21, 320	....	....	....	....	....	....	320, 493
1871	133, 485	28, 690	20, 284	15, 621	4, 161	38, 942	54, 191	6, 060	7, 231	565	18	4, 918	1, 025	....	....	315, 194
1872	177, 232	32, 562	4, 100	26, 008	3, 682	115, 332	29, 190	10, 051	19, 618	....	....	14, 830	1, 862	....	....	434, 467

Product of quicksilver during 1870, 1871, *and* 1872.

[From the Commercial Herald of January 17, 1873.]

	1870. Flasks.	1871. Flasks.	1872. Flasks.
New Almaden mine	14,000	18,763	17,753
New Idria mine	10,000	9,227	8,597
Redington mine	4,546	2,128	2,456
And sundry other mines	1,000	1,763	1,500
Totals	29,546	31,881	30,306

The exports to the different countries for 1872 and the three previous years were as follows:

To—	1869.	1870.	1871.	1872.
New York	1,500	1,000	800	1,202
China	11,600	4,050	7,900	4,810
Mexico	8,060	7,088	3,081	5,038
South America	2,900	1,300	2,200	1,300
Australia	300	300	1,100	643
British Columbia	4	9	6	2
Other countries	51	41	118	103
Total flasks	24,415	13,788	15,205	13,098

And our exports previously have been:

	Flasks.
In 1868	44,506
In 1867	28,853
In 1866	30,287
In 1865	42,469
In 1864	36,927
In 1863	26,014
In 1862	33,747
In 1861	35,995
In 1860	9,448
In 1859	3,399
In 1858	24,142
In 1857	27,262
In 1856	23,740
In 1855	27,165
In 1854	20,963
In 1853	12,737
In 1852	900

The price of this staple ruled uniformly high during the past year, say 85 to 87½ cents, but at this writing is advanced to 90 cents. The production varies little from that of 1871, as will be seen on reference to the tables annexed. The export value was in 1871, $836,038; and in 1872, $861,715.

SALT.

	1871.	1872.
Imports:		
Tons	6,949	2,403
Sacks	22,005	7,680
Cases	307	525
Exports:		
Tons	177	627
Bags	440	457

The market has been liberally supplied all the year past with Liverpool and other foreign. This, coupled with a local supply, has kept down prices to a rate barely covering cost and charges. At this date there is very little business doing from first hands. Holders of Liverpool firm at $23 to $24 for fine stoved; coarse at $19 to $20; California, $12 to $15; Mexican, $14 to $15; San Francisco Bay, $5 to $8 for common.

METALS.

Imports:	1871.	1872
Iron, pig, tons	5,399	13,138
Iron, bar, bars	99,147	276,693
Iron, plate, pieces	6,734	30,961
Iron, various, bundles	55,508	20,450
Iron, various, cases	1,054	1,237
Iron, various, pieces	45,502	13,042
Tin, plate, boxes	32,283	50,082
Steel, cases	1,311	1,782
Steel, bundles	5,202	8,118
Sheathing-metal, cases	132	506

The importation of lead has ceased entirely, in consequence of the production of that article here, which not only supplies the local want, but has furnished 5,000 tons for export in the year 1872. The Selby Lead and Silver Smelting Company are in operation constantly, but for only half the capacity of the works. The manufacturing of sheet-lead, pipe, and shot has been successful, supplying the whole want of the coast. But the proprietors, however, complain that this is a small market, and the demand as yet quite limited. Prices same as last year. There has been a brisk trade in bar, plate, and sheet irons: the supply equal to the demand. The amount of stock now on hand is larger than it was last year at this date. The prospects of liberal importations for the present year are very good. In regard to pig-iron the annual circular of Wm. Jeffray gives a succinct account of the year's business. The monthly quotations given below will show that the market has been of a very fluctuating character during the year. The small stock on hand at the beginning of 1872, combined with the very material advance on iron in England, caused prices to advance from $50 to $80 per ton, within a period of five months from the beginning of the year. Large shipments being made in the early part of the season, were freely bought up "to arrive" as soon as shipped, ranging from $50 to $57.50, the advance being anticipated; but when these arrivals began to come to hand, prices gradually declined. The importations have been heavy, and a large amount of scrap-iron brought into requisition in city and country, occasioning a material saving on account of the high prices of pig-iron; while few buildings have been constructed, which leaves a large excess of stock on hand at present over last year at this time. Closing price, in the absence of any important sales for some time, nominally $52.50. The following are the ruling monthly quotations for the past year:

SCOTCH SOFT.

January	$52 00 steady.
February	55 00 to 57 00
March	56 00 to 60 00
April	70 00 to 75 00
May	70 00 to 80 00
June	75 00 to 80 00
July	70 00 steady.
August	54 00 to 57 50
September	55 00 to 57 50
October	50 00 to 55 00
November	52 00 to 55 00
December	50 00 to 52 00

ENGLISH AND AMERICAN WHITE.

January	$50 00 steady.
February	55 00 steady.
March	55 00 steady.
April	60 00 steady.
May	65 00 steady.
June	65 00 steady.

July	$52 50 to $55 00
August	55 00 steady.
September	52 50 steady.
October	52 50 steady.
November	52 50 steady.
December	52 50 steady.

The stock of pig-iron on hand January 1, 1873, was 8,571 tons—7,463 tons soft, and 1,108 tons white—almost 3,000 tons in excess of the amount on hand at the same period last year. Shipments at present on the way will foot up nearly 3,000 tons, which, added to the supplies on hand, leaves little room for further shipments at present. Stock of pig-iron on hand January 1, 1872, 5,637 tons; importations of pig-iron for the year 1872, soft, 12,238 tons; white, 930 tons—13,168 tons; total, 18,805 tons. Detailed account of stock on hand January 1, 1873: In importers' hands, Scotch soft, 2,985 tons; English white, 270; American white, 190; in founderymen's and jobbers' hands, Scotch soft, 4,478 tons; English white, 548; American white, 100—8,571 tons; consumption of 1872, (white, 1,449; soft, 8,785,) 10,234 tons. The above synopsis shows the consumption of 1872 to be 2,275 tons less than 1871, and the importations of the year to be 7,669 tons in excess of 1871. We do not believe there has been any actual falling off in the iron consumption during the year, but the use of all the old scrap-iron in the State and on the coast has been very considerable, thus displacing so much pig-iron; but now the whole Pacific slope has been scoured for old scrap-iron, and the accumulations of scores of years used up, so that in the future there will be nothing to fall back upon, and the consumption of 1873 will show a large increase. The stock of tin-plate, sheet-zinc, &c., is light for the season.

GUNPOWDER.

Imports:	1871.	1872.
Eastern, kegs	37,120	32,368
Eastern, cases	3,575	4,006
Eastern, packages	830	....
California, kegs	108,388	122,954
California, cases	2,439	2,073

Exports:	1871.	1872.
Kegs	6,509	5,519
Cases	275	431

Specified on the way:

December 31.	1871.	1872.
Kegs	....	....
Packages	11,361	9,282

The competition between California and eastern blasting, &c., is continued, prices uniform at $3 per keg. The California Powder Works made, in 1872, 120,000 kegs blasting and 15,000 packages sporting. The Hazard and Dupont companies decline to make any exhibit. The Giant Powder Company report their product at 50,000 pounds monthly during 1872, making two qualities—No. 1 at $1, and No. 2 at 50 cents per pound—having a market for the same in all the States and Territories east of the great rivers, Mexico, British Columbia, and the Sandwich Islands. The business was inaugurated in 1868, and the sales have each year increased over 100 per cent. The company owns the patent-right for the whole United States, and supplies the Eastern States from its works in New Jersey.

Highest and lowest prices of mining

[From the San Fran

Name of company.	January.		February.		March.		April.		May.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Alps			$8 00	$5 25	$7 50	$5 25	$6 12½	$5 00	$5 25	$2 00
Alpha	$30 00	$14 00	53 00	2 00	40 50	29 00	240 00	42 50	170 00	40 00
Alpine					7 50	7 00				
American Flag			17 00	11 00	17 75	11 50	24 00	14 50	22 50	13 50
Arizona and Utah			6 00	3 00	5 00	2 50	12 00	3 12½	6 00	1 75
Adams Hill			4 00	3 50	4 00	2 00	5 00	3 00	4 00	2 00
Amador		287 00	327 00	303 00	280 00	280 00	300 00	300 00		
American Flat									4 00	4 00
Amazon										
Buckeye	3 50	3 00	5 00	3 25	6 25	4 00	14 50	8 50	12 00	2 00
Bacon					40 00	40 00	95 00	40 00	90 00	45 00
Baltimore					2 00	2 00	9 00	2 00	7 50	1 75
Baltimore American							9 50	6 50	12 00	2 00
Belcher	455 00	6 50	775 00	597 00	645 00	510 00	1,525 00	645 00	1,400 00	675 00
Bellevue			22 50	13 00	22 00	16 00	18 00	6 00	9 50	5 00
Bowery					19 00	8 00	15 00	12 00	12 00	3 75
Bullion							100 00	100 00	50 00	50 00
Bowers							45 00	30 00	25 00	8 00
Belmont							13 00	11 00	11 00	5 50
Best & Belcher										
Caledonia			21 00	10 00	21 00	9 00	145 00	18 00	125 00	55 00
Calaveras							6 00	5 00	5 50	5 00
Chapman					5 00	4 00	3 00	3 00		
Chollar Potosi	48 00	33 50	86 00	47 50	73 00	52 00	380 00	65 50	275 00	70 00
Crown Point	620 00	450 00	800 00	640 00	900 00	660 00	1,500 00	990 00	1,825 00	100 00
Consolidated Virginia	27 00	16 00	55 00	21 00	47 00	30 00	160 00	45 50	128 00	20 00
Confidence	15 00	15 00	40 00	40 00			185 00	70 00	205 00	70 00
Consolidated Chloride										
Consolidated Silver Wedge					1 85	80				
Central							40 00	10 00	20 00	3 75
Central No. 2									10 00	3 00
Chief of the Hill									5 00	5 00
Cook & Geyer									5 00	2 00
Condor									3 50	3 50
Consolidated Gold Hill									10 00	10 00
Cottonwood Creek Gold Mining Company							7 00	5 50	5 50	5 50
Daney	7 50	2 75	3 00	1 87½	4 00	2 00	9 75	3 25	6 50	2 50
Dardanelles							21 00	20 00	20 00	3 00
Eclipse							25 00	16 00	21 00	5 50
Eureka	23 00	17 50	21 00	16 75	23 00	15 00	18 50	16 00	20 00	15 00
Eureka Consolidated	26 75	23 00	27 50	23 00	30 00	22 37½	41 00	26 25	36 00	25 50
Empire Mill										
Exchequer			20 00	10 00	19 00	15 00	90 00	17 00	80 00	24 00
Excelsior			19 00	10 50	100 00	15 00	160 00	19 50	16 00	11 00
Flowery			103 00	86 00					3 00	3 00
Francis					5 00	5 00			5 00	2 00
Globe			5 00	3 00	5 25	2 00	14 00	3 25	7 50	1 50
Gould & Curry	140 00	107 00	350 00	113 00	250 00	164 00	560 00	245 00	510 00	90 00
Gold Hill Quartz			19 00	19 00						
General Lee			10	50	80	70	60	15	50	25
Gillis									2 50	2 50
Golden Chariot	28 00	13 50	18 00	11 50	23 00	12 00	25 00	16 00	16 50	11 00
Hale & Norcross	199 00	134 00	315 00	165 00	350 00	237 00	750 00	315 00	380 00	70 00
Hidden Treasure Consolidated										17 00
Hudson			3 25	3 25	3 75	3 50				190 00
Huhn & Hunt	19 75	14 00	18 00	13 00	5 00	1 75	2 75	1 62½	7 00	1 00
Hermes					5 00	5 00				
Highland Chief									23 00	5 00
Ida Ellmore					15 00	11 00	28 00	13 00	22 00	17 00
Imperial	72 50	40 00	130 00	57 00	156 00	85 00	480 00	162 00	425 00	200 00
Independent	3 75	3 00	15 00	3 00	10 00	6 25	7 25	3 50	3 75	11 00
Ingomar					4 25	3 25	4 00	2 50	3 00	7 00
Ivanhoe									5 00	
Jackson	1 75	1 00	1 12½	1 00	1 00	50	1 75	65	2 25	5 00
Julia	13 50	4 00	13 00	6 00	9 00	7 00	26 00	7 25	25 50	
Justice	4 75	2 00	5 00	4 00	10 50	5 00	47 50	7 00	35 00	1 00
Kentuck	205 00	143 00	280 00	190 00	295 00	220 00	610 00	270 00	700 00	2 50
Knickerbocker			3 50	2 00	2 75	2 00	16 00	2 25	14 50	1 00
Lehigh							2 87½	2 62½		18 00
Lillian Hall			2 25	1 50	1 50	1 25	1 37½	1 00	1 00	
Lady Bryan							9 00	5 00	8 00	13 00

stocks for the past twelve months.

cisco Stock Report.]

June.		July.		August.		September.		October.		November.		December.	
Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
$3 50	$3 50	$4 50	$2 50	$4 62½	$4 00	$5 00	$4 00	$6 00	$4 12½	$6 50	$3 75	$5 00	$3 50
60 00	30 00	80 00	27 00	66 00	35 00	47 50	33 00	60 00	32 50	58 00	44 00	50 00	37 00
......	......	......	......	......	......	......	......	......	......	......	......	......	......
21 00	15 00	24 25	18 25	27 50	16 00	20 00	6 50	20 00	13 12½	14 00	9 00	9 50	6 00
2 50	60	2 75	80	2 00	90	190 00	75	2 25	1 25	3 62½	1 62½	2 00	1 12½
4 00	2 50	3 50	2 75	3 00	1 75	2 25	1 25	1 50	1 25	1 25	1 00	75	50
......	......	......	......	......	......	......	......	10 12½	5 12½	......	......	......	......
......	......	......	......	1 75	1 75	......	......	......	......	......	......	......	......
......	......	3 00	3 00	......	......	......	......	......	......	......	......	......	......
4 50	2 50	4 00	3 00	3 75	1 75	2 75	2 75	3 00	2 00	2 37½	87½	3 00	2 37½
40 00	40 00	95 00	20 00	81 00	50 00	50 00	50 00	60 00	60 00	65 00	9 00	......	......
5 00	1 12½	4 00	1 75	......	......	......	......	2 75	2 75	......	......	......	......
2 00	2 00	2 50	1 25	......	......	......	......	3 75	1 87½	3 00	1 75	2 37½	1 25
1,120 00	650 00	1,100 00	108 00	132 00	100 00	114 00	85 00	118 00	75 00	119 00	93 50	107 00	81 50
4 00	2 00	3 50	2 50	7 12½	2 50	3 00	2 25	2 50	2 00	3 00	2 50	1 00	1 00
8 50	2 00	3 50	2 50	3 00	2 25	3 50	1 25	2 00	1 00	2 12½	1 75	1 75	80
......	......	......	......	......	......	......	......	......	......	......	......	......	......
9 00	2 00	14 00	6 00	16 00	13 25	......	......	15 00	14 00	......	......	......	......
7 25	4 00	8 50	6 25	7 87½	6 00	8 50	5 50	6 00	4 75	5 25	4 00	5 50	4 75
......	......	8 00	7 00	7 00	6 50	8 25	6 62½	6 50	6 00	8 12½	6 00	6 25	5 00
57 00	29 00	70 00	40 00	72 00	35 50	48 00	28 50	41 50	19 00	36 00	25 00	29 75	20 25
4 00	4 00	6 00	6 00	......	......	......	......	......	......	......	......	......	......
......	......	3 00	1 00	2 50	1 00	2 00	1 00	1 50	1 12½	2 00	1 00	1 50	75
122 00	75 00	126 00	102 00	99 00	62 00	75 50	61 00	72 00	50 00	77 00	60 00	77 00	44 00
200 00	107 00	172 00	142 00	146 00	108 00	143 00	102 00	128 00	75 00	131 00	102 00	110 00	87 00
23 00	15 00	45 00	21 00	44 00	21 00	75 00	23 50	75 00	49 00	86 00	43 00	66 00	42 00
5 00	4 50	15 00	5 50	13 50	7 75	11 00	7 25	15 00	9 25	14 00	11 25	12 75	10 00
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
5 00	......	11 00	6 00	12 00	11 00	11 00	7 50	10 00	8 00	9 00	4 00	7 00	7 00
......	......	2 25	2 00	......	......	......	......	3 00	2 00	4 25	4 00	......	......
5 50	4 00	4 25	4 00	10 00	4 87½	13 12½	6 75	11 25	7 00	7 62½	5 00	5 50	3 62½
2 00	2 00	......	......	1 00	80	50	50	......	......	......	......	10	10
3 75	2 75	6 50	3 50	3 12½	2 12½	3 50	1 50	1 75	50	1 87½	87½	1 00	50
......	......	7 50	2 50	8 75	5 00	5 00	5 00	6 50	4 50	6 25	5 00	5 00	5 00
......	......	......	......	......	......	......	......	......	......	......	......	......	......
3 25	2 00	2 75	1 75	2 75	1 50	1 62½	1 00	2 00	1 00	1 50	87½	75	50
6 00	5 00	7 00	5 00	......	......	......	......	......	......	......	......	......	......
8 00	4 12½	14 50	4 00	19 50	10 00	13 00	10 00	12 37½	9 00	11 25	9 75	10 00	9 00
17 00	16 00	17 12½	16 00	16 00	15 00	16 00	10 00	16 50	14 00	16 00	10 00	17 00	2 50
30 00	27 00	29 75	22 00	23 37½	19 00	22 50	18 00	23 00	17 00	17 00	23 00	19 00	11 75
......	......	19 25	9 00	17 62½	8 00	11 50	5 00	10 37½	6 00	10 50	8 62½	9 62½	6 50
24 00	7 50	27 00	8 00	23 00	14 00	18 00	13 00	20 25	12 50	20 25	16 00	16 50	14 00
......	......	60 00	13 00	13 00	10 00	14 00	10 00	14 00	13 00	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
2 00	2 00	......	......	......	......	......	......	......	......	......	......	......	......
3 12½	1 25	3 75	1 00	2 00	1 75	2 00	50	1 62½	25	2 12½	1 75	3 25	75
205 00	130 00	220 00	166 00	181 00	125 00	265 00	135 00	200 00	133 00	250 00	193 00	210 00	153 00
......	......	......	......	......	......	......	......	5 50	5 25	......	......	......	......
35	35	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	10	10	......	......	55	01	10	......
11 00	6 00	14 00	5 00	12 75	9 00	12 00	10 00	20 00	9 00	17 00	11 00	11 50	8 00
81 00	50 00	106 00	68 00	89 00	55 00	80 00	20 00	88 00	68 00	96 00	75 00	91 00	66 00
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
4 00	1 75	4 62½	2 50	6 75	3 12½	6 25	5 00	7 50	5 25	6 37½	2 75	3 50	1 87½
......	......	......	......	11 50	4 87½	14 50	12 50	10 00	7 25	17 00	9 00	15 50	10 00
3 00	3 00	2 75	2 75	......	......	......	......	......	......	......	......	......	......
19 50	15 00	20 00	12 50	17 00	12 50	15 50	10 50	13 00	7 00	7 75	12 00	13 75	9 00
8 50	4 00	16 50	4 62½	13 25	7 75	10 50	6 00	11 62½	5 25	12 25	9 25	10 37½	7 00
1 50	......	2 00	1 00	1 50	1 00	1 00	50	55	50	80	25	......	......
1 25	75	3 00	75	2 50	1 00	2 25	1 50	1 75	1 00	2 12½	62½	1 87½	1 00
1 00	......	......	......	......	......	3 00	1 62½	3 00	1 00	2 25	62½	1 00	01
80	75	1 00	75	85	75	70	50	70	50	53	40	40	40
9 00	5 00	8 00	6 25	6 00	4 75	6 50	5 00	7 62½	5 00	5 62½	3 25	9 75	2 00
12 00	8 00	23 00	8 25	16 50	9 00	12 00	7 00	8 25	5 00	9 75	7 00	5 37½	2 75
370 00	160 00	330 00	270 00	300 00	240 00	260 00	200 00	280 00	200 00	230 00	190 00	170 00	135 00
5 50	3 25	11 00	4 75	9 50	6 00	7 50	4 00	6 00	4 00	6 25	4 50	6 00	3 75
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	1 00	90	90	......	1 00	1 00	1 00	90	50	50
......	......	......	......	......	......	......	......	......	......	......	......	50	50

Highest and lowest price of mining stocks

Name of company.	January.		February.		March.		April.		May.	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
Mammoth	$0 55	$0 40	$0 70	$0 40	$0 80	$0 65	$1 10	$0 60	$2 25	
Mahogany	24 00	15 00	15 50	9 00	18 00	9 50	23 00	15 50	28 50	
Maxwell										$2 50
Meadow Valley	26 00	16 00	19 00	15 50	24 00	17 50	27 50	16 50	18 00	
Meadow Valley, west extension										
Mineral Hill										
Minnesota			4 25	2 50	4 25	3 00	5 75	3 50	4 75	4 00
Metropolitan Mill and Mining Company			1 37½	60						
Mount Jefferson					2 50	1 00				65
Monitor and Magnet					8 00	3 00				
Murphy							5 00	4 00	5 00	2 00
Mocking-bird			2 50	1 50	7 00	3 00	8 25	6 00		2 00
North Oro Fino										
Noonday			50	50	75	75	80	60	90	21
Nevada Butte										
New York Consolidated							12 00	10 00	10 00	
Newark							15 00	15 00	16 50	10 00
Occidental										
Ophir	65 00	37 00	125 00	53 00	98 00	35 00	140 00	69 00	123 00	49 00
Oakville Quartz Mining Company			10 50	10 00	6 00	6 00				3 12½
Original Hidden Treasure	8 75	6 25	8 00	7 00	13 00	7 75	21 50	12 00	17 00	9 50
Overman	53 00	30 00	75 00	41 00	66 00	46 00	270 00	65 00	205 00	50
Phenix	6 00	4 50	6 00	4 00	5 25	4 00	5 25	4 00	5 25	1 00
Peter Walter			4 00	3 00	6 00	6 00	3 00	3 00		75
Pioche	14 50	9 25	4 00	10 00	19 00	11 00	19 00	14 50	17 00	1 25
Pictou							3 50	3 00	2 50	2 00
Phil. Sheridan									3 50	
Peavine							1 50	1 00	1 00	
Pioche, West Extension			2 50	2 50	4 00	4 00	4 00	3 50	1 50	4 00
Page & Panaca			3 75	2 37½	2 37½	1 75	3 25	1 00	3 00	
Pauper										
Raymond & Ely	120 00	83 50	140 00	108 00	139 00	124 00	132 00	103 00	137 00	100 00
Rising Star										15 00
Rock Island							5 25	5 00	5 00	5 00
Savage	70 00	48 50	310 00	61 50	260 00	205 00	725 00	240 00	595 00	
Segregated Belcher	65 00	32 50	81 00	50 00	75 00	50 00	290 00	74 00	200 00	
Sierra Nevada	28 00	23 00	35 00	21 00	35 00	24 00	59 00	29 00	50 00	
Silver Hill			2 00	1 50	6 00	3 00	20 00	17 00	15 00	20 00
Silver Wave							3 50	3 25		2 75
Silver Vault										3 00
Silver Peak					8 00	3 00	7 50	6 75		2 00
Saint Patrick Gold Mining Company	46 00	46 00	30 00	16 00	21 00	20 00	25 00	20 00	20 00	2 00
Star Consolidated							3 50	3 00	6 00	5 00
Starlight									3 12½	3 00
Saint Lawrence									3 25	
Sigler									3 00	
Succor	5 62½	3 25	9 00	3 62½	6 25	4 62½	13 00	5 00	8 00	6 00
South Chariot			4 12½	2 25	20 00	2 25	5 25	3 50	4 50	1 50
South Eureka					25	25				7 00
South Emma										5 00
Senator									6 00	1 75
South Overman									1 75	
Spring Mount									5 00	4 00
Trench							23 00	18 00	19 00	2 50
Taylor			2 25	2 25	3 12½	3 00	3 25	2 50	1 75	
Union Mill and Mining										
Union Consolidated									6 50	2 75
Utah							14 00	8 00	10 00	5 50
Virginia			3 50	3 00	6 00	2 00				9 87½
Virtue	5 75	5 50	6 00	4 50	11 00	6 00	10 50		4 00	
Washington and Creole					7 25	5 00	7 50	5 00	6 75	5 00
War Eagle									9 00	
Ward Beecher			8 00	5 50	8 00	5 50	13 00	6 50	10 00	
Wellington					5 50	4 00	6 00	4 75	5 25	
Woodville										
Yellow Jacket										
Yule Gravel	69 50	60 00	91 00	61 00	88 00	71 00	300 00	82 50	325 00	100 00

for the past twelve months.—Continued.

June.		July.		August.		September.		October.		November.		December.	
Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
$1 75	$0 50	$2 50	$1 00	$0 50	$0 50	$0 60	$0 35	$0 35	$0 35	$0 50	$0 25	$0 60	$0 30
24 00	17 00	1 00	45	16 50	11 50	12 50	5 00	9 25	5 00	16 00	8 87½	12 00	8 00
...	...	22 00	13 00	...	...	...	...	...	...	...	...	...	...
16 00	14 50	...	...	31 00	15 75	34 75	19 25	30 00	23 25	27 50	20 00	20 00	17 00
...	...	20 00	15 00	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 50	1 25	...	...	2 00	1 00	1 25	50	1 50	87½	1 12½	50	1 75	50
...	...	2 75	2 00	...	...	...	...	...	...	...	...	...	...
1 00	1 00	...	...	...	...	...	...	...	...	...	...	...	...
...	...	1 00	1 00	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	1 00	1 00	...	...	...	...
3 00	1 00	...	...	2 12½	2 00	2 12½	1 25	...	...	...	...	15	15
...	...	3 00	2 00	...	...	...	...	...	...	...	...	...	...
...	...	3 00	3 00	...	...	21	...	25	25	35	05	60	35
...	...	20	10	...	...	...	...	...	...	...	...	...	...
3 00	1 00	...	...	2 00	1 00	1 50	1 00	1 25	90	2 50	1 00	2 00	1 50
5 00	3 00	1 37½	1 00	5 12½	7 12½	9 00	4 50	7 25	3 50	6 50	4 00	4 25	2 50
...	...	2 50	2 25	2 00	1 62½	3 00	1 50	1 50	1 50	2 50	1 37½	2 00	1 75
38 00	21 00	4 00	4 00	46 00	33 00	78 00	34 00	76 00	50 00	63 50	49 50	54 00	34 00
...	...	56 00	31 00	...	...	...	...	...	...	4 00	...	...	...
13 50	9 00	3 50	3 50	6 50	4 25	6 50	4 25	5 50	2 75	6 37½	3 00	5 00	4 00
93 00	58 00	11 00	6 25	87 50	65 00	75 00	57 00	95 00	46 00	82 50	70 00	79 00	55 00
4 50	3 87½	110 00	74 00	5 00	4 12½	4 00	3 87½	4 50	2 00	4 50	2 25	3 00	1 75
50	50	5 00	3 50	...	...	...	...	...	...	...	...	...	...
16 00	13 00	...	...	36 50	27 62½	31 50	17 50	18 00	14 00	17 00	9 00	11 00	7 00
30	25	49 50	15 50	...	...	50	...	35	20	50	35	50	25
...	...	25	25	1 12½	75	75	...	...	...	...	...	25	25
75	75	1 50	1 50	1 37½	1 12½	1 33⅓	90	1 00	50	1 25	55	1 50	65
1 00	1 00	1 50	40	2 00	1 12½	5 50	3 37½	5 25	4 25	2 00	...	1 75	1 50
2 50	2 00	1 75	1 50	2 75	2 00	3 62½	2 00	2 62½	1 87½	2 75	2 00	4 50	2 00
...	...	2 37½	1 50	2 00	2 00	2 00	2 00	3 00	1 50	...	...	...	...
139 00	114 00	158 00	134 00	175 00	148 00	181 00	151 00	160 00	128 00	145 00	91 00	109 00	73 00
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	75	50	...	...
185 00	122 00	...	...	170 00	85 00	153 00	84 00	113 00	79 00	110 00	73 00	88 00	55 00
107 00	52 00	226 00	130 00	126 00	75 00	91 00	63 00	87 00	49 00	90 00	70 00	80 00	57 50
19 00	14 00	130 00	82 00	16 37½	11 00	18 00	13 00	18 75	14 00	17 00	14 50	15 75	13 50
7 50	6 00	19 00	15 50	7 25	5 00	9 50	1 00	9 75	6 50	9 75	1 62½	8 75	7 00
...	...	9 00	6 00	...	...	50	50	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	4 00	...	6 50	5 25	7 12½	2 50	3 00	62½
10 00	5 00	...	...	...	...	12 50	12 00	...	...	5 00	...	...	...
3 00	1 25	...	...	1 37½	1 00	75	50	50	40	...	...	...	...
...	...	1 50	75	...	...	...	...	1 00	1 00	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 25	3 50	...	...	5 00	4 00	4 50	3 00	4 50	2 50	4 50	3 00	1 25	1 00
6 50	2 75	5 12½	3 75	2 50	1 25	2 00	1 62½	3 00	1 25	1 75	1 00	75	50
...	...	3 87½	3 12½	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 00	1 33⅓	...	...	4 62½	4 62½	1 62½	55	1 12½	1 00	...	...	1 25	1 00
...	...	50	50	...	...	2 00	...	...	...	1 25	55	25	25
1 00	1 00	...	...	...	...	1 75	1 25	1 75	1 50	1 50	...	50	50
6 00	5 00	2 00	2 00	22 00	12 00	12 50	10 00	12 00	12 00	...	...	...	...
...	...	18 00	8 00	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	1 00	1 00
6 50	2 50	...	...	2 75	2 75	2 25	1 50	2 50	1 50	1 00	...	...	...
3 00	50	3 00	2 50	...	...	3 00	2 25	3 50	3 00	...	...	...	...
...	...	4 00	3 00	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	5 00	4 12½	5 00	3 87½	4 37½	3 50	3 25	1 75	3 50	2 00
5 00	2 75	6 50	4 50	6 00	5 12½	7 25	6 50	7 25	5 00	4 50	2 50	1 00	1 00
7 00	6 00	8 00	7 00	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	4 50	...	...	...
4 00	2 00	...	...	3 75	3 00	3 50	3 00	5 50	3 00	8 00	5 00	6 00	4 12½
...	...	6 00	4 75	150 00	108 00	119 00	76 00	128 00	60 00	125 00	93 00	101 00	56 00
135 00	84 00	160 00	16 00	1 00	1 00	...	...	1 62½	1 66⅔	1 50	...	...	...

Quotations, dividends, and assessments upon stock dealt in at the San Francisco Stock and Exchange Board.

[From the San Francisco Stock Report of January, 1873.]

Name of company.	Bid.	Asked.	Number of assessments.	Number of feet in mine.	Total number of shares.	Total amount per share.	Dividends.	Total amount of assessments.	Amount of dividends disbursed.
CALIFORNIA MINES.									
Alpine			2	1,200	12,000	$2 50		$30,000	
Amador				1,850	3,700		33		$860,250
Bellevue			6	20,000	8,000	2 25		45,000	
Cederberg							1		12,000
Calaveras			1	3,200	20,000	50		10,000	
Cottonwood Creek					20,000				
Eureka				1,680	20,000		63		1,754,000
Francis			2		16,000	1 75		28,000	
Gillis			1		24,000	10		2,400	
Golden Eagle			1	2,375	10,000				
Independent Gold Mining Co.			2	1,800	25,000	90		22,500	
Keystone Quartz				10,000			1		5,000
Mount Auburn									
Mount Jefferson			3	1,500	25,000	65		16,750	
Norman									
Oakville Quartz Mining Co.									
Peter Walter			4	1,800	8,000	2 75		22,000	
Saint Patrick Gold Mining Co.			6	18,000	5,000	20 00		100,000	
Tecumseh			1	3,000	30,000	25		7,500	
Yule Gravel			1	400	10,000	25	9	2,500	40,000
WASHOE MINES.									
Arizona and Utah			2	1,900	18,000	1 50		27,000	
Alpha Consolidated	$0 42		5	300	6,000	22 00		132,000	
American Flat					30,000				
Bacon M. & M. Co				65	4,000				
Baltimore Consolidated			1		54,000	50		27,000	
Best & Belcher	5		8	224	22,400	5 58		124,992	
Belcher	75	$0 75½	8	1,040	104,000	6 35	8	660,400	2,591,120
Bowers									
Bullion			45	2,500	25,000	75 08		1,802,000	
Buckeye			6		16,000	6 75		108,000	
Caledonia	23½	24	3	5,000	20,000	9 00		180,000	
Central				150	10,800				
Central No. 2				100	20,000				
Chollar-Potosi	51½	52	3	2,800	28,000	16 50	39	462,600	3,080,000
Confidence	½	9	9	130	24,960	8 75	6	218,300	78,000
Consolidated Virginia	48½	50	12	1,160	23,600	11 84		279,600	
Consolidated Gold Hill Quartz			34.4	20,000					
Cook & Geyer			1	1,600	24,000	50		12,000	
Crown Point	91	92	21	600	100,000	6 28	25	623,370	3,198,000
Crown Point Ravine									
Daney	¾		4	2,000	24,000	4 00	2	96,000	56,000
Dardanelles				1,200	24,000				
Eclipse	9			70	25,000				
Empire	6½	6¾	10	75	50,000	3 85	21	192,500	713,500
Exchequer	13½		9	400	8,000	19 50		156,000	
Flowery			1	3,600	30,000				
Globe			1		20,000			20,000	
Gould & Curry	15½		15	1,200	4,800	217 00	36	1,041,600	3,826,800
Hale & Norcross	85		38	400	16,000	60 63	36	970,000	1,598,000
Imperial	7⅞	8	14	184	100,000	6 70	30	670,000	1,067,500
Insurance	3			2,600	30,000				
Jacob Little	4½								
Julia	4		12	2,000	30,000	8 37		161,200	
Justice	8		2		21,000	3 00		63,000	
Kentuck	9¾	10	7	95	2,000	65 00	32	130,000	1,252,000
Knickerbocker	4½		4	1,200	24,000	3 00		72,000	
Lady Bryan								110,000	
McMeans				3,600	36,000				
New York Consolidated	1½		2	3,600	3,600	75		27,000	
Occidental	1¾	2	5	800	10,000	16 50	1	165,000	20,000
Ophir	42	43	23	1,400	16,800	85 09	22	1,429,600	1,394,400
Overman	57½		23	1,200	12,800	78 61		1,006,288	
Phil. Sheridan				1,200	24,000				
Pictou			1	2,000	30,000				
Rock Island		½			24,000	12½		3,750	
Savage	62	62½	7	800	16,000	49 25	52	828,008	4,160,000
Segregated Belcher	62	62	14	160	6,400	33 25		212,800	
Senator	1⅛		6		24,000	75		12,000	

Quotations, dividends, and assessments upon stock, &c.—Continued.

Name of company.	Bid.	Asked.	Number of assessments.	Number of feet in mine.	Total number of shares.	Total amount per share.	Dividends.	Total amount of assessments.	Amount of dividends disbursed.
WASHOE MINES—Cont'd.									
Sierra Nevada	$0 13	$0 13½	36		20,000		11	$500,000	$102,500
Segregated Caledonia					10,000				
South Overman					24,000				
Sutro					24,000				
Silver Hill	5½				54,000				
Succor M. & M. Co	3¾		4	7,600	22,800	$5 50	2	125,400	22,800
Trench				20	5,000				
Tyler				2,200	33,000				
Union Consolidated			1	803	20,000	50		10,000	
Utah			1		20,000	1 00		20,000	
Woodville	4¼			1,400	28,000				
Yellow Jacket	64½	65	14	1,200	24,000	63 25	25	1,518,000	2,184,000
WINNEMUCCA.									
Starlight				6,900	25,000				
PHILADELPHIA.									
Belmont	5	5½							
BELMONT.									
Murphy				2,000	60,000				
WHITE PINE.									
General Lee			5	1,000	20,000	50		10,000	
Mammoth			11	1,800	36,000	1 95		70,200	
Noonday			11	1,000	20,000	2 65		53,000	
Original Hidden Treasure	6		8		21,333	12 50	1	266,662	31,999
Silver Wave			8	1,600	20,000	7 60		152,000	
Ward Beecher					24,000				
IDAHO MINES.									
Empire			1		25,000	50		25,000	
Golden Chariot	7½	7¾	6	750	10,000	35 90	9	155,000	350,000
Ida Ellmore			7		10,000	21 00	6	210,000	60,000
Mahogany			7	720	10,000	3 50		104,000	15,000
Minnesota	1		2	1,070	20,000	2 00		40,000	
North Oro Fino			8	600	10,000	50		5,000	
South Chariot	1½		3	660	20,000	2 50		50,000	
Virtue			2	2,600	20,000	2 50		50,000	
War Eagle			1	1,000	10,000	2 00		20,000	
COPE DISTRICT.									
Excelsior					12,000				
ELY DISTRICT.									
Arkansas			2	300	30,000	50		22,500	
Amelia									
American Flag	8	8¼	1		30,000	2 00		60,000	
Alps	3½	3⅝	2	800	30.000	1 75		37,500	
Bowery	1		2		30,000	1 75		52.500	
Chapman			1		30,000			15,000	
Chief of the Hill	3⅞	4			30,000				
Condor			1		25,000	1 00		25,000	
Ely Consolidated						50		16,000	
Pioche West Extension			2		35,000	60		21,000	
Harper									
Huhn & Hunt	3½	3⅝	3	3,600	30,000	1 75		52,500	
Ingomar	1	1¼	3	1,000	40,000	50			
Ivanhoe			1		30,000	50		15,000	
Jolly Traveler			2						
Kentucky			1	1,000	30,000	50		15,000	
Lehigh				1,000	30,000				
Lillian Hall			1	1,000	15,000	50			
Louise			3	2,400	30,000	63		18,995	
Meadow Valley	17½	17⅝	7		60,000	3 50	15	210,000	1,080,000
Marion					30,000				
Meadow Valley East									

Quotations, dividends, and assessments, upon stocks, &c.—Continued.

Name of company.	Bid.	Asked.	Number of assessments.	Number of feet in mine.	Total number of shares.	Total amount per share.	Dividends.	Total amount of assessments.	Amount of dividends disbursed.
Mocking-Bird				1,200	30,000				
Newark			2	800	32,000	$1 25		$40,000	
Orient				1,000	20,000				
Page & Panaca			2	2,400	40,000	1 00		40,000	
Peavine			2	1,000	30,000	50		15,000	
Pioche	$0 11¼	$0 11½	1	1,000	20,000	1 50	3	30,000	$60,000
Raymond & Ely	85	85½		5,000	30,000		20		2,685,000
Silver Peak					30,000				
Stanford									
Sterling			1		30,000	50		15,000	
Spring Mount					30,000				
Spring Mountain Tunnel			3		20,000	75		15,000	
Washington & Creole	2½	2¼	5	200	30,000	2 75		82,500	
EUREKA DISTRICT.									
Adams Hill	⅛		2		50,000	50		25,000	
Eureka Consclidated	11⅛	11¾	3		50,000		4		275,000
Jackson			3		50,000	75		37,500	
Phenix	1	1⅓	7		50,000	4 12		212,500	
Star Consolidated			2	18,000	50,000	50		25,000	
ESMERALDA.									
Juniata Consolidated				5,000	50,000				
UTAH.									
Deseret Consolidated			1	2,400	30,000	20		6,000	
Wellington			1		50,000				

ERRATA.

During the publication of this report the Commissioner was, for the greater part of the time, at too great a distance from Washington to read the proofs. The care and accuracy of foremen and proof-readers, and of Capt. C. W. Raymond, who revised the galleys and pages, have prevented the occurrence of serious errors. In some cases, however, proper names with which the revisers were unfamiliar have been printed erroneously. Thus, on page 1, Mr. Deetken, of Grass Valley, Cal., appears as "Dutken;" on page 153, Mr. Van Lennep, of Unionville, Nev., will find difficulty in recognizing himself as "Van Jamep;" and on page 155 Mr. Negus, of Star City, Nev., suffers a change into "Nequs." These correspondents, and any others who may be annoyed by such errors of the types, are begged to excuse the offense, in consideration of the difficulties of the case. It is really impossible for a printer in any doubtful case to know how a gentleman spells his name, unless he knows the gentleman. The names of mines, which are frequently whimsical in origin and in orthography, present still greater embarrassments. Less excusable is the transformation, on page 162, of "nut-pine" into "not pine."

R. W. R.

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