SELECTED EXTRACTIVE INDUSTRIES OF THE ARBUCKLE (OKLAHOMA) AREA

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Bachelor of Science

Southeastern State College

Durant, Oklahoma

1947

Submitted to the Department of Geography

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

1949

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SELECTED EXTRACTIVE INDUSTRIES OF THE ARBUCKLE (OKLAHOMA) AREA

The Arbuckle Area is rich in mineral deposits. The deposits of some minerals have been extracted for over fifty years while only recently others have proved of value.

The region possesses iron, lead, zinc, copper, silver, gold, manganese, and possibly others in limited and isolated quantities. The non-metals of the region have been developed and are more important at the present time. Rock asphalt has been quarried since 1890, limestone for cement since 1907, glass sand since 1913, and more recently dolomite to be used in the manufacture of rock wool and for flux for iron ore.

The author selected four industries: glass sand, limestone, cement, and rock asphalt. The author's experience in construction work proved quite helpful in understanding the methods and equipment used in the extractive industries.

The production data and other statistics that might prove helpful to competitors were withheld by the operators; therefore, the statistics in the paper are only estimates based upon research and personal interviews in the field.

The author wishes to express appreciation for all of the encouragement and assistance given him by all of the members of the Geography Department. Special thanks go to Professor George S. Corfield for helpful suggestions. Thanks are due to all the men engaged in the industries with whom the author had the opportunity to discuss their respective industries.

Many thanks are due the library staff of Oklahoma A. & M. College, especially the personnel in the documents room, for their very valuable assistance.

H. D. F.

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CHAPTER I

INTRODUCTION

The Arbuckle Mountains are old. They contain some of the oldest rocks of the continent, as geologists frequently correlate with the larger subdued province, the Appallachian Mountains. Today their moderate heights, the result of centuries of active weathering, serve as constant reminders of their former glory and definitely indicate that only roots of a loftier range remain; the estimated height during their youth was eight thousand feet. Geologically, the Arbuckle Mountains are old.

To these mountains Oklahoma owes much; their spring-fed streams of cool, clear water became favorite sites for rest and refreshment for the first people venturing into the region. Their prominent nature above the surrounding plains served as sign posts along trails which led further north or west. Their waters gave refreshment, their scrub forest fuel, and the snug caves safe retreats from the main travel routes. Very early the Indian grew to regard the Arbuckle as a benefactor. Fish from their streams, animal life from their slopes, and wood from their forests satisfied many of his early desires.

Some Indians continued the journey while others, attracted by the mountains, remained. The rugged area served as a favorite hunting ground and later grazing land long before the coming of the white man.

Since the advent of the white man, the area has about completed another cycle. White men plowed the shallow soil and aided erosion as long as the price of cotton would pay for the cultivation of submarginal agricultural land.

The shift in cash crops causes the area to revert back to a grazing economy, with emphasis placed on pure breeds of cattle.

The extractive industries serve as an auxilliary source of income for the area. In respect to land utilization, they require only a small per cent of the land.

Location

The Arbuckle Mountain Area is a moderately elevated plateau or table land located in the south central part of Oklahoma. The region extends from the vicinity of Boggy Depot in Atoka County in a northwestern direction across Johnson, Murray, and Carter Counties with a part extending northward in Pontotoc County near Ada. Longitudinally, they are about seventy miles long and have an average width of twenty miles.[1] The area rises gradually from seven hundred feet of the Arkansas River Valley on the northeast and increases in height to thirteen hundred and fifty feet at the western end. In reality, the Arbuckle Area is an uplift in the central lowland and is therefore completely surrounded by the interior lowland. On the south, it is bordered by the Red River Valley and on the west the Permian "Red Beds" overlap parts of the uplift.

The Arbuckle Area lies between 34°20' and 34°50' north latitude. 96°30' west longitude forms the grid boundary on the east while 97°30' forms the west margin. The area is fortunate as far as location is concerned as the base line crosses the uplift and also the Indian Meridian.

Size and Shape of Area

The shape of the Arbuckle Area is roughly triangular, with the longest side extending from northwest to southwest, a distance of approximately sixty miles. The other two sides of the triangle, approximately thirty-five miles on each side, appears as an arm extending from the southwest vertex.[2]

The Arbuckle Area reaches into four counties, but it is not much larger

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[1] J. A. Taft, "Geology of the Arbuckle and Wichita Mountains in Oklahoma and Indian Territory", Professional Paper No. 31, United States Geological Survey, (1904), p. 1.

[2] Ibid, p. 8.

than Pontotoc County, which has an area of 727 square miles.[3]

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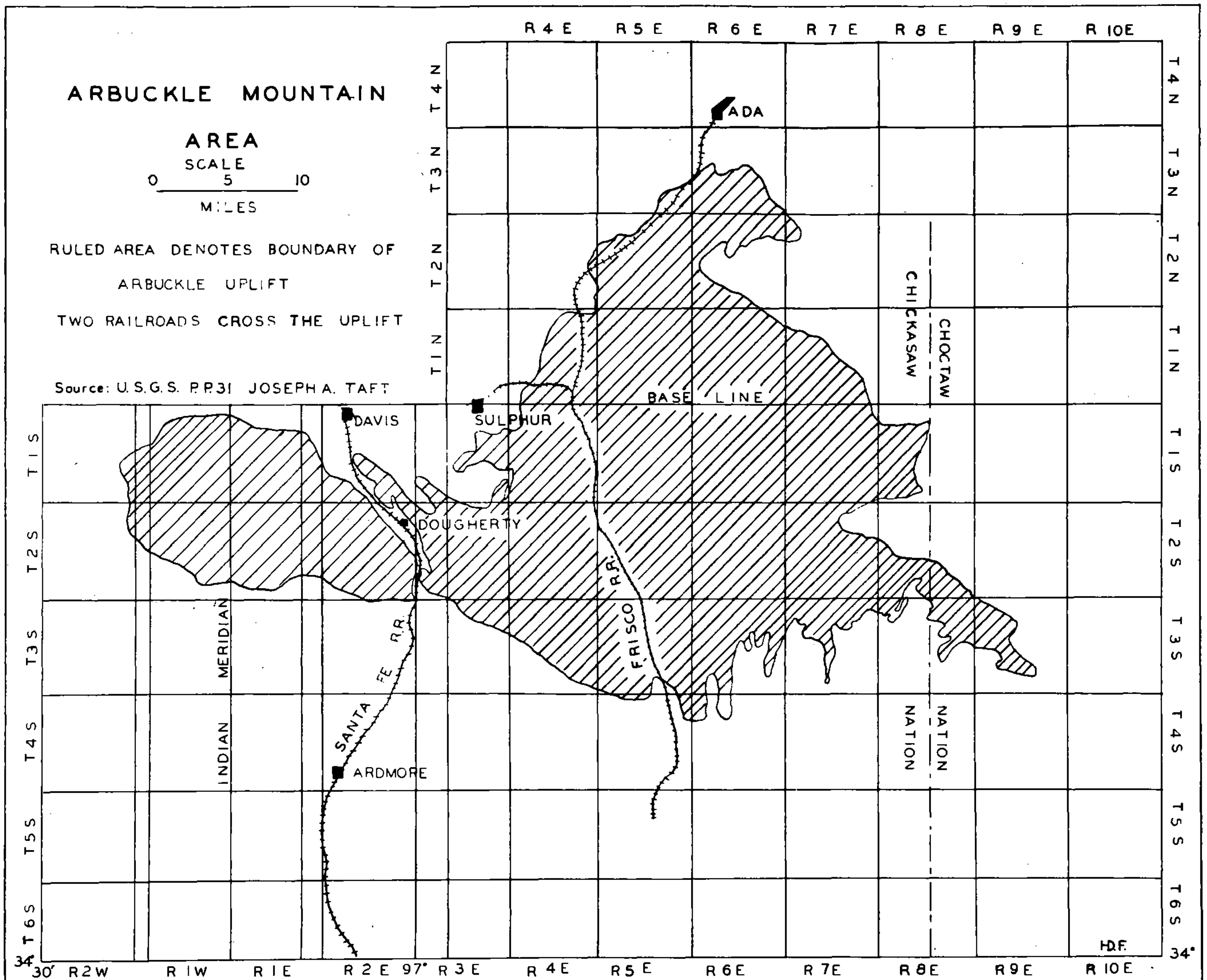
[3] E. G. Fitzpatrick et al, "Soil Survey of Pontotoc County", United States Department of Agriculture, Bureau of Plant Industry, (1941), p. 1.


ARBUCKLE MOUNTAIN
AREA
SCALE
0 5 10
MILES
RULED AREA DENOTES BOUNDARY OF
ARBUCKLE UPLIFT
TWO RAILROADS CROSS THE UPLIFT
Source: U.S.G.S. P.P.31 JOSEPH A. TAFT
ADA
DAVIS
SULPHUR
DOUGHERTY
ARDMORE
BASE LINE
SANTA FE R.R.
FRISCO R.R.
INDIAN MERIDIAN
CHICKASAW NATION
CHOCTAW NATION
R 4 E
R 5 E
R 6 E
R 7 E
R 8 E
R 9 E
R 10E
T 4 N
T 3 N
T 2 N
T 1 N
T 1 S
T 2 S
T 3 S
T 4 S
T 5 S
T 6 S
34° 30' R2W
R 1W
R 1 E
R 2 E 97° R 3 E
34°
H.D.F.

CHAPTER II

PHYSICAL FACTORS OF THE AREA

Climate[1]

The climate of the Arbuckle Area, classified as continental, receives much influence at times from the inflowing warm moist air from the Gulf of Mexico.

Temperature

The mean yearly temperature is 60°F, comparable to that of the month of April. Mean temperatures for both July and August rises to about 83°F, while the mean for January falls to approximately 42°F. Thus, all months have averages at least 10°F above freezing.

Averages do not give a clear picture of climatic conditions in the area. The temperature range for the area is great. The lowest temperature observed in the area at Sulphur was -10°F, and the highest temperature of 120°F has been recorded at Tishomingo. The skies in the region are usually clear, the average number of clear days total one hundred and eighty-two. Ninety-four were partly cloudy and eighty-nine were cloudy, but cloudy days do not affect the mining operations in the area.

Even the great range in temperatures has little effect upon the extractive industries. Possibly, the industries most affected by the climate are the rock asphalt and the glass sand industries.

The climate of the area does not hinder the production of rock asphalt as much as the climate of the market area, although similar, affects it. Rock asphalt cannot be used during cold or rainy weather. Therefore, bad weather shows a marked decrease in orders and indirectly affects production so the plants only operate around two hundred days a year due to climatic conditions.

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[1] Climatic Summary of United States, Department of Agriculture, Weather Bureau, Section 43, (1930), p. 1.

STREAM EROSION. An intrenched meander. The gorge of the Washita river at Crusher, Okla.

The climate does hinder the production of glass sand a few days a year. On days when the temperature falls below thirty-two degrees, glass sand cannot be quarried because of the use of hydraulic mining methods and also the use of water in benefication processes which freeze a few days of the year.

The rainfall averages around forty inches but is not equally distributed during the year. The monthly rainfall varies from nine in August to over thirteen inches in October, while the average yearly rainfall for a number of years is around forty inches. The yearly rainfall has varied from less than twenty-eight inches in 1939 to more than sixty inches in 1944.

The effect that rainfall has upon the extractive industries is rather complex. The increase of the water is helpful to some extent to the glass sand industry for it supplies water for their use. Excess water, however, is a detriment to the rock industries, because when their quarries fill with water, they must either fill with overburden or start working at a higher level, which reduces the height of the face. Excess water forces some operators to abandon quarries entirely.

Physiography

In Pre-Cambrian time, the region of the Arbuckle Uplift was submerged, and the Reagan Sandstone, the lowest Cambrian sediment, was laid down upon the eroded surface of the granite and porphry as a beach and off-shore deposit.[2] The Pre-Cambrian land was composed of igneous rocks, but had some relief before submergence, as is shown by the uneven deposition of the Reagan Sandstone with the igneous rocks. The area was uplifted and late Carboniferous and Cretaceous rocks, deposited across it, conceal the older rocks by unconformal overlap.

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[2] J. A. Taft, "Preliminary Report on the Geology of the Arbuckles and Wichita Mountains", Professional Paper No. 31, United States Geological Survey (1904) p. 38.

The Cretaceous strata on the southeast dips toward the northwest. Due to the processes of erosion, the older overlapping deposits are being carried away, giving a broader section across the uplift. In the Arbuckle Mountains, the rocks from the middle Cambrian, the lowest known in the region, to middle Carboniferous, which were formed previous to and were involved in the uplift, are well exposed.[3] From Cambrian time to the middle Carboniferous period, the rock beds remained practically horizontal during successive periods of sedimentation. There were probably oscillations or tremors that stirred up the sediments and gave occasion for slight erosion. Near the beginning of the Pennsylvanian or near the close of the Mississippian periods, the rocks of the Arbuckle Area were folded and the western part of the area was elevated into land, probably mountains.

The Arbuckle Uplift, despite its modest height and generally plain surface, represents an orogenic uplift of 8000 to 10,000 feet.[4] The development of the Arbuckle Uplift is similar to that of the Appalachian Mountains in the eastern part of the United States. In fact, it is believed by some geologists that they are part of the same movement.[5]

The Arbuckle Uplift includes a number of low wide anticlines and corrugated faulted synclines which together make up a broad geanticline, the borders of which are flexed down.[6] Erosion has removed the rocks down to the center of the uplift, exposing all of the sedimentary rocks as well as the Pre-Cambrian granite and porphry. Few places on the surface of the earth, where within a

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[3] Ibid, p. 33.

[4] N. M. Fenneman, Physiography of Eastern United States (1927) p. 24.

[5] C. A. Reeds, "The Arbuckle Mountains of Oklahoma", Circular No. 14, Oklahoma Geological Survey (March 1927) p. 1.

[6] Taft, op. cit., p. 38.

few miles, exhibit as many upturned and beveled-off strata as in the Arbuckle Mountains of Oklahoma.[7] Generalized and viewed as a whole, they furnish an example of an anticlinorium whose axis trends west-northwest.[8]

During and following the uplift, the mountains so far as can be observed, wore down to moderate relief. During this time, thick deposits of limestone, conglomerates from the Silurian, and Ordovician, and Cambrian rocks toward the heart of the uplift, were laid down in the bordering Carboniferous seas.[9]

Erosion progressed and, as already mentioned, during late Carboniferous time, folding and faulting occurred. Remnants of Carboniferous conglomerates appear in the present Arbuckle plateau. The Carboniferous conglomerates conceal the whole northwestern extension of the uplift. The Permian "Red Beds" rest upon this conglomerate across the extreme western end of the Arbuckle Mountains. Between the deposition of the "Red Beds" during Permian time and Cretaceous, there is no record of sedimentation and it is presumed that land conditions prevailed.

The basal formation of the lower Cretaceous lies across the southeastern side of the uplift on a nearly smooth floor composed of granite. The Cretaceous formation, slightly inclined toward the Southeast, is composed of the beach and near-shore deposits of the Cretaceous Sea, which transgressed northward probably beyond the Arbuckle Area. The nature of these deposits and the flat floor on which they rest suggest strongly that the land upon which the Cretaceous Sea advanced has been reduced to a peneplain. Regardless of the condition of the Pre-Cretaceous land, it appears that erosion reduced the rocks to a nearly flat plain. The Cretaceous sediments dip south about forty feet per

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7 Reeds, op. cit., p. 3.

8 Fenneman, op. cit., p. 624.

9 Taft, loc. cit., p. 11.

mile, and the floor underneath them nearly as much.[10] The basic Cretaceous deposits were rapidly eroded away to the south in the direction of the drainage and the dip of the strata.

After the Cretaceous sediments had been removed from the rock floors of varying hardness, on which they had been deposited, differential erosion produced the topographic forms of the Arbuckle Mountains, the parallel valleys, hills, and the etched plateau.[11]

As the soft Cretaceous rocks above the Arbuckle Uplift were removed, the streams which flowed in them without much obstruction toward the south descended and were imposed upon the hard rocks of the Cretaceous floor.[12] Mill and Pennington Creeks and Blue and Washita Rivers were imposed upon the Arbuckle Mountains. Mill and Pennington Creeks and Blue River are near the eastern end of the uplift and flow through the area where the Cretaceous material was last removed and do not flow beyond the limits of the Arbuckle Plateau.[13] The last statement is only partially right; Mill and Pennington Creeks flow into the Washita River at the southern edge of the plateau, but Blue River flows out into the Red River plain. Mill and Pennington Creeks and Blue River each has wide shallow valleys extending southward in Paleozoic and Cretaceous strata with a very little increase in grade. Washita River flows in a lower plain before reaching and after crossing the Arbuckle Mountains. The soft rocks were eroded more rapidly and the river was forced to keep pace and the river ate a deep narrow gorge across the uplift. The area is slightly dissected and the amount of relief in general is small.

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10 J. A. Taft, "Tishomingo Folio", <u>No. 98, United States Geological Survey</u> (1903) p. 5.

11 Taft, loc. cit., p. 12

12 Ibid, p. 12.

13 Ibid, p. 12

The larger streams are clearly antecedent.[14] Only two streams originate and run for any considerable distance across the formation, namely Blue River and Pennington Creek. The small streams that originate in the formation radiate in all directions. These are started by springs and fed by others until they reach one of the larger streams. The area as a whole has a dendritic stream pattern, characteristic of regions with similar physiographic history.

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[14] Charles E. Decker, "Physical Characteristics of the Arbuckle Limestone", Circular No. 5, Oklahoma Geological Survey (1928) p. 9.

CHAPTER III

ECONOMIC HISTORY OF AREA

The Arbuckle Mountain Area was included in lands originally ceded to the Choctaw Indian Nation when it was moved from Mississippi to Oklahoma about 1820. In 1837 the Chickasaws joined the Choctaws and when they separated, the Chicasaws came into control of all land between the Canadian River on the north and the Red River on the south; west of a line drawn northward from the middle fork of the Island Bayou. The Arbuckle Area was included in the land claimed by the Chickasaws. The Indians, having very little use for minerals and not agriculturally inclined, used most of the area for hunting and grazing.

Approximately sixty years ago, white men began to settle in the area. Many of the white settlers were southerners and made their living by raising cotton Naturally, they turned to this crop for a cash income. Practically all of the good pasture land was plowed up and devoted to the raising of cotton. Although the soil of the uplift is generally too shallow for farming purposes, the post war boom immediately following the first World War increased the price of cotton from forty to sixty cents per pound.

Erosion became widespread and destroyed large areas of good pasture land. The economic slump caused many farmers to lose their farms. Gradually, as a result, farmers moved out of the area and large land holdings were built up until today the surface of the land has reverted to grazing and the area as a whole has been referred to as "Hereford Heaven" because of the large number of pure breed cattle being raised there.

The minerals of the area have been exploited for about sixty years and for economic reasons the plants were located on the railroads. The Gulf Colorado and Santa Fe Railroad crossed this area on the west by 1872 and the Frisco a few years later on the eastern part.

Transportation

The transportation net of the Arbuckle Area is not as dense as in the plains area either north or south of the area. Two reasons for the lack of transportation routes include: The physiography of the area hinders road building, the area of upturned strata and deep gorges would entail the building of expensive bridges has retarded the opening of section lines. Roads in the area follow the valleys and cross the streams at fords.

Much of the land is very sparsely populated, in fact has slightly more than half the average density for the state as a whole.

The area can be crossed in the north-south direction without too much difficulty. United States Highway No. 77, the principal highway between Kansas City and Dallas, crosses the area south of Davis and affords easy access to the recreational area around Honey Creek. Turner Falls is noted over the area as a picnic and camping resort. Price's Falls east of Highway 77 serves as a Baptist encampment area and is occupied by conventions and youth camps during most of the summer months.

The area also is crossed by Oklahoma State Highway No. 18 which makes Sulphur and Platt National Park available to the rest of the state. Platt National Park is shown for its mineral waters, of which the one containing sulphur is the most odorous. There is a large public camping area and people come from all parts of the southwest to bathe in the mineral water.

Oklahoma State Highway No. 99 crosses the eastern fringe of the area and provides the people of the area as well as Tishomingo and the rest of Johnston County an all-weather route into Ada, the largest city of the area and principal trade center.

Oklahoma State Highway No. 12 connects Ada and Tishomingo through the area and provides Fitzhugh, Roff Mill Creek, and Troy an all-weather route to either Tishomingo on the south or Ada on the north.

State Highway No. 7 crosses the area in an east west direction and serves to connect the north south highways.

Trade Centers

The city of Sulphur is the only incorporated community within the limits of the uplift. There are numerous small, one and two store, villages in the area but the larger towns and the principal trade centers are located on the plains at the fringe of the uplift.

The Hearst Publications made a marketing survey and named Ada on the north and Ardmore on the south as the principal trade centers of the area. Of course groceries and small items are bought locally, usually at the village store, but automobiles and large items such as furniture and clothing are bought either by mail or in the larger towns nearby.

The trade from the Sulphur and Davis area goes to Ardmore while the Tishomingo and Highway 12 group of hamlets goes to Ada.

Recreation

The Arbuckle Area, with its up-turned strata of rocks, its clear travertine streams and beautiful colored rock formations, has long been a constant delight to the people of the nearby plains area.

The city of Davis, with the aid of United States Government, developed Turner Falls as a park and picnic area. The falls are in Honey Creek and are not very high but to the people of the plains area that are used to seeing sand choked, sluggish streams, the clear blue water cascading over the rocks is a wonderful sight to behold. Below the falls a large area has been blasted out to provide a swimming hole called the "Blue Hole"; the name applied has particular significance within the area because the blue water denoted depth.

Turner Falls Park area is free to all and is said to be one of the most beautiful areas in the entire state. It is located on United States Highway No. 77 and is easily accessible to most of the state.

Other areas along Honey Creek have been developed and serve as summer camps for both private families and different religious organizations. Possibly the largest denominational camp is located at Price's Falls. The Price's Falls encampment area belongs to the Baptist Church and is located east of Highway 77.

Platt National Park, located at Sulphur, Oklahoma, at the junction of Oklahoma Highways 18 and 7, has the distinction of being the only National Park in the southcentral part of the state.

The chief attraction of Platt National Park is mineral springs which are similar to European spas. There are thirty-one large springs within the park limits. Eighteen contain sulphur water, four iron, and three bromide, while six are fresh water. Camping facilities as well as the waters are free and each year large crowds visit the area.

Statistical Data of the Area

The Arbuckle Area comprises the greater part of three counties: Murray, Johnston, and Pontotoc. There have not been any statistics released for the Arbuckle Area alone, so any figures shown on the following chart or tables are compiled for the whole county and not just the area of the uplift.

Population

Counties	Population	Area in Sq. Miles	Density
Johnston	15,970	657	15.7
Murray	13,841	428	23.3
Pontotoc	40,093	719	38.4
Total	79,904	Total 1804	

The three counties have a small percentage of colored people.

	White	Colored
Murray	13,438	403
Johnston	15,476	484
Pontotoc	38,085	1307

The colored people are engaged in agricultural pursuits and very few work in the mining industries.

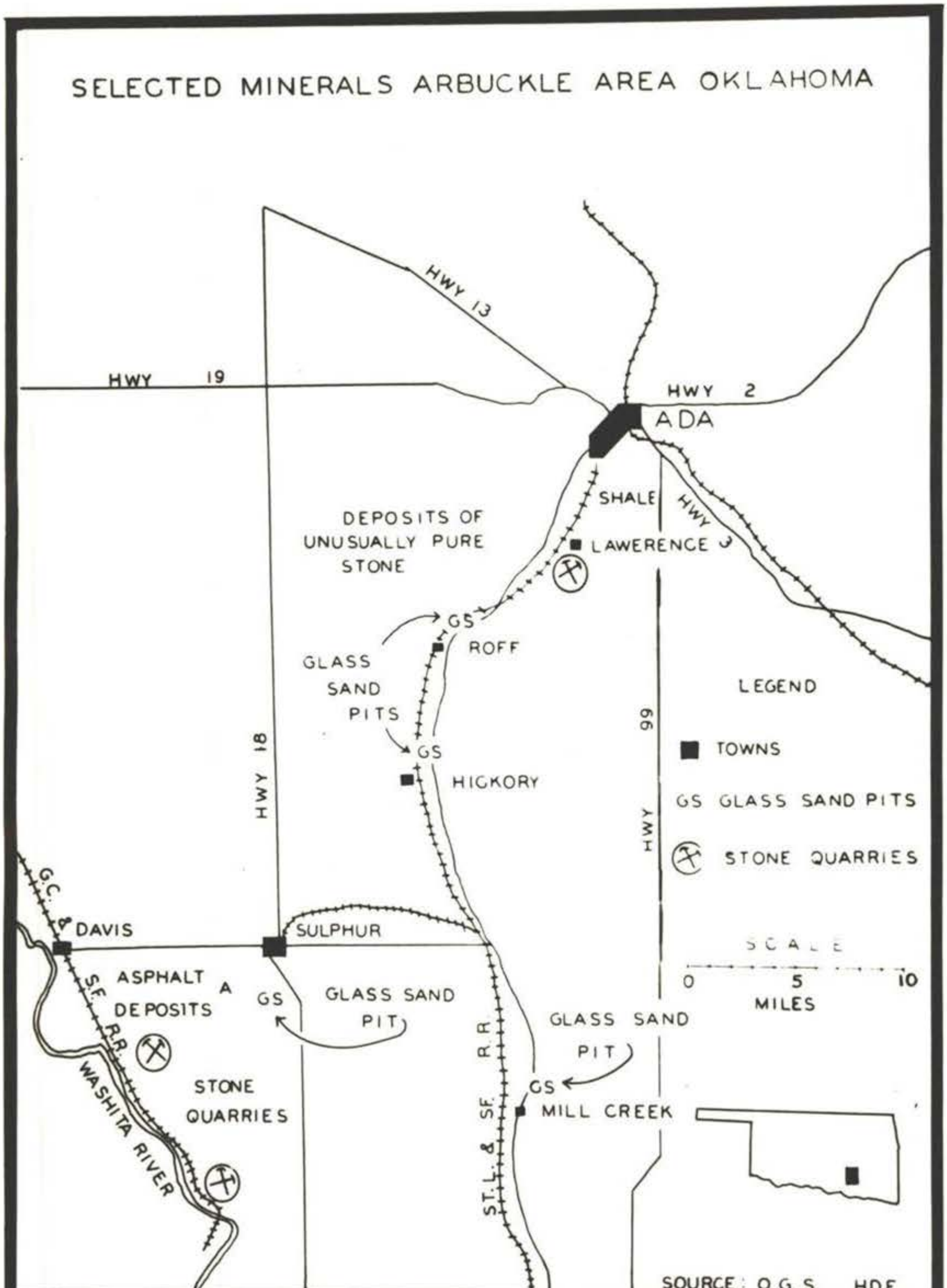
Distribution of Labor Forces

County	Agriculture	Mining	Manufacturing	Total
Pontotoc	3,196	959	1026	13,093
Murray	1,347	127	74	4,274
Johnston	2,329	(Data figures not available[1])		

Mining Industry

County	Value	Number of Workers	Wages
Pontotoc	$1,568,000	190	$304,000
Murray	559,000	159	139,000
Johnston	(Not shown)		

[1] Not shown because of disclosure of operations of individual establishments, "County Data Book", United States Bureau of Census (1940) p. 310.


SELECTED MINERALS ARBUCKLE AREA OKLAHOMA
HWY 13
HWY 19
HWY 2
ADA
SHALE
HWY 3
DEPOSITS OF UNUSUALLY PURE STONE
LAWERENCE
GS
ROFF
GLASS SAND PITS
LEGEND
HWY 99
HWY 18
GS
HICKORY
TOWNS
GS GLASS SAND PITS
STONE QUARRIES
G.C. & S.F. R.R.
DAVIS
SULPHUR
SCALE
ASPHALT A DEPOSITS
GS
GLASS SAND PIT
0 5 10
MILES
GLASS SAND PIT
ST. L. & S.F. R.R.
WASHITA RIVER
STONE QUARRIES
GS
MILL CREEK
SOURCE: O.G.S. H.D.F.

CHAPTER IV

PRODUCTION OF GLASS SAND IN ARBUCKLE AREA

Definition of Glass Sand

One of the principal mineral raw materials produced in the Arbuckle Area includes glass sand, sometimes referred to as silica sand or melting sand to distinguish it from the lower grade high iron content sand used in concrete and in connection with sand blast. Glass sand, high in silica and low in iron content, proves best for the making of glass. The amount of iron and other impurities determine the type of glass a given sand will make. The only physical property that will determine the type of glass is the size of the particles. Large grained glass sand is used in the making of optical glass while high iron content and small particle sand lends itself best to the making of containers and plate or window glass.[1]

Development of Glass Industry in Oklahoma

In order to understand the rapid development of the glass industry in Oklahoma, one must study the development in the United States as a whole to determine the important factors in the exploitation of glass sand deposits. The development of Oklahoma glass sand deposits, of which the most important and only area still producing lie in the Arbuckle Area, came about when fuel shortages appeared in the eastern part of the United States.[2]

With the decline of natural gas production in Ohio and Indiana, many glass plants moved westward to the newly-discovered oil and gas fields of southeastern Kansas. During the period 1902 to 1905, twenty plants were established

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[1] J. O. King, Superintendent of Oklahoma Silica Sand Company, Hickory, Oklahoma, Personal Interview (March 1949).

[2] W. E. Ham, "Geology and Glass Sand Resources, Central Arbuckle Mountains, Oklahoma", Oklahoma Geological Survey Bulletin 65 (1945) p. 15.

in Kansas and once across the line in Indian Territory (now Oklahoma) at Bartlesville.[3]

These above mentioned plants used sand from the St. Peter sandstone of eastern Missouri. The freight charges increased the price of the sand to approximately four times the price of the sand at the quarry. In reality the high price of sand was a minor factor but according to Burchard, "The Kansas plants were subject to sand famines, due to the fact that the producers were so far from the plants and the railroads were unable to move the material when needed."[4] The conditions that existed led Mr. Burchard to make the following statement, "Probably nowhere in the United States is there at the present (1907) a greater need for a local supply of glass sand than in southeastern Kansas."[5] The unfavorable location in regard to raw material plus the exhaustion of Kansas gas pools led to the decline of the Kansas glass industry.

The number of glass plants decreased from twenty in 1905 to five in 1919, then to two in 1927, and only one in 1929. The census listed none in 1939.[6] The few glass plants in Oklahoma would have disappeared like the ones in Kansas except for the discovery of natural gas in Oklahoma in 1904. The infant glass industry in Oklahoma rested upon two factors, namely, the abundant supply of natural gas and an available market for the finished products. The population of Oklahoma reached 1,400,000 by 1907, thereby supplied the needed market.[7]

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3 E. F. Burchard, "Notes on Various Glass Sands Mainly Undeveloped", United States Geological Survey Bulletin 315 (1907) p. 379.

4 Ibid., p. 379.

5 E. F. Burchard, "Glass Sands of Middle Mississippi Basin", United States Geological Survey Bulletin 285 (1906) p. 460.

6 Fifteenth and Sixteenth Census of United States (1930 and 1940).

7 E. E. Dale, Readings in Oklahoma History (1930) p. 643.

As the number of Kansas plants declined the number of plants in Oklahoma increased. In 1913 Oklahoma boasted six plants, two each at Tulsa and Okmulgee and one each at Bartlesville and Avant. Surprising as it may seem, the Oklahoma plants obtained raw glass sand from the same source of supply as the defunct Kansas plants but also suffered the same difficulties; namely, high priced and inadequate transportation.[8]

The need for a local supply of glass sand was realized. Mr. Frank Buttram made an investigation and published his findings in a report by the Oklahoma Geological Survey.[9] He found three areas in Oklahoma which possessed high quality glass sand; the Burgen sandstone in northeastern Oklahoma, the Trinity sand of the Red River Valley, and the Simpson Formation of the Arbuckle Area. At present, the Arbuckle Area is the only one used to any great extent.

The publication of Mr. Buttram's report, coupled with economic factors, caused a rapid increase in the number of plants in Oklahoma so by 1914 nineteen plants operated in the state. Very little is known about the size of the plants or the extent of their production.

The pioneer glass sand producer in the state was the Mid-Continent Glass Sand Company of Roff. The first carload of Oklahoma glass sand was shipped in August of 1913. The sand was of high quality and the demand increased, so additional plants were added to the area. There are now three producing plants in the area.

Methods of Discovery

The glass sand deposits of the central part of the Arbuckle Area do not outcrop very often, so the method used to discover new deposits combine both

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8 W. E. Ham, op. cit., p. 15.

9 Frank Buttram, "The Glass Sands of Oklahoma", Oklahoma Geological Survey Bulletin 10 (1910) p. 91.

geology and engineering. The geologist discovers from field trips or from areal photos probable locations, then sink pits or dig holes to determine the thickness of the deposits.

Economic Factors that Determine the Location of Plant

The following factors determine the usefulness of sand as a glass making agency: The quality of the sand claims primary importance. Sand with less than ninety-eight per cent silica or with more than three tenths of one per cent iron lessens the suitability for the making of glass products.[10] High iron content departs an objectionable color to the glass and, if the color is not desired, the sand has to be washed to remove the iron oxide. This process is called benefication. The size of the particles determine the price, as size determines the use of the glass sand. Optical glass demands large particles whereas ordinary containers and plate or window glass require sand with small particles. The degree of cementation also affects the price of the sand.[11] If the sand is highly cemented, dynamite breaks it from the face, which adds to the cost of production.

Factors that Determine the Usefulness of Sand as a Glass Making Agency

The size and shape of the particles of sand also determine the use of a given deposit. The small grain's high iron content sand is used for ordinary jobs, bottles, and low grade window glass where flaws and color are not objectionable.

Quantity

In determining the location of a glass sand quarry, quantity ranks second only to quality. A deposit should consist of a thickness of at least four feet

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10 Ham, <u>op. cit.</u>, p. 51.

11 King, <u>op. cit.</u>, Personal Interview.

and with an areal extent large enough for continuous operations, probably twenty acres. The overburden should not be excessively thick. Its removal adds to the final cost of the sand. In some cases, an overburden of twenty feet has been removed, but an overburden of less than ten feet is desirable.[12] The thickness of the deposit will determine the amount of overburden that can be removed profitably. If the height of the face becomes too great, the cost of lifting the sand may exceed the cost of the removal of additional overburden.

Location

Location is very important both to the location of units within the plant, such as nearness of the quarry to the benefication equipment, but the nearness of the deposit to existing transportation routes should receive consideration as well. The price of the sand will not warrant any excess handling and therefore the plant must be located on a railroad, or if the deposit is great enough and the price will permit, on a siding or spur one mile long from the main line. The Sulphur Silica Sand Company tried hauling their sand by truck and then loading it on the freight cars, for all the sand leaves the area by rail transportation, but evidently the cost of handling the sand twice was too great and the company no longer operates. The other three plants, located on the St. Louis and San Francisco Railroad, have sidings or spurs that permit the loading of the cars direct from the bins of the benefication plant. The benefication plants are so located that the sand is pumped directly from the pit to the plant, therefore further cutting down handling charges.

Water and Power Supply

Since the hydraulic monitor system proves the cheapest method of handling sand, a good supply of pur water is needed, both for monitoring and for the

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[12] Ham, op. cit., p. 51.

benefication of the sand. Water would present a problem in some parts of the world such as southern California, but in the Arbuckle Area, it becomes relatively unimportant because of the plentiful supply for this type of operation. If surface water is not available, wells dug into the sand deposit suffice, for it is a good aquifer.

In the early days of operation, a steam pulsometer described as a steam-driver pump lifted the sand from the sump and deposited it in the plant. Coal generating the steam served as a source of power. Now all but one of the old steam pumps have disappeared. Electricity claims first importance as motive power.

Quarrying and Benefication

All of the pits in the Arbuckle Area are sunk in level ground, the overburden is removed by scrapers or bulldozers, and the reddish clay soil finds its way into waste land or into abandoned pits. The removal of large areas of overburden at one time is practiced primarily to prevent the washing of iron oxide from the overburden into the pure sand or sump.

After the sand becomes exposed, the pits are deepened as fast as possible to increase the working face. The advantages of a deep pit include (1) a large face available for production, (2) reduced cost because the cost of removing the overburden has been met, (3) less opportunity for surface iron staining, and (4) the quality of the sand increases at lower depths.[13] Of course the deepening of the pit increases the cost of pumping, so the decision rests with the operator to determine when the cost of pumping exceeds the cost of removing overburden and sinking a new pit. Forty or fifty feet of sand can be worked profitably. One plant in the Arbuckle Area, the Millcreek Sand Company,

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[13] Ham, op. cit., p. 52.

operates a face sixty-seven feet high and pumps sand eighty-five feet vertically from the sump to the wash house.[14]

The quarry face is attacked by hydraulic methods which employ monitors that force water against the face and dislodges the sand. Usually, the pressure behind the water approximates one hundred pounds. When cementation is great, the operators must use explosives to loosen the sand. The loose sand falls into the sump or lake of water in the bottom of the pit. Then steam pulsometers or electrically-driven pumps lift it to the work house.

Benefication

Benefication lends its name to the purification of washing of glass sands. The Oklahoma glass sand, although high grade, has too much iron oxide in it for use in the natural state. The benefication process in the Arbuckle Area is relatively simple, as only washing is used in two plants. The washing removes all of the loose clay, pyrite, and limonite so that after benefication, the Oklahoma sands yield ninety-nine and eight tenths per cent silica and only three hundredths per cent iron oxide.[15]

The crude sand from the sump is passed over screens to remove large particles of limonite that in some deposits reach the size of five tenths of one inch to one inch. This limonite has a percentage of twenty eight and ninety-six hundredths per cent $F_2\ O_3$.[16] After screening, the sand goes to the wash boxes where it is kept agitated; the greater the agitation, the more impurities will be removed.

The sand from the wash boxes is taken to wet storage where draining for thirty-six to forty-eight hours takes place. The next step depends upon the

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14 H. E. Swanson, "Beneficating of Glass Sand": Rock Products, Volume 88, No. 3 (March 1945) p. 58.

15 Ibid, p. 61.

16 Ham, op. cit., p. 53.

nature of the sand shipped. If wet sand is desired, it is loaded into cars and the plant has finished its job. If dry sand is desired, the sand from the draining basins runs through rotary kilns for removal of the water.

Method of Shipment

Glass sand is shipped exclusively by rail. At one time, only cement hoppers were used but, due to car shortages and increased demand for cement hoppers to haul cement, paper-lined boxcars, and tarpaulin-covered coal cars increased carrying facilities as each car hauls approximately fifty tons. The St. Louis and San Francisco Railroad hauls all of the glass sand produced in Oklahoma, as it all is mined near their lines.

Uses and Distribution

Nearly all the glass sand from the Arbuckle Area goes into glass, although negligible amounts find use as abrasives.

The glass plants, located near natural gas supply but using Arbuckle glass sand are as follows:

Hazel-Atlas Glass Company Plants — At Ada and Blackwell

Pittsburgh Plate Glass Company — Henryetta

Ball Brothers Plant at Okmulgee and Wichita Falls, Texas

Liberty Glass Company — Sapulpa

Bartlett-Collins Glass Company — Sapulpa

George F. Collins Glass Company — Sapulpa

Kerr Glass Company — Sand Springs

Kerr-Hubbard Glass Company — Sand Springs

Hyatt Glass Company — Poteau

Corning Glass Company - Muskogee

Limiting Factors of Production

Increased freight rates and shortages of cars have reduced the area that the Arbuckle producers could supply. The purchasers became more particular about the type sand they buy. Most plants want large-grained sand and the first plant to establish a classification plant will corner the market for a short time. The Arbuckle Area cannot expect markets north or east of Oklahoma, due to favorable deposits in Arkansas and Missouri; but due to its geographical location, the area can compete with the Arkansas plants for the Texas and Mexico trade because of its shorter haul.[17] In March 1949 three cars went north to the plants in Oklahoma and one car went south to Mexico from the Arbuckle Area.[18]

Production Statistics and Prices

Between 1920-1940, annual production averaged 24,500 tons with a value of $45,541.

In 1941 shortly after the Sulphur Silica Sand Company opened its pit, production increased to 80,437 tons valued at $128,599. The price of processed sand F. O. B. plant was $1.95 per ton dry and $1.65 per ton moist in 1945. Since then, the price increased until now it stands at $2.50 per ton.[19]

In 1944 Mr. Ham of the Oklahoma Geological Survey estimated the production at 130,000 tons with a probable value of $235,000. Since production figures are not available, only estimates can be made. The author, using approximate figures obtained from the operators, attempts to show an increase in production for 1946 and 1947. It is estimated that all of the plants in the area ship 50 cars a week and each car will average 50 tons, so we can say 2500 tons at the present price of $2.50 a ton would give us the price received from one

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17 Ham, op. cit., p. 55.

18 J. O. King, Loc. cit., Personal Interview.

19 Ibid, Personal Interview.

week's production to be $6,250. For 50 weeks (a normal production year), it would be $312,500.

Future of the Industry

Nature endowed the area with minerals of such abundance that it would be useless to think of immediate conservation measures. Some study should be given to the development of the region to supply employment for the young people of the area who heretofore had to leave their birthplace in order to find work. It is estimated that Oklahoma with its Arbuckle Area has enough glass sand to supply the world for an indefinite period of time. The area has the fuel and other minerals needed in development of the industry. It is now up to the people to promote the wise use of their rich heritage.


Oklahoma Silica Sand
Hickory, Oklahoma


Sand Pit- Monitor Background
Pulsometer Foreground


Classifying Baffles
Drier in Shed


Mid-Continent Sand Company
Note Cement Hopper

CHAPTER V

ASPHALT PRODUCTION IN THE ARBUCKLE AREA

Asphalt is a residue from petroleum (crude oil). Petroleum is a mixture of carbon and hydrogen compounds, of which some are gases, some are liquids, and some are solid when separated from the other. When they are together, they are oils of different fluidity, expressed in gravity. The heavy part of the oil is called the base. The bases are one of two kinds, paraffin or asphalt. Asphalt is therefore the heavy part of one class of crude oil. The asphalts of commerce are derived in one of two ways, by natural distillation of the light oil in the strata leaving the heavy part only, or by distillation at the refineries.

Asphalt is a black non-oxidized bituminous hydro-carbon; in the natural state it may range from a semi-fluid to a solid.[1]

Development of the Industry

The history of asphalt goes back to the ancient Egyptians. Mummies have been found wrapped in cloth impregnated with asphalt. This illustrates the life of asphalt when not exposed to adverse weather conditions. Other civilizations down through the ages have used it in one or more of its various uses, but no effort will be made to give a complete history of the industry.

The main asphalt industry wasn't developed until after the coming of the automobile and the demand for hard-surfaced roads increased. Even after the demand for rock asphalt increased, the growth of the industry was retarded by untrue propaganda put out by the importers. Mr. Clifford Richardson in his book, "The Modern Asphalt Pavement", describes Oklahoma asphalt as not suitable

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[1] Ray Cross, "Handbook of Petroleum, Asphalt and Natural Gas", Kansas City Testing Laboratories Bulletin 25 (1928) p. 1.

for road building. Mr. E. G. Woodruff made this statement in 1934: "Twenty-five years ago, there was no asphalt produced at the refinery and nearly all of the asphalt used came from Trinidad."[2]

An effort was made to extract the bitumen from the rock by melting, but it was never successful in the Arbuckle Area. The first quarry operated in the area was under the control of Messieurs Ledbetter and Legrand of Ardmore Indian Territory and was opened just above water level in the banks of Rock Creek about 1890. The quarry was located about two miles west of Schley and about eight miles northeast of Dougherty, the nearest station on the Gulf Colorado and Santa Fe Railroad. The material from this quarry was used in the surfacing of streets in Ardmore.[3]

Discovery of Deposits

The discovery of deposits is not difficult because they are usually found along faults or fractures. Some geologists believe that the asphalt which is in the limestone and sandstone is the residue of petroleum which has ascended through fractures in the Viola limestone from the Wilcox sand which lies below. The Wilcox sand is the oil-bearing sand found in many of Oklahoma's oil fields. The asphalt itself is a tarry-like residue resulting from a partial decomposition of the petroleum near the earth's surface.

Factors that Determine the Location of the Plant

The quality of the material is very important. Rock asphalt is used as a binder for crushed stone. It must be sticky, not hard and brittle. Also, the bituminous content of the impregnated material should be high enough to

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[2] E. G. Woodruff, "Construction Materials of Oklahoma", Federal Emergency Relief Administration Publication (1934) p. 3.

[3] C. P. Wolcott, "Directors Report and Paper on Asphalt and Bituminous Rock Deposits", Twenty-Second Annual Report, Part One, United States Geological Survey (1901-1902) p. 273.

bind the non-impregnated materials together. The following table shows the analysis of a typical asphalt deposit of the area:

Analysis of Typical Rock Asphalt (Dougherty)

Bitumen soluble in CS_2	6.77 per cent
Specific Gravity	.99 per cent
Loss at 160 degrees centigrade (5 hours)	6.13 per cent
Fixed Carbon	6.95 per cent

Quantity

A rock asphalt plant is very expensive to build, therefore a large quantity of material should be available. The size of the plant and not the supply of material should determine the output of the plant. The Arbuckle Area possesses a very large supply. The deposits, generally estimated to contain from two to thirteen million tons, can be easily obtained.[4]

Quarrying and Processing

The limestone is quarried by ordinary methods, drilling shot holes and blasting along the face. The face is approximately one hundred feet in height and the length is steadily increasing. The stone is loaded on Ford, one and a half ton, trucks with hydraulic dump beds holding about two yards and carried to the plant. The limestone is weighed along with the sandstone and is mixed in a proportion of about sixty-five per cent limestone and thirty-five per cent sand.

The mixture is then carried to a Williams hammer mill. After the rock is crushed to the proper size and mixed well, it is blended with refiners' asphalt heated to over 200 degrees Fahrenheit.[5] The asphalt content of this mixture, though controlled, usually runs less than six per cent by weight.

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[4] W. E. Ham, "Field Trip Log (Ada District)", Oklahoma Geological Survey (1946) p. 6.

[5] Woodruff, op. cit., p. 6.

The finished composition is loaded in coal cars and hauled four miles over a company-owned railroad spur by company-owned locomotives to Dougherty. The finished composition is used for road building and surfacing over the southwest. One time the market area was much greater, but due to high freight rates and car shortages during the busy season, the market has declined and very little is sold outside of Oklahoma, New Mexico, and Kansas.[6] The company at its peak employed over four hundred men and produced thirty cars of road materials per day.[7] Each car contained fifty to seventy tons each. At the present time, the company employs about two hundred men for about seven months of the year. Inclement weather does not affect the production of the material, but it does affect the market, and as it is a low cost product, it cannot absorb excessive handling charges. The greatest production comes during the summer months, when they are handicapped because of lack of freight cars. At this time, freight cars are being used to haul winter coal to the eastern part of the United States for winter use.[8]

Production Statistics

The average wage scale is eighty-five cents an hour for semi-skilled and one dollar and thirty-five cents for skilled labor, which is above the union scale. Although the price of labor has doubled and the cost of heavy equipment has increased sixty per cent, the price of rock asphalt has only increased fifty cents per ton in the past fifteen years.[9]

Since the Southern Rock Asphalt Company is the only one of its kind in

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[6] R. D. Farmer, President Southern Rock Asphalt Company, Personal Interview (March 1949).

[7] Woodruff, op. cit., p. 8.

[8] Farmer, op. cit., Personal Interview.

[9] Ibid., Personal Interview.

the state, the Minerals Year Book, as well as the United States Census, will not divulge production figures. The value added to the area can be arrived at by the following method of projection. If the plant produces thirty cars a day and the cars average sixty tons and the plant operates twenty days per month for seven months out of the year; by multiplying the number of cars by sixty, we arrive at the number of tons produced on an average day. Multiply the number of days by the number of tons, and we arrive at the yearly production. If we then multiply by the cost per ton, we arrive at the total yearly income of the company, which approximates one million, two hundred thousand dollars.

Future of the Industry

The production of rock asphalt is declining due to reduction in orders or demand. Why has the demand decreased? Asphalt is a very sensitive index to the weather; when it is extremely hot, it will melt and will not support great loads. On the other hand, with much rain and ice, it has a tendency to flake off or work out in chug holes so that the price of maintenance is very great. The following chart shows the various annual road maintenance cost per mile for various types of roads:[10]

Annual Road Maintenance Cost Per Mile

Concrete	$ 97.18
Rock Asphalt	154.78
Brick (Concrete base)	221.58
Bituminous concrete	248.93
Bituminous Macadam	541.42
Gravel	276.74

Rock asphalt is second only to concrete as to cost of maintenance, so its use will probably continue for several years. As long as asphalt is used, the Arbuckle Area and the Southern Rock Asphalt Company will be an asset to the area. Oklahoma is one of the richest asphalt-bearing centers of the United

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10 E. B. Alderfer and H. E. Michl, Economics of American Industry (1942) p. 176.

States. The deposits are generally estimated to contain from two million to thirteen million tons of easily-obtained materials. In actual production, Oklahoma ranks first in value and second in tons of native rock asphalt produced in the United States.[11]

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[11] Ham, op. cit., p. 6.

Asphalt Face- Dark Spot
Shows Concentrated Bitumen

Southern Rock Asphalt
Crusher and Mixing Plant

CHAPTER VI

CEMENT PRODUCTION IN ARBUCKLE AREA

Portland cement may be defined as an intimate mixture of pulverized lime, alumina, and silica burned to a point where fusion begins, and the resulting clinker ground to a fine powder.[1] Many locations in the world possess deposits of limestone and shale that have all of the chemical substances needed to make Portland cement. All that is necessary is to combine the raw materials in the correct proportions.

Development of the Industry

Portland cement was first made in 1824 by Joseph Aspdin, a brick layer of Leeds, England.[2] The new cement did not receive a ready acceptance because of the amount of natural cement found in England. In the early fifties, Portland cement proved its superiority over natural cement, and caused the industry to expand rapidly.

The increase in the Portland cement industry in the United States lagged behind other countries, as the first plant was not established in America until 1872. Two reasons account for this lag: One, we had a large supply of natural cement, and second, the demand for the already proved European cement was so great that many American producers were forced to market their products under foreign brand names.[3]

The domestic production exceeded imports in 1896 and by 1900, Portland cement production exceeded natural cement. The real development of the industry began after 1900 and shortly after that the industry came to Oklahoma.

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[1] E. B. Alderfer and H. E. Michl, Economics of American Industry (1942) p. 174.

[2] Ibid, p. 174.

[3] Ibid, p. 175.

The factors which have the greatest influence upon the location of a cement plant include the relative position of raw materials and market, the quality of raw materials, and quantity, as well as the nearness to an adequate supply of fuel. Since raw materials are widespread, the primary consideration of placing a mill is given to the market.

Quality of Raw Materials

From the numerous tests and experiments made by the United States Geological Survey, it has been ascertained that raw material must be of the correct chemical composition if it is to be used for cement material.

This implies if the material used is limestone ($Ca\ CO_3$), it must contain as small a percentage as possible of magnesium carbonate ($Mg\ CO_3$) under present conditions. A maximum of five to six per cent is all that can be tolerated. Free silica in the form of sand or chert must be of a low percentage or completely absent. A percentage of less than one per cent is desired.

The Ideal Portland Cement Company of Ada uses both limestone and shale. The chemical composition of the limestone is quite stable but the chemical composition of the shale varies as shown by the following table:

Analysis of Sylvan Shale[4]

	$Si\ O_2$	$F_2\ O_3$ and $Al_2\ O_3$	$Ca\ O$	$Mg\ O$
Sample 1	42.56	17.20	12.58	6.22
Sample 2	40.84	18.84	13.80	5.22

Analysis of Viola Limestone[5]

$Si\ O_2$	$Fe_3\ O_2$	$Al_2\ O_3$	$Ca\ O$	$Mg\ O$	CO_2	Pb
42	10	.70	55.08	.28	43.11	.32

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[4] A. O. Bayless, Chief Chemist, Ideal Portland Cement Company, Ada, Personal Letter, (June 1949).

[5] Ibid.

Quantity of Raw Material

A Portland cement plant running on dry raw materials such as a mixture of limestone and shale will use approximately twenty thousand tons of raw materials a year per kiln. This amount includes fifteen thousand tons of limestone and five thousand tons of shale. Assuming that the limestone weighs one hundred and sixty pounds per cubic foot, which is a fair average weight, each kiln will require about one hundred and ninety thousand cubic feet of limestone per year. As clay and shale yield water, a cubic foot of shale will not weigh over one hundred and twenty-five pounds, so each kiln will require approximately eighty thousand cubic feet per year of clay or shale.[6]

A cement plant is very expensive and in order to justify the erection of such a plant, there should be in sight at least three million, eight hundred thousand cubic feet of limestone and one million, six hundred thousand cubic feet of shale for each kiln.[7] Although these figures may seem large, the Arbuckle Area has one hundred times as much materials resting upon the surface, in addition to other limestone and shales that could be used if the need arose. Dr. C. E. Gould estimates that Oklahoma has enough raw materials to supply the whole southwest for an indefinite period of time.[8]

Location with Respect to Fuel Supplies

The next factor of importance after the consideration of quantity and quality is location in respect to fuel supplies. This factor alone gives the Oklahoma producer a distinct advantage. Every barrel of cement (three hundred and eighty pounds) implies that at least two hundred to three hundred pounds of

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6 E. F. Eckle, "Portland Cement Resources of Indian Territory", United States Geological Survey Bulletin 243 (1905) p. 40.

7 *Ibid.*, p. 40.

8 E. F. Eckle, *op. cit.*, p. 40.

coal has been used in the power plant and the kiln.[9] Each kiln with its corresponding crusher equipment will use from six thousand to nine thousand tons of coal per year. The item of fuel cost is therefore highly important, for in in the average plant, thirty to forty per cent of the cost will be charged to coal supply. The above relationship of plant operations cost to fuel supply was in effect in 1905 but since coal is no longer used, it would be hard to estimate the relationship today since the plants use natural gas. Although, coal is no longer used either in the crusher equipment or in the kilns. The local supply of cheap fuel obtained from the Lehigh strip pits served as an important factor in the location of the present plant as well as the Choctaw Company of Hartshorne, in the early days.

Location with Regard to Market

In order for a new plant to become established in the trade, it should have a local market area, within which it may sell on a non-competitive basis and have easy access to a larger though competitive market area.[10]

In regard to the market, the cement plant at Ada was very fortunate for in 1904, when established, no other plant existed in the area and Dallas had the nearest plant in its trade territory. The impetus of statehood increased the market and the output of the plant increased steadily ever since.

Location with Respect to Transportation Routes

As Portland cement is a bulky product and low in price, transportation rates influence its value. As all Portland cement companies use rail transportation exclusively, the Ideal Company at Ada is well located. Three railroads lead out of Ada; namely, the St. Louis and San Francisco, the Missouri, Kansas

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9 E. C. Eckle, loc. cit., p. 42.

10 Ibid., p. 44.

and Texas, and the Oklahoma City, Ada, and Atoka. All of the railroads operate on a competitive basis, which helps to keep the final cost down and aids the infant industry.

Quarrying of Raw Materials

The limestone is quarried by the usual method of drilling shot holes above the face and exploding dynamite to loosen the rock. After the loosened stone falls to the bottom of the quarry, electric-powered shovels load it into electric rail cars. This quarry carries the distinction of the only one in the area which uses electricity to transport raw materials. The loaded cars, powered by thirty-five horse power direct-current electric motors, run up hill to the crusher, located approximately one hundred feet above the bottom of the quarry pit. After emptying their load, the electricity is cut off, and the cars roll back by gravity to the pit. However, to keep them from going too fast, the cars use regenerative breaking power.

The crusher which receives the load from the electric cars is a forty-eight by seventy-two inch jaw crusher. After the stone has passed through the primary crusher, it is then fed into a number nine Williams hammer mill and loaded into freight coal cars and carried to the plant at Ada by the Frisco Railroad.

Production Statistics

The present plant has produced as high as two thousand tons per day. The production per man hour averages 4.816 tons. The quarry has a very enviable safety record; they have operated 89,856 man hours without a lost time injury. This is a very remarkable record considering that in 1948 the quarry used one hundred and fifty thousand pounds of explosives, produced three hundred and thirty-seven thousand tons of limestone, and one hundred twenty-seven thousand, five hundred tons of shale, or a total of four hundred and sixty-four thousand, nine hundred tons of raw materials. Since the plant was opened in 1907, eleven million, six hundred thousand tons of stone and three million, five hundred and ten thousand tons of shale have passed through the mill.[11]

Labor Conditions

The quarry employs about forty men, most of whom have worked for the company several years. Mr. S. N. Robinson, the Assistant Superintendent and head electrician, has been with the company on the same job for twenty-nine years. The workmen belong to the United Limestone and Gypsum Workers Union and receive $1.06 to $1.25 per hour and are permitted to work at least forty hours a week. Most of the workers live in company-owned houses made of reinforced concrete. The rent on a four room semi-modern house runs from six to eleven dollars a month, even during the present housing shortage. Some families use butane but most of them depend upon coal, furnished by the company at cost. The village has one hundred per cent enrollment with the Blue Cross and Blue Shield hospitalization plan. A privately-owned store housed in a company-owned building serves the community.

Future of the Industry

The actual production of the plant is not available but Dr. E. E. Dale made this statement in 1930: "The Ada plant employs 425 men and produces six thousand barrels per day."[12]

Using Dr. Dale's figures as a check, one can estimate the quarry production into cement production and by the projection method, the 1948 production was two million, three hundred seventy-six thousand barrels, and according to

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11 S. N. Robinson, Assistant Quarry Superintendent, Ideal Portland Cement Company, Personal Interview (March 1949).

12 E. E. Dale, Reading in Oklahoma History (1930) p. 754.

Mr. Kieth Marshall, the plant is one hundred five thousand barrels behind their orders at the present time.[13] Therefore, this rapidly increasing demand assures a bright future.

13 Kieth Marshall, Secretary Ada Chamber of Commerce, Personal Interview (March 1949).

Limestone Face
Operating Equipment

Living Quarters
Crusher in Background

Transportation
Crusher to Plant

Cement Plant
Ada, Oklahoma

Ideal Cement Company's Operations, Lawrence, Oklahoma

CHAPTER VII

PRODUCTION OF CRUSHED STONE

Crushed stone is simply what the name implies. Massive deposits of stone that have been processed or crushed to a more useable size or state.

Development of the Industry

Stone deposits are not developed until the need for stone arises. Crushed stone has many uses. Some of the greatest uses are coarse aggregate in concrete, filter stone in sanitation plants, ballast for railroads, and French drains around foundation laid in marshy places, where hardness and porosity are required.

Stones have been broken and used by man since early history and, although stone is very useful, its market value is low, so no effort has been made to trace the development through historic time. The crushed stone industry depends upon the market and will never develop until a market is born.

Quarries have been in operation in the Arbuckle Area since before statehood and, as the population grew and the demand for better roads and different type buildings increased, the crushed stone industry developed also.

Factors that Determine Plant Location

It is extremely hard to determine which factor is the most important in the location of a rock crusher. Some maintain that market is the primary factor, others give quality and quantity, and still others give location in respect to transportation facilities first consideration.

Quality

The quality or characteristics of the stone depends upon the use to which it is made. Stone with definite cleavage is not desirable for the coarse aggregate of concrete but serves veneering purposes excellently. Stone with definite cleavage also is not very good for filter stone or ballast. Since the above mentioned uses are the most important, the quality or physical characteristics of crushed stone should be hard, massive, with no definite cleavage lines. Concrete is only as strong as the stone used in it. The Arbuckle limestone is tough, hard, and has great crushing strength. It has been used extensively for concrete throughout the south central part of the state.

Quantity and Market

The quantity and market will determine the size of crusher needed. The initial outlay for even a small crusher is great and therefore, a large quantity of stone should be available. Quality and quantity are not important if there is no demand for the finished product. If there is a demand for the product and the plant is located away from existing transportation agencies, the transportation could make the price of crushed stone prohibitive.

Much of the limestone of the Arbuckles, referred to as "rotten limestone", was broken during the uplift to such small pieces that it prevents its use for trimming. The quantity of limestone is inexhaustible. The most important formation in the Arbuckle Area, the "Arbuckle limestone" forms the main mass of the Arbuckle Mountains uplift, attains a thickness of 8000 feet, and covers an area of approximately 350 square miles, or 48 per cent of the total area.[1]

Quarrying

Quarrying methods in the Arbuckle Area do not differ greatly from methods used in other parts of the United States. A general discussion will be given and differences from this general method will be listed.

It is advantageous to quarry limestone from an uplift or area not having a thick overburden, for the overburden must be removed before the stone is crushed or in some cases, the stone is washed to remove clay and shale which

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1 "Operating Trends", Rock Products, Volume 49, Number 2 (February 1946) pp 98-99.

are detrimental to crushed stone used in concrete. The overburden, absent from both operating pits in the Arbuckle Area, requires no additional cost for removal.

Stone is quarried from a sixty-foot face, developed by digging into the side of a large hill adjacent to the Washita River Gorge. Absence of any overburden permits drilling of explosive shot holes from above. The holes used for explosives (six inches in diameter) are placed on fifteen-foot centers. After drilling, the holes are loaded with 60 per cent gelatin. About one hundred holes are connected electrically and shot at once. Each shot yields about 100,000 tons of limestone.

Proximity to the main line of the Santa Fe Railroad prevents the use of dynamite at the Dolese Brothers Plant. Blasting might jar the rails loose or scattered debris could fall on the tracks. Dolese Brothers built a special steam shovel that would bite into the face of the hill, thus eliminating the need for explosives. The stone is loaded into large Euclid diesel trucks accommodating 15 tons at a time and carried to the crusher.

Type of Crusher Equipment Used

There are two main types of primary crushers in use today in the area. Dolese Brothers use a rotary crusher while the Raford Company uses a thirty-two by forty inch jaw crusher. The jaw crusher is preferred now because it calls for less crushing at the face. A thirty-two by forty inch jaw crusher will crush a stone nearly that many inches large. After the rock passes through the primary crusher, it is screened and sent through several secondary crushers and re-screened after each crushing.

The Raford crusher, the most modern crusher in the area, uses a series of conveyer belts and screens to obtain stone of five different sizes. The size of the crushed stone varies from one and a half inches used in asphaltic concrete to "ag-stone" used as fertilizer. The crushed stone is moved by conveyor belts and placed in three storage bins and from which it can be loaded directly into freight cars.

Dolese Brothers use buckets to lift the stone to storage bins where it can be loaded into freight cars. Electricity furnished by Oklahoma Gas and Electric Company supplies all of the power used at both crusher plants.

Cost and Production

The Raford Plant can produce four hundred and fifty tons per hour.[2] They employ approximately thirty men. The Dolese plants possibly employ a few more and have a slightly larger production. Since the competition is great between the two plants, production figures are not available.

The price of crushed stone varies with the size. The following table gives prices in effect March 1, 1949.

Cost per Ton of Crushed Limestone F. O. B. Plant

Size	Cost
2½ inch	$1.20
1½ inch	1.20
1¼ inch	1.20
½ inch	1.40
2½ inch mesh chips	1.40
"Ag-stone"	1.40
Screenings	.65

Living Conditions

The Dolese Brothers Plant owns the houses in which the workmen live. They are white shotgun-houses in good state of repair; all but three face each other along a wide lane. The rent charged is quite reasonable, and living conditions in the village are quite good. The houses do not have running water inside, but each has running water on the back porch. The water comes from a

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2 Mr. W. E. Boyd, Superintendent Raford Stone Company, Dougherty, Oklahoma, Personal Interview.

spring which is about fourteen feet above the level of the houses.

There are twenty-five houses in the village, part of which have two rooms and the remainder three rooms. There is a two-teacher school and a Post Office in the village, but it does not boast of a store of any kind, so many supplies must be bought in surrounding towns.

The men working for the Raford Company all belong to the union and receive seventy-five to one dollar and twenty cents an hour, but they can only work forty hours per week. The employees of Dolese Brothers are not unionized and receive a slightly lower wage scale but are permitted to work as many hours as they are needed. Both companies supply the sole means of support for their workmen. Quarrying at these two plants is full time and does not necessitate or force the men to seek employment elsewhere.

Future of the Industry

The future of the industry will depend upon economic conditions outside the area. These industries have a large market area and supply most of the crushed stone used in Oklahoma City as well as the south central part of the state. The southwestern portion of the state is supplied by the Wichita Area and the southeastern part by the Dolese crusher at Bromide or the Southwest Stone Company at Stringtown, Oklahoma. The freight rate tends to disperse the plants and when rates get too high a new plant is established in the expanded market area, providing the material is available. The only expansion the Arbuckle Area crushed stone plants can expect will be growth in demand within their market area. Both plants are located on the Gulf Coast and Santa Fe Railroad and use Dougherty as the shipping center.

Other Minerals of the Arbuckle Area[3]

Iron and Manganese

Iron is present in all of the rocks of the Arbuckle Mountains, both igneous and sedimentary. The deposits are small and are considered as accessory minerals.

Manganese iron ore deposits were worked in 1891 and 1905. The pits produced 206 long tons of ore, having a value of $1,174.

Lead and Zinc

Lead and zinc appear in the Arbuckle Mountains but in very small amounts. Galena crystal was reported by the Chief Chemist of the Ideal Portland Cement Company, Ada.

Gold, Silver, and Copper

Gold, silver, and copper do not occur in the region in paying quantities but are present along the streams.

The presence of the above mentioned minerals along with the ones discussed in this report assures the Arbuckle Area of a very bright future. If the oil and gas fields on the outer boundaries of the uplift continue to produce, the Arbuckle Area may become one of Oklahoma's greatest industrial areas, because of its wealth of minerals and labor resources.

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[3] C. A. Reeds, "A Report on the Geological and Mineral Resources of the Arbuckle Mountains, Oklahoma", Oklahoma Geological Survey Bulletin Number 3 (1910) pp. 53-67.

Company Owned Village
Dolese Bros. Company

Quarrying Limestone
Raford Stone Company

Crushing Equipment- Raford Stone Company

SELECTED BIBLIOGRAPHY

A. Government Publications

United States Department of Agriculture. "Soil Survey of Pontotoc County, Oklahoma", Bureau of Plant Industry (1941).

United States Department of Agriculture, "Climatic Summary of the United States", Weather Bureau, Section 43, Washington (1930).

United States Department of Commerce, "County Data Book", Bureau of Census, Washington (1947).

United States Department of Commerce, "Census of the United States", Bureau of Census, Washington (1930 and 1940).

United States Department of Commerce, United States Census of Manufactures, United States Government Printing Office, Washington (1930 and 1940).

United States Department of Interior, "United States Geologic Atlas, Atoka Folio No. 79", United States Geological Survey (1902).

United States Department of Interior, Geologic Map of the Sulphur Asphalt Area, Murray County, Oklahoma, United States Geological Survey Oil and gas Investigations (1944).

United States Department of Interior, United States Minerals Yearbook, United States Government Printing Office, Washington (1942, 1944, 1945).

United States Department of Interior, "Notes on Various Glass Sands Mainly Undeveloped", United States Geological Survey Bulletin 315 (1906).

United States Department of Interior, "Glass Sands of United States", United States Geological Survey Bulletin 285 (1906).

United States Department of Interior, "Paper on Asphalt and Bituminous Rock Deposits", United States Geological Survey, Twenty-Second Annual Report, (1901-1902).

United States Department of Interior, "United States Geological Atlas, Tishomingo Folio, Number 98", United States Geological Survey (1903).

United States Department of Interior, "Geology of the Arbuckle and Wichita Mountains in Oklahoma and Indian Territory", United States Geological Survey, Professional Paper 31 (1904)

United States Department of Interior, "Technology and Use of Silica and Sand", United States Bureau of Mines Bulletin 269 (1927).

United States Department of Interior, "Portland Cement Resources of Indian Territory", United States Geological Survey Bulletin 243 (1905).

B. State Publications

Oklahoma Geological Survey, "Glass Sands of Oklahoma", Geological Bulletin 10, (1910).

Oklahoma Geological Survey, "Preliminary Report on Rock Asphalt, Asphaltite, Petroleum, and Natural Gas in Oklahoma", Geological Bulletin 2 (1911).

Oklahoma Geological Survey, "Portland Cement", Geological Bulletin 5 (1911).

Oklahoma Geological Survey, "A Report on Geological and Mineral Resources of the Arbuckle Mountains, Geological Bulletin 3 (1910).

Oklahoma Geological Survey, "The Arbuckle Mountains, Oklahoma", Geological Circular 14 (1927).

Oklahoma Geological Survey, "Rock Asphalts of Oklahoma and Their Use in Paving", Geological Circular 5 (1913).

Oklahoma Geological Survey, "Preliminary Report on Road Materials and Road Conditions of Oklahoma", Geological Bulletin 8 (1911).

Oklahoma Geological Survey, "Glass Sands", Geological Mineral Report 3 (1939).

Oklahoma Geological Survey, "Mineral Production of Oklahoma 1885-1940", Geological Mineral Report 13 (1942).

Oklahoma Geological Survey, "Field Trip Log, Ada District", Geological Publication (1946).

Oklahoma Geological Survey, "Geology and Glass Sands Resources, Central Arbuckle Mountains, Oklahoma", Geological Bulletin 65 (1945).

Oklahoma Geological Survey, "Geography of Oklahoma", Geological Bulletin 27, (1917).

Federal Emergency Relief Act, "Construction Materials of Oklahoma", Federal Emergency Relief Administration Publication, Oklahoma City (1934).

Kansas City Testing Laboratories, "Hand Book of Petroleum, Asphalt, and Natural Gas", Kansas City Testing Laboratories Bulletin 25 (1928).

C. Personal Interviews and Letters

Bayless, A. O., Chief Chemist, Ideal Portland Cement Company, Ada, Oklahoma, Personal Interview and Personal Correspondence.

Boyd, W. E., Superintendent, Raford Stone Company, Dougherty, Oklahoma, Personal Interviews.

King, J. O., Superintendent, Oklahoma Silica Sand Company, Hickory, Oklahoma, Personal Interview.

Robinson, S. N., Chief Electrician, Ideal Portland Cement Quarry, Lawrence, Oklahoma, Personal Interview.

Sutton, Paul, Superintendent of Quarries, Ideal Portland Cement Company, Lawrence, Oklahoma, Personal Interview.

Farmer, R. D., President, Southern Rock Asphalt Company, Sulphur, Oklahoma, Personal Interview.

D. Periodicals

Swanson, H. E., "Beneficating of Glass Sand", Rock Products Volume 48, Number 3 (March 1945).

Rockwood, Nathan C., "Oklahoma, Favored with Varied Mineral Resources", Rock Products Volume 49, Number 2 (February 1946).

E. Books

Alderfer, E. B., and Michl, H. E., Economics of American Industry, New York, McGraw Hill Book Company (1942).

Dale, E. E., Readings in Oklahoma History, Evanston, Indiana, Row Peterson and Company (1930).

Fenneman, N. M., Physiography of the Eastern United States, New York, McGraw Hill Book Company (1937).

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