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REPORT

OF A

RECONNAISSANCE OF THE YUKON RIVER,

ALASKA TERRITORY.

JULY TO SEPTEMBER, 1869.

BY CAPTAIN CHARLES W. RAYMOND,

CORPS OF ENGINEERS, U. S. ARMY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1871.

LETTER

OF

THE SECRETARY OF WAR,

TRANSMITTING

Report of engineer reconnaissance of the Yukon River, Alaska Territory, with appendix and map.

APRIL 17, 1871.—Referred to the Committee on Military Affairs and ordered to be printed.

WAR DEPARTMENT, *April* 15, 1871.

The Secretary of War has the honor to submit to the United States Senate the accompanying report of an engineer reconnaissance of the Yukon River, Alaska Territory, made under the orders of the commanding general Military Division of the Pacific, which, with the accompanying appendix and map, it is believed will be of interest to the public generally.

WM. W. BELKNAP,
Secretary of War.

LETTER OF TRANSMITTAL.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS,
New York, *April* 1, 1871.

GENERAL: I have the honor to transmit, through the Engineer Bureau, to the commanding general of the Military Division of the Pacific, the accompanying report of a reconnaissance on the Yukon River, Alaska, made during the summer of the year 1869, together with a map illustrative of the same.

The reduction of the field-notes and the construction of the map have involved considerable labor, most of which has been undertaken by myself; and as this work has been the occupation of my leisure from other duties, the delay in its completion until the present time has been unavoidable.

Mr. John J. Major, my assistant in the field, rendered valuable and zealous aid throughout the expedition. His services are indicated in the report and records.

Acknowledgment is also due to Professor George Davidson, United States Coast Survey, for kind assistance and advice in the preparation of the expedition; to Brevet Lieutenant Colonel Williamson, Corps of Engineers, Commodore Emmons, United States Navy, and Professors Hilgard and Schott, of the United States Coast Survey, for useful suggestions, and for data necessary in the reduction of field-notes; and to Messrs. William H. Dall, Frederick Whymper, and William H. Ennis, for maps and general information.

I am under obligations to Captain Riedell, superintendent of the trading-station at Redoubt St. Michael's, for a series of meteorological observations at that station; to Mr. Ferdinand Westdahl for skillful aid on several occasions in the repair of instruments, and in the observatory; and to Mr. John Clark for his generous coöperation during our return journey to the coast, mention of which will be found in the report.

To the traders of Northern Alaska, and especially to those who were my companions during our journey up the Yukon, I am indebted for ready and effective assistance on many occasions.

I would also express my sense of the courteous hospitality of Mr. John Wilson, of the Hudson Bay Company, in charge at Fort Yukon at the time of my arrival at that post.

The reduction of the astronomical field-notes has been essentially facilitated by the able and diligent assistance of Messrs. A. Faber du Faur and William C. Gunnell, to whom, as also to Mr. E. v. Diezelski for his intelligent coöperation in the construction of the accompanying map, my thanks are due.

In transmitting this report I cannot but regret that the information which it contains is in so many respects incomplete. I may, however, call attention to the fact that it is the result of a rapid reconnaissance, executed under peculiar disadvantages, and scarcely to be dignified by the title of an exploration. The circumstances of the expedition are described in detail in the report, and it is believed that they will sufficiently account for many inaccuracies and omissions.

Very respectfully, your obedient servant,

CHAS. W. RAYMOND,
Captain of Engineers.

The CHIEF OF ENGINEERS,
United States Army, Washington, D. C.

ORDERS AND INSTRUCTIONS.

[Special Orders No. 54.]

HEADQUARTERS MILITARY DIVISION OF THE PACIFIC,
San Francisco, California, April 2, 1869.

Captain C. W. Raymond, Corps of Engineers, will proceed by the first opportunity, via Sitka and Kodiak, to Fort Yukon, Alaska, and will carry out instructions given from this office. Upon completion of these duties he will return to, and report for duty at, these headquarters.

By order of Major General Halleck:

JAMES B. FRY,
Assistant Adjutant General.

Official:

W. R. SMEDBERG,
Brevet Lieutenant Colonel United States Army, A. A. A. G.

HEADQUARTERS MILITARY DIVISION OF THE PACIFIC,
San Francisco, California, April 2, 1869.

CAPTAIN: In connection with Special Orders No. 54, current series, from this office, Major General Halleck directs me to say that the main object of your visit to Alaska is, the determination of the latitude and longitude of Fort Yukon. He directs, also, that, so far as practicable, you ascertain and report upon the amount of trade carried on by the Hudson Bay Company within our territory, reporting more particularly upon the quantity of goods brought by them from British territory. He further desires all information that you can obtain in reference to the resources of the Yukon and its tributaries, and with regard to the number and disposition of the native tribes on or in its vicinity.

The general directs you to make a report upon the number and condition of the public buildings at Michaelovski.

Very respectfully, your obedient servant,

ROBERT N. SCOTT,
Brevet Lieutenant Colonel and A. A. A. G.

Captain C. W. RAYMOND,
United States Corps of Engineers, present.

INTRODUCTION.

When the transfer of the territory of Alaska to the United States was consummated, few Americans were aware that we had acquired a river which, rising far in the interior and draining a vast area, flows two thousand miles in its course to the sea. The Yukon is the largest and longest stream emptying on the western coast of the American continent, and it may well be regarded as one of the great rivers of the world.

This mighty stream, the region which it waters, and the tribes which inhabit its banks, will be the subjects of subsequent chapters. In these introductory pages I propose to give, as briefly as may be, a history of the explorations which have been made in this portion of the new Territory; to indicate the sources of information which exist concerning it; to explain the character and scope of the duty with which I have been honored; and, finally, to describe the system which has been followed in the preparation of this report.

The coast of Russian America and the islands of the Aleutian Archipelago have been well examined by both Russian and English navigators. The interior of Alaska is, however, comparatively unknown. In the year 1842 Lieutenant Zagoskin, of the Russian navy, visited, under the direction of the Russian government, the region of the Kvichpak (Yukon) River and made extensive explorations, remaining in the country about two years. He afterwards published a book (which I believe has been translated into German) containing the results of his observations. This book I have not been able to obtain, and consequently the little I have gathered concerning Lieutenant Zagoskin's explorations has been derived entirely from secondary sources. He traveled from the mouth of the river to a point a little above Nulato, the most eastern post of the Russian company, a distance from the sea of about six hundred miles. His book was almost the only authority concerning the river, until, in the year 1855, the Western Union Telegraph Company commenced explorations for an overland telegraph route, in order, by a cable crossing Behring Strait, to connect the eastern and western hemispheres. This enterprising company employed several hundred explorers on both sides of the Pacific; and their explorations in the northern section of Russian America have added greatly to our knowledge of this part of the continent.

It is said that the honor of having made the first journey from the western coast to Fort Yukon belongs to Ivan Simonsen Lukeen, an employé of the Russian company at St. Michael's, who succeeded in reaching the fort in the summer of 1863; but the information thus obtained was not made public. This journey was next made, in the summer of 1866, by Messrs. Ketchum and Labarge, of the telegraph company. Up to this time the Yukon River of the English and the Kvichpak River of the Russians had been supposed to be distinct streams; and they are represented on quite recent maps, the former emptying into the Arctic Ocean and the latter into Norton Sound. From this exploration we first learn that they are one and the same stream.

In the winter of 1866–'67, these adventurous travelers again made their way, this time on the ice, to Fort Yukon, and in the following summer pushed on to Fort Selkirk, more than four hundred miles farther up the river, and the highest point yet reached by explorers from the coast. These gentlemen have published no account of their adventures. I have, however, had the pleasure of traveling a considerable distance on the Yukon River with Mr. Michael Labarge. Since the year 1866 he has been almost constantly upon the river, and is well informed concerning its topography and the manners and customs of the native tribes which inhabit its banks. I am indebted to him for a large amount of valuable information, which I could not otherwise have obtained.

The next expedition up the river to Fort Yukon was made by Messrs. William H. Dall and Frederick Whymper, the former director of the scientific corps of the telegraph company, the latter likewise an officer of the company and an artist. In the autumn of 1866 these gentlemen crossed the portage from Unalachleet to Nulato, where they wintered, and started early in the spring of 1867 for Fort Yukon. Making their way with considerable difficulty in "baidarras," or skin-boats, they finally reached their destination in the latter part of June, after traveling almost constantly, day and night, for twenty-nine days. They remained at Fort Yukon for about two weeks, and then, reëmbarking in their light boats, started down the river. Traveling night and day, and aided by the rapid current, they arrived at St. Michael's Island after a journey of fifteen days and a half, which Mr. Whymper terms a mere holiday excursion. To this exploration we are indebted for a large amount of reliable information concerning the Yukon. In 1869 Mr. Whymper published his "Travels in Alaska and on the Yukon," which gives a pleasant account, accompanied with excellent illustrations of this and other explorations, and conveys a clear and truthful idea of the regions which it describes. After this journey, Mr. Dall remained for more than a year on the lower part of the river. He was able to collect from the Russians and English a vast amount of information, and he seems to have combined with these advantages great energy and a special fitness for the work. In 1870 he published a large volume, entitled "Alaska and its Resources," which is filled with information concerning the Territory, gathered not only from his own experiences, but from every other available source, and which will, I am confident, long remain our best authority on many points of interest regarding Alaska.

The upper portion of the river, between Fort Yukon and Fort Selkirk, has been known for many years to the traders of the Hudson Bay Company. Above the latter point the river was partially explored in 1867 by Michael Byrnes, an employé of the telegraph company. The remaining portion is only known from the reports of Indians.

In the spring of 1869 it was thought desirable that an officer should be sent to Northeastern Alaska for the purpose of ascertaining the geographical position of Fort Yukon. Having offered my services in the performance of this duty, I was ordered to report to Major General H. W. Halleck, then commanding the Military Division of the Pacific, and I received from him the order and instructions which are prefixed to this report.

In this place it seems proper that I should briefly state the circumstances which led to the expedition.

Fort Yukon, situated at the most northerly point of the Yukon River, had been for the past twenty years the extreme western trading-station of the Hudson Bay Company. It was supposed to be west of the boundary between Russian and British America, (although its position had never been definitely ascertained,) and its establishment was therefore contrary to the terms of a treaty existing between the Russian and English governments. The traders of the Russian company had, however, with one exception, never ascended the river beyond a point several hundred miles below the post, and seem to have had no disposition to object to this invasion of rights which they did not desire to enjoy. Nevertheless, this post was the occasion of great loss to the Russian company; for upon the opening of the Yukon in the spring, the enterprising and energetic Scotchmen of the station were accustomed to descend the river for some three hundred miles to a station called Nuclucayette, where they met the assembled Indian tribes, and purchased their stores of winter skins, before the tardy Russians, delayed by current and ice, could arrive at the trading-ground.

The retirement of the Russian American Company, consequent upon the transfer of the territory to the United States, inaugurated a new order of things. Immediately several American companies located small establishments upon the river and near the coast, and one company sent up the river a small party, which succeeded after great efforts in reaching a point near Nuclucayette, and wintered opposite the mouth of the great Tananá.

In the following spring, when the traders of the Hudson Bay Company paid their annual visit to Nuclucayette, their right to trade in the "Indian country" of the United States was fiercely contested, and they were informed by the Americans that any future attempt to purchase skins within our territory would be resisted, if necessary, by force.

In the spring of 1869, a new venture was projected by capitalists in San Francisco. It was proposed to transport a small steamer upon the deck of a sailing-vessel to some point near the mouth of the river, and, launching it, to ascend, if possible, as far as Fort Yukon, trading along the banks. In connection with this enterprise it was regarded as extremely desirable that the question of English right to trade in this portion of our territory should be definitely settled; and as the region in the vicinity of Fort Yukon was supposed to be peculiarly rich in furs, it was also desired that the position of this post should be officially determined, and, if it was found to be within the Territory of the United States, that measures should be taken to cause its abandonment by the English company.

The duties with which I was charged by General Halleck's letter of instructions are as follows:

1. To determine the latitude and longitude of Fort Yukon.

2. To ascertain and report upon the amount of trade carried on by the Hudson Bay Company within our territory, reporting more particularly upon the quantity of goods brought by them from British territory.

3. To obtain as much information as practicable concerning the resources of the Yukon and its tributaries, and with regard to the number and disposition of the native tribes in its vicinity.

4. To report upon the number and condition of the public buildings at Michaelovski, (Redoubt St. Michael's.)

The obstacles encountered in making the required astronomical observations, and the means by which they were fortunately overcome, will be referred to in the proper place.

The collection of general information was a matter of considerable difficulty. The Russians had retired from this part of the Territory, and the experience of the American traders was for the most part extremely limited. The chief trader was also unfortunately absent from

Fort Yukon, his place being filled by an officer but lately arrived, and consequently unable to give much information.

The measure of success which has attended my efforts to carry out my instructions will be shown by the following chapters.

In the arrangement of this report the following system has been adopted:

The report is divided into two parts and is accompanied by four appendixes.

Part I is the "General Report." It is divided into five chapters, as follows:

Chapter I. Narrative of the expedition.

Chapter II. Description of the river and adjacent country.

Chapter III. The native tribes.

Chapter IV. Trade of Hudson Bay Company—Buildings.

Chapter V. Resources of the country.

Part II contains a description of the various observations made in the field, the methods employed in their reduction, and the results obtained. It is divided into four chapters, as follows:

Chapter I. Astronomical determinations.

Chapter II. Magnetic observations.

Chapter III. Meteorological observations—Altitude of Fort Yukon.

Chapter IV. The map.

The appendixes are distinguished by the letters A, B, C, and D.

Appendix A contains a large portion of the astronomical record, and such of the computations, in a condensed form, as have been thought necessary to indicate clearly the methods followed.

Appendix B contains the entire record and reduction of magnetic observations.

Appendix C contains the meteorological record and the computation of the altitude of Fort Yukon.

Appendix D contains a table of distances on the Yukon River.

A map of the Yukon River, from Fort Yukon to the sea, accompanies this report.

PART I.

GENERAL REPORT.

GENERAL REPORT.

CHAPTER I.

NARRATIVE OF THE EXPEDITION.

On the 6th day of April, 1869, accompanied by Mr. John J. Major, my assistant, I sailed from the harbor of San Francisco, on the brig Commodore, bound for the port of Sitka. This vessel was to transport the employés and supplies of a new trading company to St. Michael's Island, in Norton Sound, and she carried upon her deck a small stern-wheel steamer, about fifty feet in length, entitled the Yukon, which was to attempt the ascent of the great Kvichpak or Yukon River.

We arrived at Sitka on the 24th day of April, after an uneventful voyage of eighteen days. We remained here two weeks, and during this time, although the weather was generally unfavorable, we succeeded in obtaining a few observations to determine the errors of the chronometers.

At this point private Michael Foley, Ninth United States Infantry, joined my party, being ordered to report to me for duty by Brevet Major General Davis commanding the department. He accompanied me during the remainder of the expedition.

On the 9th day of May we sailed from the harbor of Sitka, and after a stormy voyage of twelve days we arrived at Ounalaska Harbor, in the Aleutian Islands. The circumstances of the expedition detained us here for about two weeks, and during this time the chronometer error was determined on several occasions.

We sailed from the harbor of Ounalaska on the 8th day of June, expecting to arrive at St. Michael's Island in about a week. The weather was, however, generally unfavorable, and on the 13th we encountered extensive fields of ice, which had been detached and driven off from the northern coast. To escape this danger we were compelled to turn back several times and finally to make considerable easting in order to pass between the ice-fields and the coast. Much delayed by these obstacles, and also by a severe northwestern gale which lasted for several days, we arrived finally at St. Michael's Island, on the 29th day of June, after a voyage of twenty-four days.

I shall describe this island in another chapter. It is sufficient to say here that, although the anchorage is entirely open, the island covers it from most of the prevailing winds, and it is the nearest position to the mouths of the Yukon at which a vessel can lie with safety.

We remained at St. Michael's Island four days, making the necessary preparations for our journey up the river. On the 1st of July the little steamer Yukon was successfully launched, and a short trial-trip gave excellent results. Sextant observations for the determination of time were made at this station. I left here a set of meteorological instruments, with which Captain Riedell, the chief trader of the station, kindly volunteered to observe.

Having obtained two large open boats, which we loaded with supplies and trading goods, and having constructed a small rough pilot-house upon the steamer's deck, we were prepared for departure. Early on the morning of the 4th of July, taking our boats in tow, with flags flying and guns firing, we started on our voyage to the upper mouth of the great river. Our party was composed as follows: Captain Benjamin Hall, master; John R. Forbes, engineer; Frederick M. Smith, superintendent; Ferdinand Westdahl, chief trader; Michael Labarge, chief trader; John Godfrey, trader; Robert Bird, trader; Lewis B. Parrott, passenger; Captain Charles W. Raymond, John J. Major, Michael Foley, and two laborers. Our course lay through the narrow channel which separates the island from the main-land and along the coast for about seventy miles. We accomplished this portion of our journey without much difficulty, although our little vessel was hardly fitted for this sort of navigation, and early on the morning of July 5 we entered the upper mouth of the Yukon River.

A native, well acquainted with the lower portion of the river, had been engaged at St. Michael's, and under his guidance we groped our way among the islands and shoals, occasionally grounding or turning back to seek a more favorable channel. As there was a bright twilight during the short time that the sun was below the horizon we traveled night and day, only stopping occasionally to obtain wood or to purchase a few skins or a little game at some native village. Our approach was usually the occasion of considerable excitement. As we drew near a village, we were accustomed to herald our coming by a vigorous sounding of the whistle, and this was usually followed by a general stampede of men, women, children, and dogs. Our little steamer, which, puffing about the bay of San Francisco, had seemed a mere toy, appeared to them a huge monster, breathing fire and smoke. Curiosity would, however, bring the more daring ones to the river's bank, and, having won their confidence by a few judicious presents, we would soon find our boat surrounded by a score or two of noisy and excited natives. These people, and the natives of the country generally, will form the subject of a subsequent chapter.

Throughout the trip I alternated with Mr. Major in taking notes and bearings, from which to construct a map of the river, and we employed every opportunity to make observations on shore. We found this duty somewhat severe, as it had to be continued throughout both day and night; and our accommodations were so limited that it was often impossible to obtain a place in which to sleep when not at work. We persevered, however, and the map which I have the pleasure to submit with this report is the result.

The swarms of mosquitoes and gnats which abound on the river during the months of June and July proved a very serious annoyance. When the boat was not in motion we were obliged to wear face nets and gloves; and on one occasion an attempt to make sextant observations failed completely from this cause. The mosquitoes are much larger but I think not so active as those met with in lower latitudes. The gnats or sand-flies are very troublesome, and so small that a net is no protection from them.

Two or three times a day the steamer stopped to obtain wood. This was usually cut from drift-timber, which is piled in large heaps at short intervals along the river, where it collects in the spring. Occasionally in the latter part of the journey we were obliged to cut standing timber.

On the 12th of July we arrived at Anvic, a small native village situated at the mouth of the Anvic River. Here we stopped two days, and established a trading-station, leaving Bird temporarily in charge of it. At this place we obtained a variety of observations.

We left Anvic on the 14th. About twenty miles above, the river narrows and the current runs with great velocity. Doubts had been expressed as to the possibility of our passing this point. By skillful management, however, this obstacle was overcome without serious difficulty. At the request of the entire party, I have given this place the name of "Hall's Rapids," in honor of Captain Benjamin Hall, who thus first passed this point with a steamer. This is the only name which has been left by my expedition in the territory.

We arrived at Nulato on the 19th. This was once the easternmost station of the Russian company; but at the time of our visit it had been abandoned. We stopped here two days. A trading-station was established, and a few observations were obtained.

Leaving Nulato on the 19th, we arrived at Fort Adams on the 22d. This station is near the mouth of the Tananá River, the most important tributary of the Yukon, and was at this time the easternmost station ever established on the river from the western coast. Shortly before our arrival at this place we met two traders, Robert and Moses, Canadian Frenchmen and friends of Labarge, who were slowly making their way down the river in a rudely constructed boat. They were immediately engaged by the superintendent of the company; and Labarge started on a canoe journey down the river for a temporary visit to St. Michael's.

Our party remained at Fort Adams two days, landing supplies and making necessary repairs; and here a variety of observations were obtained.

We left Fort Adams on the 24th. About seventeen miles above the station, we passed Nuclucayette and the mouth of the Tananá River, the waters of which increase the current of the Yukon for a considerable distance. From this point the river gradually narrows, and its banks increase in height; and we learned, from these indications, that we were gradually approaching the Rampart Mountains, and the rapids, of whose dangers we had heard so much from the natives below. About noon on the 25th we arrived at the entrance of these rapids, and, after taking on a good supply of wood, we passed through them without great difficulty, although the channel is narrow and the current runs with great rapidity.

After passing this point, we met with no further obstacles, although the shallowness of the upper portion of the river, and the great velocity of the current in many places, rendered our voyaging extremely slow.

On the 31st of July, at 4 p. m., we arrived at Fort Yukon, thus successfully terminating the first journey by steam ever made on the Yukon River. The time of actual travel, including stoppages for wood, was twenty-three days, and the distance passed over about one thousand and forty statute miles.

At Fort Yukon, notwithstanding the somewhat unpleasant character of our errand, we were cordially welcomed by Mr. John Wilson, the agent of the Hudson Bay Company at the station, and by the Rev. Mr. Bumpus, a missionary of the Church of England, lately arrived from Fort Simpson, on the Mackenzie River. Mr. Major and I were speedily established in one of the comfortable log buildings which compose the fort, while the remainder of the party were domiciled in the steamer or encamped on the shore near by.

As the river was rapidly falling, it was necessary that the steamer should start on her seaward journey as soon as possible, and I was, of course, anxious to make an approximate determination of our geographical position without delay, in order that my companions might make their arrangements accordingly, and carry back the information to the coast. A week of unfavorable weather entirely prevented us from obtaining suitable observations; but on the 7th of August we obtained a good observation of the solar eclipse, from which we were able to compute an approximate longitude, sufficiently accurate to set at rest the question at issue, and inform our traders that they were in American territory.

It seems proper to say, in this connection, that by General Halleck's permission I had consented temporarily to represent the Treasury Department, and under the instructions of that Department, on the 9th of August, at 12 m., I notified the representative of the Hudson Bay Company that the station is in the territory of the United States; that the introduction of trading goods, or any trade by foreigners with the natives, is illegal, and must cease; and that the Hudson Bay Company must vacate the buildings as soon as practicable. I then took possession of the buildings and raised the flag of the United States over the fort.

Early on the morning of August 10 the steamer started on her return trip down the river, leaving Mr. Westdahl and Moses in charge of the trading-station which had been established at the fort. I also remained, with Mr. Major and Private Foley, in order to obtain observations for more accurate determinations. The nights were so light as to greatly embarrass astronomical observations, and I desired, therefore, to remain as long as possible.

In the latter part of August the river commenced falling rapidly. This, we presumed, was occasioned by the freezing of the tributaries near their sources, and it was regarded as an indication that the season was near its close. We reluctantly decided that it would be unsafe to delay our departure longer, and made our arrangements to leave the fort early on the 27th.

I was anxious to employ the bark canoes of the country for our journey, as they are considered by far the best boats for this sort of travel, and this opinion is confirmed by my subsequent experience; but none could be obtained. The ingenuity of Moses had, however, devised and, with our assistance, constructed a small skiff of well-seasoned timber sawn from spruce drift-logs. She was calked with rags, and finally coated thickly with pitch. Moses called her the "Eclipse."

On the evening of the 26th she was completed, and we placed her in the water, fastening her with a strip of moose-hide. On the next day we intended to dismantle our observatory, and toward evening begin our journey. But in the morning we discovered that the hungry dogs of the station had eaten the moose-skin fastening, and our boat had started off on an independent voyage to the coast. A pursuit was immediately instituted, and toward evening the party returned, bringing with them the Eclipse, in a somewhat dilapidated condition. In excuse for the dogs, it should be added that they are fed but once a week during the summer.

This little accident was the occasion of some delay; but on the 28th of August, at 4 p. m., we finally left the fort. The party consisted of Mr. Major, Private Foley, and myself, and two natives, who had been brought up from Nulato, and were to accompany us as far as that place. We were obliged to leave our observatory tents and some of our instruments, to be sent down at the first convenient opportunity. We took with us, however, a small A tent, which had been used as a magnetic observatory. For provisions we had a ham, a small piece of bacon, and a little hardtack, and about twenty-five pounds of "moose pemmican," a very seasonable present from Mr. Wilson. This pemmican is an article of considerable importance among the traders of the Hudson Bay

Company, and well deserves a description. Moose (or any other) meat is carefully and thoroughly dried in the sun, and then pounded to a powder. The sinews having been picked out, it is placed in a tight buckskin bag, and boiling fat is poured on it. Marrow is preferred. The bag is then fastened and pressed with a heavy weight. In cooking it, a small portion is placed with a little water in a frying-pan over a bright fire, and a little salt is added when it can be obtained. By absorbing water it increases to at least twice its former bulk, and a handful will make a hearty meal for one man. When properly prepared, it has an agreeable taste. We found it admirably adapted to persons working hard and requiring strong food. In addition to the provisions mentioned we had a supply of tea, the universal drink of travelers of every description in this country.

Our journey down the river was too monotonous to require much description. We felt the necessity of traveling with rapidity, and unless the weather was unfavorable we were at the oars from sunrise until it became too dark to proceed with safety. We then landed and went into camp for the night. When the wind was favorable a small sail which Mr. Westdahl had rigged for us proved of material assistance. We were occasionally compelled to land to repair our boat, which it was almost impossible to keep reasonably tight, and we were much delayed by this cause. Passing through the Ramparts we saw a good many moose. Early on the morning of September 3, we entered the rapids. They were covered with a dense white fog, but this lifted before we came to the most dangerous part, and we were enabled to pass in safety. About 7 p. m. on the same day we arrived at Fort Adams.

We found Robert alone in charge of the station. He informed us that the steamer had come down from Fort Yukon to this point *in one day*. Being, of course, obliged to run ahead of the current, she had descended with great rapidity. From this point the journey up the river had consumed seven days. We remained here until the evening of the next day, as our boat was sadly in need of repairs.

Having obtained a supply of provisions, we again started, and, after traveling four days and a half, arrived at Nulato about noon on the 8th. Here we expected to find American traders, and also to obtain a good boat; but no boat could be procured, and the traders had gone to St. Michael's, leaving the station in charge of a native. Our Indians could not be persuaded to accompany us farther, nor could others be obtained, and, after a delay of an hour or two, we started again, somewhat disconsolately, in our battered and leaky boat, with our force seriously weakened, and the most laborious part of our journey still before us.

On the 12th, at about 4 p. m., a sudden turn brought us to Hall's Rapids. A strong breeze blowing against the current made this portion of the river very rough. Suddenly, and almost without notice, our boat was swept into the rapids, and it was only by great exertions that we were able to reach the shore in safety. This last trial was almost too much for the Eclipse. She was now very nearly a wreck. Nevertheless, not being in a condition to choose, we reëmbarked early the next morning, one man bailing and the two others at the oars, and, swiftly passing the rapids, worked our way slowly down the river. At 4 p. m. we pulled the Eclipse, now thoroughly useless, upon the shore near Anvic, where I presume she still remains, unless the process of disintegration has at length been completed.

At Anvic we found Mr. John Clark in charge of the station, and also our old friends, John Godfrey and Robert Bird, the trappers. We endeavored to obtain here one of the large native seal-skin boats, called "baidarras," and some Indians; but the season was so far advanced that the natives were afraid to attempt the journey down the river and along the coast, a state of affairs which gave us not a little anxiety. On questioning the old chief of the village, however, I ascertained that the Indians are accustomed occasionally, in the summer, to ascend the Anvic River, (which, at some distance from the Yukon, makes a great bend toward the coast,) to a point near its head-waters, and cross by a tolerable portage to the native village of Ikikiktoik, situated on Norton Sound, about eighteen miles north of St. Michael's Island. But it was feared that an ascent of the river would prove impracticable so late in the season; and Mr. Clark, being a new-comer to this part of the country, was unable to advise me, although he promptly volunteered to accompany me if I should decide to make the attempt. This being apparently the only avenue of escape, I did not hesitate long. Mr. Clark went energetically to work, and in a few hours had procured six birch-bark canoes and a sufficient number of Indians.

At 4 p. m. on the 14th we left Anvic. Our journey up the river was extremely slow. We were obliged to *pole* the canoes all the way, on account of the shallowness of the water and the great rapidity of the current. We were somewhat delayed by frequent injuries to our boats; but the birch-bark canoe is easily and quickly repaired. Our Indians, not fancying hard work, were often quite anxious to leave our service, in most cases taking an informal departure during the night; but we managed to keep our force pretty well recruited by a system of mild conscription on the native villages along the river.

On the evening of the 14th we made an unpleasant discovery. The larger portion of our provisions, which we supposed safely packed in one of the canoes, had been left behind. An Indian was immediately sent back to Anvic, with a note from Mr. Clark, directing Bird to send us supplies for five days. Our messenger overtook us on the evening of the next day. He brought a note from Bird, saying that he could not make out Mr. Clark's "handwrite," but he presumed we wanted something to eat. The provisions accompanying this epistle consisted of about sufficient hard-tack for a single meal, which we proceeded to eat upon the spot, making up our minds to live upon the country thereafter. Fortunately we had plenty of tea.

On the evening of the 18th we arrived at a large village. We were received with great kindness by the chief, and comfortably installed in the best house, which he vacated for our accommodation. He informed us that, on account of the shallowness of the river, it would be impossible for us to reach the entrance of the portage by water. We were determined, however, to go on as far as possible. We made a hearty meal on fish, seasoned with gunpowder, and spent a very comfortable night at the village.

On the next morning, having exchanged our canoes for a large skin "baidarra," drawing somewhat less water, we resumed our journey. The chief accompanied us at his own desire. Previously we had had considerable rain, but on this day the weather was delightful. We worked our way along very slowly until night, the water becoming more and more shallow. At dark we went into camp, and an examination of the river from the shore proved further progress by boats impossible.

We were now about fifty miles from the river's mouth, and probably about twenty miles from the portage, and we had to choose between two courses. We could easily return to Anvic and winter at that place, or we could attempt to cross the country in a direct line to Ikikiktoik, on the coast. The first course seemed out of the question, since the station was provisioned for only three men. On the other hand, a portage across an unexplored country of an extremely difficult character, known to be intersected with mountain ranges, necessitating a dependence principally upon the rivers for our supply of food, which might be cut off in a moment by a sudden change of weather, appeared equally impracticable. After much anxious discussion, it was finally determined to keep on, and not to turn back unless it should become absolutely necessary.

During the night there was a violent rain-storm. In the morning we packed everything which it was necessary to carry on the backs of the Indians. We abandoned our tent and such other articles as were not absolutely required, and, under the guidance of the chief, began our journey. Our course lay first over a gentle ascent covered with pines and thick underbrush, which much impeded our progress. After an hour's travel we descended into a mossy swamp, through which we traveled until night. At dark we went into camp, wet and very tired. Of our provisions there only remained a small piece of ham, which we had carefully laid aside while on the river, to be used when fish could not be obtained. This we divided, the ration consisting of a thin piece about the size of a half-dollar. Fortunately we were able to recruit exhausted nature with unlimited tea, although we had been for several days without sugar. It may appear strange that we did not bring fish with us from the river, but they could not have been obtained without delay; and we had underestimated the distance to the second crossing of the Anvic River, where we supposed we could obtain an abundant supply.

On the next morning we made an early start, without breakfast. Ascending the first range of hills we passed over a divide, and early in the afternoon we began to descend into the valley beyond. As the valley first came in view, a welcome sight greeted our eyes. It was the smoke of a camp-fire, and, as we drew nearer, we saw a little hut covered with hides, and near by rude frames, from which were suspended great sides of reindeer meat. During our day's journey we had seen many herds of reindeer feeding on the hills, but we could not spare time to hunt them. On approaching the hut we found that it was the habitation of one of the natives of the coast. Earlier in the season he had penetrated to this valley to hunt, but, having been seized with a severe attack of rheumatism, he had been compelled to remain later than usual, until his friends should come for him. His wife was with him. Upon inquiry we found that he was a brother of "New Year's," and, I believe, nearly related to "Hungry" and "Lunchy," all Indians celebrated in the annals of the telegraph company's explorations. He begged so earnestly for "American medicine" that we had not the heart to refuse him, although we had nothing of that character except a Seidlitz powder. We gave him the contents of the blue paper, and, to our astonishment, he soon declared that he felt much better.

At this camp we feasted to our hearts' content. New Year's brother most generously told us to take all the meat we wished, refusing any compensation. We decided to remain here during this day, and prepare provisions for the rest of the journey. The meat not having been dried, we could not make "pemmican," but we prepared a substitute for it in the following way: The meat was thoroughly boiled, and then cut into very small pieces. These were placed in a bag and boiling grease poured over them. The whole was then pressed tightly into the smal est possible space. This would have proved a very good substitute had not a good deal of the meat which we were obliged to use been tainted, which made it all offensive.

Mr. Major made, from a description given by New Year's brother, a little topographical sketch of the country, which was very useful to us, and proved wonderfully correct.

On the morning of September 22d we again broke camp, and began the ascent of the range of hills on the west side of the valley. From this point the timber entirely disappears, except a little low brush near the water-courses. The nights had now become cold, and, in order to find a camp where brush-wood could be obtained, it was necessary to reach the second crossing of the Anvic River. We passed over two ranges of high hills, alternately plunging through a thick, wet moss, and stumbling over rough stones. At 8 p. m. we finally arrived at the Anvic River, almost dead with fatigue. On the last range of hills Foley's strength completely failed him. Early in the march his shoes had become unserviceable, and he was obliged to substitute for them moose-skin moccasins; consequently, his feet had been severely bruised. He made a great effort to keep on, but, being taken with vomiting, he declared that he could go no farther. We made him a bed on the hill-side, and then went on down to the river, where the light of a distant camp-fire assured us that assistance and food could be obtained. On our arrival at the river we found a temporary fishing-camp, occupied by Coast Indians. A party was immediately sent back with food and fuel to Foley, and he arrived safely at the camp about noon on the next day. At this camp we found plenty of provisions. We obtained here a few reindeer tongues, which are justly considered a great delicacy. We remained at this camp until about 1 p. m. Having profited a good deal by this rest, we started with renewed spirits on our journey. We ascended the hills on the west of the Anvic Valley, and when we reached the summit we saw with delight the broad expanse of Norton Sound in the distance. We then descended into the valley of the Golsova Richka, and at sunset we arrived at the little river. Wading it, we went into camp on its western bank. On the next morning we made an early start, as there is no fuel and no place suitable for a camp between the Golsova and the coast, and it was therefore necessary to conclude our journey in one day. We first passed over a low range of hills bordering the river. Our journey then lay over an almost level country, with the exception of a high hill near the coast, which we crossed to avoid swamps.

Travel in this part of the country is extremely difficult. The ground is covered with hummocks and deep moss, and it is nearly all a swamp. Through this terrible region we floundered until eight o'clock in the evening, when our troubles were terminated by our safe arrival at Ikikiktoik. This was perhaps our most fatiguing day's journey. We traveled about twenty miles through a country which, under any circumstances except those of actual necessity, might well be called impassable.

At Ikikiktoik we expected to find plenty of natives and boats, and we intended to conclude our journey to St. Michael's Island on the same night. Unfortunately, however, we found the village temporarily deserted. But one native remained—a sick man—and one small boat, capable of carrying only one person. We were therefore compelled to spend the night here. We had eaten the last of our provisions, supposing our journey to be practically ended; but, fortunately, one of the Indians had killed a rabbit as we were entering the village. With this, and some sea-water, we made a soup, which we fancied delicious, as we had not tasted salt for more than a week.

Early the next morning I dispatched a messenger to St. Michael's Island with a request for assistance, and about nightfall the superintendent of the company, Captain Ennis, arrived with a whale-boat and a bountiful supply of provisions, and transported us to the ship. Thus ended our eventful and, in some respects, unpleasant journey.

On the 27th of September the Commodore sailed for San Francisco. On the 3d of October we arrived at the Island of St. George, and here we obtained the first news which we had received from the civilized world for about six months. On the 6th of October we arrived at Ounalaska Island, where we were delayed several days. A voyage of twenty-seven days from this place, during which we experieneed a succession of severe gales in Behring Sea, and, indeed, unfavorable weather all the way, brought us at length to San Francisco, where we arrived on November 6th, exactly seven months from the time of our departure.

CHAPTER II.

DESCRIPTION OF THE RIVER AND ADJACENT COUNTRY.

The great Yukon River, the largest stream emptying on the western coast of America, is supposed to take its rise approximately in latitude 58° 31′ north and longitude 131° 50′ west. At its head-waters it is known as the Tahco River, and it is said to have been visited many years ago by the traders and trappers of the Hudson Bay Territory. The northernmost point of the river is at Fort Yukon, where it makes a sudden and decided bend toward the southwest. The little that we know concerning this portion of the Yukon is derived from the accounts of Ketcham and Labarge and Michael Byrnes, (*vide* Introduction, pages 7 and 8,) and various reports of Indians, which establish the identity of the Tahco River and the Yukon. The general direction of the river from its head-waters to Fort Yukon is supposed to be about northwest. The length of this portion of the river must be at least one thousand miles. From Lake Labarge (about latitude 61° 45′ north and longitude 135° 30′ west) to Fort Yukon it is called the Lewis River. Just below the lake a tributary enters from the south. From its head-waters the Indian tribes inhabiting the vicinity are accustomed to make a portage to the head-waters of the Chilcat, proceeding via the latter river to Sitka for purposes of trade.

Probably the largest tributary of the Yukon above Fort Yukon is the Pelly, which enters the main river from the east, approximately in latitude 63° north and longitude 136° 40′ west. At its mouth the Hudson Bay Company formerly had a trading-station, called Fort Selkirk, which was destroyed by Indians in the year 1851, and since that time has remained unoccupied. This portion of the river is described as flowing, with an extremely rapid current, through a mountainous country.

Fort Yukon, situated in latitude 66° 33′ 47″ north and longitude 145° 17′ 47″ west, is the highest point which my expedition reached. Here the Yukon receives the waters of the Rat, or Porcupine, a large tributary, emptying on the right bank, and flowing from its head-waters in a general direction a little south of west.

From Fort Yukon to the mouth of the Chetaut River, a distance of about two hundred miles, measured along the deepest channel, the river has a general direction about west-southwest. The windings of the stream, however, within this distance are innumerable, the air-line distance between these points being only about one hundred and fifty miles. The country on both sides of the river is low and level, usually consisting of sand or gravel. The average width of the river is about three-fourths of a mile, but in some places, measuring across its numerous islands, it widens out to five or six miles. The current through all its passages is extremely rapid, and in many places the best channel is not more than three feet in depth. The vegetation on the banks and islands is principally a chaparral of willow and poplar, with occasional groves of spruce and birch. The principal tributaries emptying into this portion of the river are the Achenchik, Notochargut or Dall, Chetletchuk, and Chetaut Rivers, all of which flow from the north. None of these rivers seem to be of much importance, with the exception of the Chetaut, which has been ascended for a few miles and found to abound in fish and game. There are no native villages on this portion of the river.

From the mouth of the Chetaut the Yukon rapidly changes in character. It gradually narrows into one channel; the islands disappear; the banks rise into hills; the stream becomes deep and rapid, until finally it plunges with great velocity through the Rampart Range. The bluff hills composing this range rise close to the water's edge. They are composed principally of a hard, greenish rock. Slate is occasionally seen, and at the rapids true granite appears in a ledge running across the river. Most of the hills are covered with groves of spruce intermingled with birch, but the trees are all small, and in many places they lie for some distance scattered in every direction, showing the small depth to which their roots attain in the frozen ground and the great force of the winter winds.

From the Chetaut River to the Rampart Rapids, a distance of some sixty miles, the general direction is about southwest. The river averages about two-thirds of a mile in width, but at the rapids the width does not exceed one hundred and fifty yards. The tributaries emptying into this portion of the river are, from the north, the Atonisonik, and, from the south, the Yukuchargut or Whymper River. Neither is important.

The first native village met with in descending the river is situated on the right bank, just below the Rampart Rapids. It is occupied by Senati, an old Kutchin chief, and his people, whose permanent home is probably in the vicinity of Fort Yukon, but who have established themselves in this place for the purpose of fishing. It is indicated on my map as Senati's Village.

From the Ramparts to Nulato, a distance of some two hundred and forty miles, the river has a general direction about west by south. There are, however, many bends, although these are less sudden and numerous than in the other portions of the river.

After leaving the Rampart gorge, the stream widens and the current diminishes in rapidity. The right bank is for the most part hilly, and on the left, although this shore is generally low and flat, hills and bluffs occasionally rise close to the water's edge. The channel, as a general rule, runs close to the right bank, a remark which holds good for all that portion of the river below the Ramparts. The average width is about three-fourths of a mile. Now and then islands are encountered, but for the most part the stream is open and the channel plain.

This portion of the river, in my opinion, far surpasses all other parts in natural beauty. About fifty miles below Fort Adams, the Suquonillá range of mountains commences on the right bank. It is a succession of elegant, well-defined peaks and ridges, describing a beautiful curve for many miles, with its concavity toward the river and its flanks resting at the water's edge. The right bank of the river is well timbered with spruce, poplar, and birch.

The principal rocks of this part of the river are slate and sandstone. Some of the sandstone bluffs are very remarkable in appearance. Quartz is found, and occasionally granite. I examined a specimen of bituminous coal which we obtained on this part of the river. It is of good quality, but the seam is very limited in extent.

The principal tributaries emptying into this part of the river are as follows: From the north, the Tosekargut, Newchuklikargut, Newikargut, Melozekargut, and the Kuyukuk; from the south, the Tananá, Atutsakulakushchargut, Yukokargut, and the Kukuyukuk. The termination *Kargut* or *Chargut* signifies, in the native dialect, a little stream. Some of these "little streams," nevertheless, are large and important rivers, populated by many Indian tribes, and navigable for a considerable distance. Chief among all these rivers in importance, size, and beauty—chief, indeed, among all the tributaries of the Yukon—stands the great Tananá, "the river of the mountains." It empties into the Yukon about thirty miles below the Ramparts, and its rapid waters increase the current of the main river for a long distance. Only a few miles from its mouth have been traveled by white men. It apparently comes from the southeast; but it is believed that many miles above the explored portion it makes a great bend from the east, its sources lying near the Upper Yukon.

At the mouth of the Tananá is the trading ground called Nuclucayette, where the Indians inhabiting the banks of this tributary are accustomed to congregate in the spring. About seventeen miles below, and on the right bank of the Yukon, at the mouth of the Tasekargut River, is the American trading-station called Fort Adams. The principal trading villages between this point and Nulato are Chokoyik, Newikargut, and Sakadelontin. A mile above the old Russian fort at Nulato, (now abandoned,) there is an American trading-station.

From Nulato to Andreavsky, an abandoned Russian trading-station, situated about three hundred and fifty miles below the first-named place, the river has the following approximate directions: From Nulato to Anvic, south-southwest; from Anvic to the upper entrance of the Shagelook Slough, south-southeast; from the upper entrance of the Shagelook Slough to the Great Bend, southwest; from the Great Bend to Andreavsky, west by south. It is difficult to convey an idea of this portion of the river, its numerous windings, its thousand islands, its bars and shoals, ever changing and shifting, baffling the traveler in his search for the channel. Generally speaking the right bank is high, exhibiting many bluffs of sand and rock, formed by the ice torrents in the spring.

In this connection I may mention a rapid change which is going on here and in many other parts of the river. The ice undermines the high banks sometimes to a distance of twenty or thirty feet. On the projecting tops of the banks there are usually many trees. These, loosened by the action of frost and water, are soon precipitated into the stream beneath; and thus the river goes on widening and shoaling, while immense quantities of drift-wood are sent down to the sea. Sometimes the right bank rises into high hills; again it falls away to rolling ground, and occasionally to flats. The left bank is low and level. Here and there, however, small hills are seen standing back a mile or two from the water, and for nearly the whole distance a range of distant mountains parallel to this shore is visible. In these mountains lie the sources of the great river Kuskokvim. The sandstones and slates continue throughout this portion of the river, but on the lower part a dark volcanic rock makes its appearance. Between a point near Andreavsky and the sea no rocks were observed. The hills on the right bank are generally well covered with spruce and poplar, occasionally intermingled with a little birch. Owing to the coldness of the winter climate, these trees do not usually grow to a great size; the left bank and the islands are generally covered with chaparral of willow and alder. This portion of the river has few tributaries of sufficient size to require notice, although there are many small streams, entering usually from the north. The principal tributaries from the north are the Takaitski, the Anvic, and the Konnekova or Clear River. The Takaitski empties into the Yukon about fifty miles below Nulato. It abounds in fish, and it is said that many Indians dwell upon its banks. The Anvic enters the Yukon about one hundred and sixty miles below Nulato. It is the only tributary of the great river which I have ascended for any considerable distance. It has its source in the mountain ranges which run parallel to the sea-coast; runs from its head-waters in a northerly direction for about twelve miles, and then, making a long regular bend to the east and south, flows generally in a southerly direction until it reaches the main river. Its banks are often high and steep. The hills of the right bank of the Yukon turn at Anvic and follow the left bank of this river up to the point where it makes its great bend away from the coast. Its very shallow waters run with great velocity. It is, in a word, throughout nearly its whole extent a torrent. This river is traveled somewhat in summer by Indians, who occasionally reach its head-waters and make from thence a portage to the coast.

The Konnekova River enters the Yukon about one hundred and eighty miles below Anvic. At its mouth it is about five hundred yards in width, and so shallow that a bark canoe can hardly ride upon its waters. It abounds in fish, and empties a clear silver stream into the muddy waters of the Yukon. Two rivers join this portion of the Yukon from the south, the Kaiyuh and the Shagelook.

The mouth of the Kaiyuh River is said to be situated about forty miles below Nulato. It was not noted in our itinerary, and I have no information concerning it.

About one hundred and thirty miles below Nulato the Yukon separates into two branches. The main stream pursues a southerly course, but the lesser branch, running at first a little south of east, makes finally a great bend to the south and west, and enters the main river again about sixty miles below the point of separation. This lesser branch is entitled the Shagelook Slough, and on it, a few miles from its entrance, is situated the mouth of the Shagelook River. Of this river little is known. I have not even seen its mouth, but its valley is said to be the richest fur country on the lower Yukon.

A little below Andreavsky the Yukon bends abruptly to the northward, and runs about north by west from this point to the sea. There are said to be three principal outlets—the Aphoon or upper, the Kvichpak or middle, and the Kousilvak or lower mouth. Of these I had an opportunity to examine but one—the Aphoon. A little below Andreavsky the hills of the right bank die away, and the country on both sides of the river becomes low and flat. Shoals and sand-bars are found on every side. The river spreads out to a width of about three miles, and finally, at a point about twenty-two miles below Andreavsky, separates into its mouths. The Aphoon outlet is about forty miles in length, and has an average width of perhaps one-third of a mile. Its banks are low and flat, and are covered with chaparral of alder and willow. This outlet enters the sea approximately in north latitude 63° 10′ and west longitude 164°.

Besides Nulato, the Russian American Company formerly had trading-stations at the Mission, (two hundred and fifty miles below Nulato,) Andreavsky, and Coatlick, (near the coast.) With the exception of the Mission, where there is an American trading-station, these points are now abandoned. There is also an American trading-station at Anvic.

The principal native villages situated on the main river between Nulato and the sea, in the order named, are as follows: Upper Kahltog, Kahltog, Lower Kahltog, Hultulkakut, Tagutakaka, Muskoietaka, Anvic, Makagamute, Ingekasagmi, Nunaikagumute, Kuyikaniukpuk, Ikaklagmute, Kochkogamute, Yukagamute, Chukchukamute, Tlatekamute, and Ankachagamuk. On the Anvic River three villages were noted. One of them is called Anemuk. The names of the others were not ascertained.

From the upper mouth of the Yukon to Redoubt St. Michael's the traveled way lies along the coast. It is a distance of about fifty-five miles to the southwest extremity of St. Michael's Island. Going through a narrow passage between the islands and the main-land, about fifteen miles in length, we finally arrive at the anchorage off "the redoubt." This passage is known as "the canal."

Several streams empty into Norton Sound, between the upper mouth of the Yukon and St. Michael's Island.. There are also several native villages on this part of the coast, which were temporarily unoccupied at the time of our visit. The coast is low and flat, but back a few miles from the sea are several parallel ranges of hills. An idea of the country back of the coast may, perhaps, be obtained from a brief description of the ground which we passed over in our portage from the Anvic River to the sea.

For about twenty miles from the coast the country is flat, swampy, and filled with standing pools. Close to the coast, however, there are a few isolated hills of volcanic character. There is no timber. A little brush grows around the pools, and the remainder of the country is covered with coarse moss. Back of this belt of land is the first hill range, about a thousand feet in height. On the other side of this is the valley of the Golsova Richka, a beautiful little river, which runs northward, parallel with the coast, and empties into Norton Sound. This valley is full of swamps and chaparral. Crossing two more ranges of higher hills, we descend again into a narrow valley and arrive at the head-waters of the Anvic River. This valley exhibits the same characteristics as that of the Golsova Richka. Beyond it rises another range of high hills, and beyond this again is another swampy valley, watered by a tributary of the Anvic. Thus far the hills are steep, barren, treeless, and in some cases swampy to their very tops. Beyond this, however, timber begins to appear. The eastern side of the next range of hills is thickly covered with spruce, poplar, and close underbrush. Passing these hills, and through a valley about eight miles in width, we cross a narrow belt of rising ground, and finally descend again to the banks of the Anvic.

St. Michael's Island is situated in latitude 63° 28′ north and longitude 161° 52′ 28″ west, and is separated only by a narrow channel from the main-land. It is about seventeen miles long and thirteen miles wide. At the northeast extremity there is a point of land on which are situated the buildings composing "the redoubt," described elsewhere in this report. This was the depot station established in 1833 by the Russian American Company for this portion of the territory. Back of the redoubt for a mile or two the island is low, level, and swampy. Beyond the low ground are two low hills. There are no trees on the island. Wood for fuel is obtained from the drift-timber brought down by the Yukon in the spring. Directly west of St. Michael's, and at no great distance, is Stuart's Island, which is of about the same size and has the same general characteristics as the former.

I have now concluded the account of that portion of the Yukon River territory which I have personally visited. There are, however, some adjacent portions of the country which are well known from the frequent journeys which have been made across them, and a few remarks on these portages will not be inappropriate.

About forty miles northeast of St. Michael's Island the Unalachleet River empties into Norton Sound. Its general direction from its head-waters, which are some fifty miles from the coast, is about southwest. At its mouth was formerly situated an important trading-station of the Russian company, now abandoned. This river is navigable for small boats for a considerable distance. The Russians, and in later years the explorers of the Western Union Telegraph Company, were accustomed to travel to Nulato by ascending the river, either by boats or on the ice, according to the season of the year, as far as the native village of Ulukuk, whence they made a portage to the Yukon, concluding the journey on that river.

The winter portage from Ulukuk has, for about fourteen miles, a general direction about east-southeast to the Vesolia Sopka, ("Cheerful Mountain,") which forms the termination of the Ulukuk Hills. The route to this point lies principally across an almost level country, with hillocks here and there, and occasional clumps of low willows. It is intersected by small streams emptying into a branch of the Unalachleet River. From the Vesolia Sopka the portage has a general direction of about northeast, and it terminates on the right bank of the Yukon, a few miles below Kahltog. The distance is about fifty miles. This portion of the route traverses sparsely wooded hills, and beyond these a low country, bordering a marsh called Beaver Lake; then over the flanks of some high hills, beyond which lies the Yukon. This brief description is drawn from Mr. Dall's account of his explorations.

The summer portage from Ulukuk is along the valley of a branch of the Unalachleet River, in a southeasterly direction, and reaches the Yukon at Yakutskalitnik, a point about eighty miles below Nulato.

I have spoken before of the portage from the head-waters of the Anvic River to the coast. A portage from the head-waters of the Golsova Richka to the mouth of the Anvic River, indicated on the map of Lieutenant Zagoskin, of the Russian navy, seems to me extremely doubtful.

The Russians formerly had a station called Redoubt Kolmakoff, on the Kuskokvim River, which is south of the Yukon, and empties into Behring Sea in approximate latitude 60° north and longitude 162° west. From this river they were accustomed to cross to the Yukon, striking the latter about six miles below the Mission.

For the following description I am indebted to Mr. Zandt, a trader, who made the journey in the summer of the year 1869, and kindly furnished me with a sketch of the country. The general direction of the route, starting from the Kuskokvim, is about northwest. The journey commences by the ascent for about five miles of a small river called the Mahkahsatule. A short portage of half a mile is then made to Lake

Kuklaelekuhta, which is about one mile in length. This lake is crossed, and a portage of three-fourths of a mile over a swampy plain covered with birch leads to another lake, which is a little larger than the first, and constitutes one of the sources of the Kuichavak River. Crossing this lake and descending the Kuichavak for about seven miles, the route ascends one of its branches called Oukahkl to a lake of the same name. This lake is about two miles in width. A small stream connects it with the next lake, which is called Koulakh, and is the largest in the chain. From Lake Koulakh a short portage is made to Lake Philikh-Tulik, which is somewhat smaller than the foregoing. A portage of one mile from this lake over low pine-clad hills leads to the Talbiksokh River, which is descended for about eight miles to its junction with the Yukon. The country surrounding the lakes is generally low and swampy. The journey from the Kuskokvim River to the Mission can be made by rapid traveling in two days. The distance is estimated at fifty-five miles. From the mouth of the Kuskokvim to the Mission the journey requires about nine days.

From the head-waters of the Kotelkakut River, (the eastern branch of the Kuyukuk River, which empties into the Yukon a few miles above Nulato,) the natives are said to make a portage to the head-waters of the Quisnon, and descending this and the Tosecargut River, of which it is a western tributary, to make their way to Fort Adams. I have no information regarding the character of the country in the vicinity of these streams.

A variety of game is found in the vicinity of the Yukon River and its tributaries. I shall mention here only the kinds commonly used for food which were observed during the expedition. The fur-bearing animals are enumerated in a subsequent chapter.

Moose are abundant on the upper part of the river, especially in the Ramparts, where we saw a great number in the month of September during our return journey. Lynx and bear tracks were observed on this part of the river. The black bear is the most common. At Fort Adams I saw a gray bear-skin measuring ten feet and six inches in length. Moose are rarely found below Nulato. One was killed, however, on an island near the mouth of the river in the summer of 1869. During the summer reindeer are abundant among the hills, especially on the lower part of the river. They are said to have diminished greatly in number since the introduction of fire-arms. We observed many herds of these animals during our journey from the Anvic River to the sea. In the months of July and August the moose and reindeer are frequently seen in the river, where they seek a refuge from the mosquitoes. Brown and black bears are abundant on the lower part of the river. About the first of May vast flocks of ducks and geese make their appearance. They seek the ponds and small lakes in the interior to breed, and early in the fall they commence their departure southward. They are seen along the whole extent of the Yukon. The varieties of geese I could not distinguish. Of the ducks the teal, perhaps, was the most common, and after this the mallard. The canvas-back was also often observed. Swans and sand-hill cranes are abundant, especially between Nulato and Fort Adams.

CHAPTER III.

THE NATIVE TRIBES.

Owing to the rapidity with which we were obliged to travel, and the time required for other duties, my opportunities for observation among the native tribes were limited. I have endeavored, however, to collect as much information as possible concerning them. The tribes that have fallen under my observation may be divided into two great classes. To these the names *Orarian* and *Indian* have been appropriately given by Mr. Dall. The Orarian tribes are those which live upon the coast, or at or near the mouths of large tributaries; the Indian tribes are those which are found only in the interior. Those Orarian tribes concerning which I can speak from personal knowledge are located between Behring Strait and the upper or Aphoon mouth of the Kvichpak or Yukon, and along the banks of the lower part of the river for a distance of about three hundred miles. They belong to the sub-group "Innuit" of Dall. The Indian tribes reside upon the banks of the Yukon and its tributaries to some distance above Fort Yukon. That this classification of the native tribes is a natural one is apparent from several considerations. The Orarian languages, while bearing more or less resemblance to each other, differ entirely from the Indian languages, which also seem to have had a common origin. Moreover, there is a marked difference between Orarians and Indians, in appearance, dress, character, habits, and customs.

ORARIAN TRIBES.—The general name of Malemute is often applied to all these natives, but correctly there are several large tribes, of which the Malemute is one. The principal tribes seem to be the *Kaveaks*, the *Malemutes*, and the *Ikvagmutes* or *Lower Kvichpaks*, often called *Magamutes*, and sometimes *Primoske*. The Kaveaks inhabit a portion of the coast between Behring Strait and Sound Golovnin; the Malemutes are situated between the sound and the Unalachleet River, and at the mouth and along the banks of that river; and the Ikvagmutes are found at the mouths of the Kvichpak or Yukon, and for a distance of about three hundred miles along its banks. These natives are often known by the names of the villages they inhabit; but this nomenclature seems to be merely accidental and has no connection with their condition, character, or habits. They intermingle with each other to a great extent, having been brought together during many years by their trading interests at St. Michael's, and consequently there is a great similarity in their language, customs, character, and appearance. It is almost impossible to form an estimate of the number of these people, as they continually travel up and down the coast and rivers, and are rarely met with in large parties. A Russian trader of long experience informs me that in his opinion they number about five thousand.

During the winter these tribes live in their villages, trapping for skins in the vicinity, and making occasional trips to St. Michael's for purposes of trading. In the summer they scatter more widely, collecting stores of food for winter use. The Kaveaks and Malemutes in their skin canoes hunt the walrus and the hair-seal, and, making their way into the valleys between the low coast ranges, kill the reindeer in great numbers. During the summer the Ikvagmutes are engaged in fishing for salmon, which frequent in enormous numbers nearly all the rivers of Northern Alaska.

Most of these natives seem vigorous and healthy, and among them are many very fine-looking men. In these respects the Kaveaks and Malemutes are far superior to the others, as might be expected from their more active and hazardous pursuits; nevertheless, I found among them many of the diseases incident to reckless exposure. Consumption, colds, asthma, rheumatism, and croup were by no means uncommon. Of the last-named disease great numbers of their children die yearly.

The food of these people consists of fish, (fresh and dried,) reindeer meat, walrus and seal meat, and oil. Their villages contain from two or three to a dozen families, and are composed of rude, low houses, built of logs and covered with earth. The door is simply a small round hole placed near the ground, so that it is impossible to enter except on the hands and knees. The fire is placed in the center of the building, and the smoke makes its way through an opening in the roof. Rude as these houses are, they are nevertheless tight and warm. In the winter they are exchanged for houses entirely or partially underground. Nearly every village contains a large building called the "dance-house," which is used as a bath-house, and on occasions of festivity. It also serves as a sort of hotel for the accommodation of travelers. It is similar to the other houses except in size, and does not require particular description.

The Orarians all wear skin clothing both in summer and in winter. The "parca" is a sort of long shirt of reindeer-skin, the hair being worn outward in dry weather and inward in wet. It has a hood attached, which forms a covering for the head, and which is usually trimmed with the "cacajou" or wolverine-skin. In the summer leggins and boots of reindeer-skin are worn, the latter being provided with "moclock" or seal-skin soles. The winter boots are entirely of moclock, and are made with so much skill that they are completely water-tight. Reindeer-skins, being of such extensive use, are objects of great value among these tribes; and I have known them, and also wolverine-skins, to be brought from other portions of the Territory by the traders, to be employed in the purchase of furs. The reindeer, however, abounds in the valleys near the coast.

The natives do not seem to be fond of ornaments. The upper lip is usually perforated under the corners of the mouth, and through these holes pieces of bone or bits of round stone or metal are inserted. The women tattoo their chins in vertical parallel lines. The dress of the women so closely resembles that of the men that it would be almost impossible to distinguish them but for these marks.

These people, especially the Lower Kvichpaks, are very unclean in their habits. Urine is used in tanning all the skins which they wear, which consequently have an exceedingly offensive smell. They use the same liquid for bathing their persons also. Their villages are filthy, and their houses swarm with vermin. They have no idea of comfort, few artificial wants, and consequently little industry. Virtue seems to be unknown among their women. They are all more or less acquainted with the use of intoxicating liquor, and the northern tribes obtain quantities of spirits from the whalers who trade with them along the coast; but as in all my experience I did not observe a single case of intoxication, I do not believe them to be intemperate. Indeed, I am told that they often resold spirits to the Russians, among whom the use of intoxicating liquors was carried to a great excess. The use of tobacco for smoking is common. They prefer a very strong, coarse variety, which they have been accustomed to receive from the Russians. The native pipe consists of a leaden bowl and a stem formed of two pieces of wood hollowed out and lashed firmly together with a deer-skin thong wound spirally about them. The bowl will contain a bit of tobacco scarcely as large as a pea; one or two whiffs and the operation is over. The effect is so powerful that for a moment they are intoxicated. Mr. Dall says that they inhale the smoke, and he thinks that the prevalence of asthma and congestion of the lungs, to which I have before referred, is due to this cause.

During the summer the natives travel along the coast and on the rivers. They have three kinds of boats—the *bidark* or *bidárka*, the bidarrá, and the bark canoe. The bidark is a long, flat-bottomed, canoe-shaped boat, consisting of a light frame-work of wood, tightly lashed together, and covered with oiled seal-skin. This covering extends completely over the top, holes being left for the occupants. The bidark has usually one hole, but sometimes two, or even three. The traveler, having taken his seat, envelopes the upper portion of his body in a light, thin, water-proof shirt, made, I believe, of seal-gut, which is fastened to the rim of the hole. Thus prepared the natives do not hesitate to venture out even in a very rough sea. The bidark is propelled with the paddle, and the skill which they attain in its management is surprising. I have been repeatedly told that the people in the vicinity of Behring Strait will turn their boats over and come up on the other side. (Dr. Kane has described the performance of the same feat by Greenlanders in their kajacks.) These boats differ little, if at all, from those of the Aleuts of Ounalaska Island.

The bidarrá is also a skin boat, closely resembling the bidark in construction; but it is much larger, and the top is not covered. It is usually propelled with paddles, but I have occasionally seen rude sails employed. Some of them will carry fifteen or twenty persons apiece, and possibly even more. This boat draws very little water, is extremely light, and easily and rapidly propelled, and has a great carrying capacity. The objection to it as a river-boat is that it is easily injured and not very readily repaired, and it requires frequent oiling to keep it impervious to water.

The birch-bark canoe is found only on the rivers. It is entirely unsuitable for coast travel. It is more common among the Indian than among the Orarian tribes, though I have often seen it among the Lower Kvichpaks. It is constructed by sewing, with spruce-roots, a covering of birch-bark over a strong frame-work of wood, and then carefully pitching the seams. The largest bark canoes which I saw would easily carry four men. The usual size is designed for one or two only.

Our journey up the Anvic River was made entirely in these boats, and I found them admirably adapted to river travel. They are light and draw very little water, and though easily injured they are quickly repaired. In the bow of each canoe a little pitch and birch-bark are always kept. If a boat is injured it is taken out of the water and turned upside down. A small fire is quickly made. If the hole in the boat is small, a burning brand is held over it and a little pitch melted upon it and pressed into shape with the wetted ball of the thumb. If the damage is more serious, a patch of bark is cut and fastened firmly in the proper place by a layer of melted pitch run along its edges. The natives make these repairs very rapidly and skillfully, so that an accident ordinarily causes a delay of a few minutes only.

During the winter the natives travel in sledges drawn by dogs. The dogs are of various colors and sizes. The prevailing color on the coast seems to be a light gray. At Redoubt St. Michael's there was a number of fine large dogs, the Russians having evidently taken considerable pains in selecting and preserving the most promising. The dogs of the natives generally are miserable curs. Except when traveling, they are never fed; and they are, consequently, always ravenous, and will devour the most disgusting filth. They often go into the water and catch fish very skillfully. They will eat any articles composed of leather, such as boots or harness, and sometimes even cloth. They never bark, but howl dismally. They are very cowardly, and always slink away at the approach of a white man. The sledges are made of spruce, and most of those that I saw were shod with bone. I had no opportunity of seeing the dogs in harness, but I was informed that a team usually consists of seven dogs, harnessed two and two, with one leading. Usually a native runs before the team and leads the way. In traveling, provisions have to be carried for the dogs as well as the men; and this is a serious obstacle to long journeys. When the country is in a proper condition for sledge-traveling, snow-shoes are a necessity. Those which I saw consisted of a strong light frame, varying from two to four feet in length, covered with a netting of deer or seal skin.

The time of year during which I was among these tribes was not favorable for observing their customs. I am told that in the long nights of winter, when they are gathered together in their villages, they indulge in many curious ceremonies and festivities.

On the coast and at different points on the lower part of the Yukon, the Greco-Russian church has had for years its establishments and its priests, but I could see no traces of religious influence beyond a few natives who had been in the service of the Russian company. Owing to my limited opportunities, I did not become acquainted with any of the superstitions which these savages, like all others, are said to possess. They do not seem to have any belief in a Supreme Being, and I think it may be fairly asserted that they are without a religion.

Finally, these Orarian tribes are kind, peaceable, generous, and hospitable. I had many opportunities of judging them in these respects, and am indebted to them for cheerful assistance on many different occasions.

INDIAN TRIBES.—The Indian tribes of which I shall speak are all located on the banks of the Yukon and its tributaries. They may, for the purpose of description, be subdivided into two classes; the tribes situated on the river and below Nuclucayette, and accustomed to trade principally hitherto at the Russian stations, and those near or east of Fort Yukon, who have traded principally at that station with the Hudson Bay Company only.

Tribes below Nuclucayette.—The principal tribes of which I have any knowledge are the Ingeletes and the Kuyukuks. The Ingelete people occupy both banks of the Yukon and its tributaries, from a short distance above the Mission to Nulato. I was informed that one of their villages on the Yukon, about sixty-five miles above the Mission, is called *Makagamute*, but other explorers have given it the name of *Manki*, and probably on quite as good authority. Their most important village, however, is Anvic, situated at the mouth of the Anvic River, and they have several villages on the banks of that stream.

At first observation this people might be classified as Orarian. Their character, customs, and appearance closely resemble those of the coast natives; but their language is very similar to that of the Kuyukuks, while it is entirely different from the Orarian dialects, containing, I believe, no words in common with them. Their villages and houses do not differ materially from those already described. They wear the same dress as the coast tribes, and have the same disregard for ornaments. Those on the Anvic River occasionally cross a portage to the coast, and trade at Redoubt St. Michael's, and this intercourse probably accounts for the similarities referred to. Indeed, I should remark that what I have said applies to the Ingeletes of the Anvic and Yukon, and may not be true of the subdivisions of this family farther to the eastward.

The principal Ingelete tribe east of the Yukon is the Shagelook tribe, situated on the banks of the Great Shagelook Slough and River. I am informed that they are superior in many respects to the Ingeletes of the Yukon. They are said to be warlike, enterprising, and intelligent. Hunting is their chief means of livelihood. They wear a deer-skin dress, and are addicted to ornaments. In a word, the characteristics which they exhibit are decidedly *Indian*, while those of the other Ingeletes are as decidedly *Orarian*.

The Ingeletes of the Yukon, like all the Indians on the lower portion of the river, are much less active and energetic than the natives of the coast. Drawing their entire subsistence with little labor from the waters of the great river, they seem utterly destitute of ambition and of any desire to improve their condition. Cowardly and degraded in the extreme, they live in constant dread of the Indians who inhabit the higher portions of the river. Nevertheless they are remarkably honest, good-natured, hospitable, and generous.

The Indians between Nulato and Nuclucayette, at the mouth of the Tananá River, were usually called by the Russians, *Kuyukunski*. The name *Kuyukuk* belongs properly, however, to a powerful tribe inhabiting the banks of the Kuyukuk River, a large tributary, which enters the Yukon from the north, about twenty-two miles above Nulato. During the summer many of their fishing-camps are seen on the banks of the Yukon. Other tribes may be occasionally met with on this part of the river, but this is certainly by far the most important. In dress, customs, and appearance, these people do not differ materially from the Ingeletes. The languages of the two tribes are clearly allied. In character, however, the difference is decided. They possess few, if any, of the good traits which I have ascribed to the lower tribes. They are very cowardly, but at the same time cruel and treacherous. No trouble has been experienced from them during late years; but in the year 1851 they made a descent upon the Russian trading-station at Fort Nulato, killed nearly all the garrison, and almost exterminated a tribe of Ingeletes, whose village was near the fort. I could not find any one in the Territory who could give me a detailed and trustworthy narrative of this occurrence, and I am unable to resist the temptation to quote entire Mr. Dall's graphic account, which was undoubtedly obtained from reliable Russian sources. In memory of a brave officer, whose assassins still remain unpunished, the story may well be repeated:

For ten years, though frequently threatened, the little settlement escaped injury, Derábin meanwhile carrying on a lucrative traffic with the natives for furs. In the spring of 1851, Lieutenant Barnard, of her Majesty's steamer Enterprise, arrived at Nulato with the bidárshik, in search of information with regard to the fate of Sir John Franklin. He was a member of Captain Collinson's expedition, and, with Mr. Adams, a surgeon, and one man, had been left by the Enterprise at St. Michael's the preceding fall. Being probably a blunt, straightforward Englishman, with no knowledge of Indian character and suspicion, he made the remark in the presence of others that he intended to "send" for the principal chief of the Koyukun tribe of Indians, whose headquarters were on the Koyúkuk and Ketelkakat Rivers, and who were then holding one of their annual festivals, about twenty-five miles from Nulato. This unfortunately worded remark was conveyed to the chief in question, through some of the Indians at the post, by a passing native. This chief was the most wealthy and influential in that part of the country, widely known and distinguished by a remarkably large and prominent Roman nose, from which he had received a name which, literally translated, means "hump-backed nose." He was not accustomed to be "sent" for. When the Russians desired to see him they respectfully requested the honor of his presence. His Indian pride rose at the insult, and he immediately called a council to discuss the rumor. The shamáns were of course first consulted, and they unanimously declared that it boded no good to the chief in question. The council then decided that if the report proved true they would, with all the Indians there assembled, go together to the fort and demand satisfaction. They waited some time, and finally were about to disperse to their homes when a single dog-sled appeared on the river. This sled was accompanied by Iván Búlegin, a Russian, and an Indian workman of the Nulato tribe, who had been sent up to see if any information were attainable, and, if so, to bring down the Tyóne of Koyúkuk. The ill-fated Búlegin drew his sled up on the bank, sending the Indian who accompanied him for water to boil the chynik. Sitting down on his sled to rest himself, he was approached stealthily from behind, and, being struck on the head with an ax or club, was instantly killed. The sled was dragged away and plundered; when the Nulato Indian returned and saw what had been done he turned to run, but the Koyúkuns called to him, saying, "Are you not one of us? We will not hurt you." Overcome by fear, he returned and unwillingly assisted in the atrocity which followed. Búlegin's body was stripped, the flesh cut in slices from the bones, and the savages, infuriated like wild animals by the sight of blood, roasted these remains and devoured them. An Indian, who noticed the reluctance with which Búlegin's companion joined in the hurried feast, crept up behind him and drove his knife up to the hilt in his neck. The fighting-men present then stripped themselves of all incumbrances except their bows and arrows, and putting on their snow-shoes set out at once for Nulato. Less than a half mile below the trading-post were three large winter-houses crowded with Ingaliks of the Nulato tribe, in all about a hundred men, women, and children. These houses were situated near the river bank, a few rods northeast of the mouth of the Nulato River. It being in the month of February and an unusually warm spring, the Nulato Indians had taken the precaution to clear away the snow from above their birch-bark canoes, forty or fifty of which were lying about. Intending to forestall retaliation for the death of Búlegin's companion, the Koyúkuns approached with the greatest quietness, not to disturb the sleeping inmates. The canoes were seized, broken up, thrust into the apertures in the roofs and the narrow underground entrances of the houses, and fired. The frightened inhabitants, wakened by the noise and crackling of the flames, endeavored vainly to force a passage through the fire. Some of the men, seizing axes, cut their way out through the wooden walls, but were mercilessly shot down by the arrows of the Koyúkuns. Many were suffocated in the smoke. A few women were taken by the victors, and one or two children were able to save themselves in the woods, through the negligence or pity of the conquerors.

A young man called Wolasátux, renowned for his skill with the bow, escaped to the mountains, eluding the vigilance of the pursuers by his swiftness of foot. All the rest were smothered or fell beneath the knives and arrows of the assailants. But little noise was made, except by the screams of the women and shouts of the destroyers, for at that time the Indians had no guns. The slumbers of the Russians were not disturbed.

It is said that two Indian women, who were employed at the fort, having risen early to boil the chyniks for the morning meal, heard and understood the cries of the victims, but, overcome by fear and anguish at the death of their kindred, stupidly shut themselves into the cook-house, and did not alarm the Russians.

The Koyúkuns next made for the trading-post and found the bidárshik, just risen, sitting behind one of the houses. Saying to Iván, one of their tribe, who had been employed at the fort as interpreter, "If you do not kill the bidárshik, we will kill you," they forced him to consent. He approached Derábin and stabbed him in the back repeatedly, so that he fell to rise no more. The Russian interpreter, a man said to have understood seven languages, happening to come out, saw the act, and turning unarmed to the Indians upbraided them for the murder, but fell in the doorway pierced with seven arrows. Rushing over his prostrate body, they entered the house. Barnard was lying on his bed reading; at the sight of the hostile Indians he raised himself up to reach his gun, which hung above his head. Twice he fired, and twice the barrel was struck upward, the balls taking effect in the ceiling. An Indian shamán, christened Larriówn by the Russians, and his brother seized the arms, and one plunged his knife into the Englishman's abdomen, so that when it was withdrawn the intestines followed it, and he fell back mortally wounded. Several shots were fired, and one struck Larriówn in the groin. Three children and their mother were killed; their father, Teléezhik, being absent in the Káviak Peninsula, as interpreter, with Captain Bedford Pim.

Leaving the bidárshik's house, the Indians next attacked the *casármer* or room where the workmen lived, where there were two Russians and several creoles. They had barricaded the door, and, being at some distance from the other house, knew nothing that had happened. One of them aimed through the window at the crowd of Indians; when the other, hoping to avoid bloodshed, advised him to fire above their heads, in hope that they would disperse The crowd separated, but did not retreat, and only answered by a shower of arrows. The next shot, better aimed, killed one of the Indians, when a panic seemed to seize them, and they immediately retreated with their booty and prisoners to Koyúkuk. Larriówn sat in great agony in the outer room of the bidárshik's house. A Russian lay in the inner room, helpless from fever, who had been overlooked by the Indians in the excitement. His wife, an Indian woman, named Maria, brought him a loaded pistol, and held him up while he fired at the shamán. His trembling hand could not direct the ball, and Larriówn dragged himself out to the river bank. Here he found a Koyúkun woman, who had been staying at the fort, with her baby on a little sled, which she was drawing by a band over her forehead. He threw the child into the snow, and ordered her to draw him to Koyúkuk. She refused, and he stabbed her to the heart. How he finally got away no one knows. Thus ended the Nulato massacre.

An Ingalik, named Lófka, was sent by the Russians with a letter to the redoubt. He placed it in his boot fortunately, for he was stopped on the river and searched by two Koyúkuns, who suspected his errand. Finding nothing, they let him go.

Mr. Adams, the surgeon, immediately started, with Teléezhik and a párty of Russians, for Nulato. Captain Pim, having returned from his adventurous journey frostbitten, could not accompany him, and remained at Unalaklik.

The Russians had sewed up the wounds; but before Mr. Adams arrived, Lieutenant Barnard was dead. It only remained for him to perform the last sad offices and to erect a cross over his grave, with the following inscription:

"Lieutenant J. J. Barnard, of H. M. Enterprise, killed Feb. 16, 1851, by the Koukuk Indians.—F. A."

The Russian American Company, as is the wont of trading companies, never took any measures of retaliation for this massacre. Larriówn and Iván, the murderers of the bidárshik, are frequent visitors at the fort. Presents were sent to the Koyúkun chiefs, and there the matter ended. A stockaded fort was soon built on the present site, and the graves of Barnard and Derábin lie a stone's throw behind it. The excavations where the Indian houses stood are still to be seen, and form the graves of those natives who perished by the massacre.

The complete success of this affair has undoubtedly been the occasion of what I take to be the most prominent characteristic of this tribe—their intolerable insolence. They look at a stranger with an impudent, half-threatening stare. They are, however, too cowardly to offer open violence. They are sometimes, although not usually, dishonest. One of them, having appropriated some small articles, received a sound thrashing from an American trader of our party, to his intense disgust and astonishment; but he made no resistance.

The people who inhabit the banks of the Tananá River, the principal tributary of the Yukon, are called *Tenan-Kutchin*,* ("People of the Mountains,") and are known at Fort Yukon as *Gens des Buttes*. They do not frequent the Yukon during the summer; and, consequently, I saw very few of them. In the early spring they descend to the mouth of the Tananá, and make their camps at Nuclucayette, where they meet the traders and dispose of the furs which they have collected during the winter. They are said to be active, intelligent, and enterprising; but violent and warlike. They live principally by hunting. They are much addicted to the use of ornaments, such as beads and feathers.

The influence of the Russian church (if it had any influence) did not extend beyond Nulato; and no attempt has ever been made to instruct or civilize the Indians of this part of the river. Their superstitions are endless: every tribe has its medicine-man. But I had no opportunity to obtain any connected idea of their beliefs or worships.

The Tenan-Kutchin and the Indians of Fort Yukon are occasionally met with between Nuclucayette and the Ramparts. Beyond this point there are no Indians until we arrive at Fort Yukon.

The principal tribes which have been accustomed to trade at this post are the *Kotchá-Kutchin*, (or "Low-landers,") who live between the Porcupine and Yukon Rivers near their junction; the *Hun-Kutchin*, or *Gens*

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* I give this name on the authority of Mr. Dall, as I did not happen to hear it applied to them. There can be no doubt that this is one of the *Kutchin* tribes.

des Bois, and the *Tutchone-Kutchin*,* or *Gens des Foux*, who inhabit the Upper Yukon; and the Porcupines, or *Gens de Rat*, who live upon the banks of the Porcupine or Rat River. There are undoubtedly other tribes, but these are all that I have noted. These tribes have all been classified under the head of *Northern Tinneh*. † At Fort Yukon the general name of *Loucheux* is applied to them. I had no opportunities of visiting any of their villages, which are all distant from the fort, and consequently I know very little about them. A few trading parties came to the station during our visit, and among them were the finest Indians that I have ever seen. The women are virtuous; the men are brave, manly, intelligent, and enterprising. They are said to be essentially a commercial people, trading for furs with other tribes and disposing of them again to the white traders. Some of them were very much interested in my operations, and I found no difficulty in making them comprehend, through an interpreter, the general method and purpose of my astronomical observations. Indeed, they are accustomed to note time roughly by the relative positions of stars. Their clothing is of moose-skin, with the exception of a few articles which they obtain by trade. They fish little, and are almost exclusively engaged in trading furs and hunting the moose, which abounds in these parts.

For a number of years past a missionary of the Church of England has been stationed at this post. The influence which he has exerted has been of great benefit to the natives; and although little has been done toward civilizing them, they far surpass all the other tribes of the river.

CHAPTER IV.

TRADE OF HUDSON BAY COMPANY—BUILDINGS.

The only establishment which the Hudson Bay Company has occupied on the Yukon River during late years was Fort Yukon. In the year 1847 employés of the company descended the Porcupine River and established this station at its mouth. Trading goods and supplies were brought from Fort Simpson, on the Mackenzie, to Lapierre House, on the Porcupine, to which place a party from Fort Yukon annually ascended to receive them and deliver their furs.

The force at the station usually consisted of one chief trader and two or three men. The chief trader received about £100, the men about £5 each per annum. Whenever any material was needed for clothing, whether buckskin, fur, or cloth, it was purchased at a fixed, and usually pretty high, price from the company. The men were not allowed, under any circumstances, to trade with the Indians on their own account.

Owing to the difficulty of transportation, the supplies sent to this station were very limited in quantity. The chief trader received an allowance of tea sufficient to last a year, and sufficient sugar and flour to last a month or two. The men received only an allowance of tea. All other supplies were drawn from the country.

From this brief statement it will appear that the business of the station was conducted on the lowest possible scale of expense.

The skins obtained were principally those of the stone-marten or *American sable*, mink, beaver, otter, black bear, white, red, black, and

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* I borrow this name also from Mr. Dall, as the latter name only was noted.

† Bernard R. Ross, esq., Smithsonian Report, 1866, page 303.

silver-gray foxes. The most valuable skins are, I believe, those of the black and the silver-gray fox, comparatively few of which are obtained; and next to these are the beaver and stone-marten.

Little or no trapping was done by white men. The furs were almost without exception obtained by barter from the natives. A regular scale of prices was established, the beaver-skin being the standard. Thus the price of a gun was eighteen skins. If martens were offered they were taken at the rate of two to one beaver-skin, and inferior furs were received in a similar manner, according to their relative value.

The following list shows the kind of goods at Fort Yukon in the year 1869: Guns, double and single barrel, made in London; pocket-knives, one and two blades; pants, ordinary and fine; white flannel shirts; red flannel shirts; calico shirts; "yacht" shirts; prints; heavy cloth; blue striped drugget; white striped drugget; shawls, large and small; cotton drill; bullets, twenty-eight to the pound; shot, No. 4; butcher-knives; tin pans, various sizes; tin cups; metal buttons; pearl buttons; linen thread, skeins and spool; silk handkerchiefs; cotton handkerchiefs; silver rings; capotes, (overcoats;) neck-handkerchiefs, (black;) Paris neckties; English belts; Canadian belts; gunpowder; ribbon, (wide;) ribbon, (narrow.) With the exception of gunpowder, of which about one thousand two hundred pounds were disposed of annually, there were but small quantities of these articles on hand, the difficulty of transporting goods from York Factory to Fort Yukon preventing the importation of large supplies.

Furs were obtained at this station in two ways—first, by trade with the tribes inhabiting the vicinity and those on the Porcupine and Upper Yukon; and, second, by descending the river in boats early in the spring and trading with the tribes at Nuclucayette. Probably about half the furs annually collected at this station were purchased at the mouth of the Tananá.

From the imperfect data which I have been able to obtain it is difficult to fix with anything like accuracy the annual trade at this station. It has been estimated at ten thousand skins, a number which is perhaps somewhat in excess of the truth. Five thousand skins, principally martens, are said to have been purchased by English traders in the spring of 1869 at Nuclucayette.

The fur trade on the lower portion of the river below Nuclucayette was conducted, previous to the transfer of the territory, entirely by the Russian American Company. This company had a number of stations on the river and coast, the principal of which were Unalachleet, St. Michael's, Andreavsky, Mission, and Nulato. As the employés of this company had left the country before my arrival, there were no sources of information from which to estimate the amount of trade. From the best information which I could obtain, American traders, in the season of 1868-'69, collected about ten thousand skins between Nuclucayette and the coast.

The buildings on St. Michael's Island (Michaelovski) consist of the "redoubt," a small chapel belonging to the Greek church, and two or three small log-houses put up by American traders.

The buildings which constitute what is called the "redoubt" I presume to be, under the terms of the treaty of cession, the property of the United States, referred to in my instructions as public buildings. They are all within a rectangular inclosure, formed partly by the buildings themselves and partly by a stockade. The stockade is loop-holed and the inclosure flanked by two small towers.

The houses are constructed of drift-logs. The following list exhibits their number, capacity, and condition: Three store-houses, two in good order, one in need of repair; one barrack for unmarried men, two rooms, could accommodate twenty men, in good condition; one barrack for married men, one large and one small room, needs repair; one house, four small rooms, in good condition; one house, two rooms, in good condition; one house, four rooms, in good condition; one bath-house, two small rooms, needs repair.

At Unalachleet, Andreavsky, Mission, Nulato, and Fort Yukon, there are also log buildings which are presumed to be public property. They are all in poor condition, except those at Fort Yukon, which are superior to any others on the river. They are of no value to the Government.

CHAPTER V.

RESOURCES OF THE COUNTRY.

The information which I have been able to collect concerning the resources of the Yukon River is too uncertain and limited to justify definite conclusions. The remarks which follow will therefore be very general in character, and the opinions which I advance may be much modified when more accurate statistics are obtained.

In the examination of this subject the fur trade demands the first consideration. Indeed, it is the only resource of the country as yet developed. This trade has been heretofore in the hands of two companies, the Hudson Bay Company, having one station at Fort Yukon, and the Russian American Company, having various stations along the lower part of the river and on the coast.

I have before remarked that the trade of the Hudson Bay Company was carried on at the very minimum of expense, and the same may be said with reference to the Russian company. The Russian force on the Yukon consisted principally of men sent from various places in the Territory who had been guilty of crimes and misdemeanors. The English force at Fort Yukon consisted of men far from civilization, without means of transportation, and usually, by reason of debt, in the power of the company. The employés of both companies were practically slaves.

It is scarcely necessary to remark that the business of collecting furs cannot be conducted in this way by Americans. In the summer of 1869 traders in the employ of American companies were receiving from $80 to $100 per month in coin, while men occupying corresponding positions in the Hudson Bay Company were paid £5 per annum. The former required a large and expensive variety of supplies, and could not be engaged on any other terms. The latter may be said to have practically subsisted on the country.

It is to be remarked that the Hudson Bay Company, in abandoning its station, does not necessarily lose the trade which it enjoyed at Fort Yukon. A large portion of the business was conducted with tribes living in or near the English territory, and these people, having been accustomed to trade with the company for many years, will carry their furs to Lapierre House, on the Porcupine, or to the new station which will probably be constructed near the boundary.

The trade which will be controlled by Americans will therefore be that of the Russian company, increased by the number of skins annually obtained by the English at Nuclucayette. I suppose the aggregate from both sources does not exceed fifteen thousand skins.

The geography of the river and adjacent territory controls in a marked manner the character of the trade carried on upon the Yukon. In previous chapters I have remarked that the river runs in many places with a swift current; that it is filled with shoals and difficult of navigation even for small boats; and that there is not sufficient water at any of its mouths, as far as has been determined, to float a vessel of sufficient size to voyage upon the sea. Vessels, therefore, which come to the coast for furs must lie at St. Michael's, and the river must be ascended and the different points of trade visited in boats. Owing to the condition of the ice in Behring Sea a vessel cannot reach St. Michael's Island much before the middle of June. A trip in open boats to Nuclucayette would then require the whole season, leaving no time for return. Such a journey would be found extremely difficult, as trading goods and provisions would have to be transported, and very unprofitable, since few good furs would be obtained, as the summer skins are worthless.

From these remarks it follows that a profitable management of the fur trade of the Yukon requires the establishment and maintenance of permanent stations on the river. This is no place for small enterprises. It is impossible for sloops and schooners to run in and rapidly trade with the natives, delaying only for a few hours or days, as can be done in some other parts of the Territory.

I suppose about five stations are required to collect, with convenience, the furs on the lower part of the river, and for these there will be necessary a force of about fifteen men. Whether the amount of trade will justify the expense of such an establishment, including the cost of transporting goods, supplies, and furs to and from the river, remains to be seen.

A brief account of American enterprises on the Yukon since the transfer of the Territory to the present time will not be uninstructive.

The company on whose vessel I traveled established its stations on the Yukon in the summer of 1869, during the journey described in this report. Upon our arrival at St. Michael's Island we found the stations of two companies, both of which had been engaged in the trade since the transfer of the Territory. Before our departure one of the companies abandoned the business and sold its stock to the new company. A large sloop, with a complete stock of trading goods, had arrived about the same time, with the purpose of opening an establishment. The owner, however, did not appear to think the prospect encouraging, and he also sold out to the new company. As for small vessels, many of which visited Norton Sound during the year following the transfer, they in every case went away empty-handed.

When I left St. Michael's Island in the fall of 1869, the condition of things was this: two powerful and determined companies, having abundant capital, occupied various stations on the river and coast, and an active competition had commenced. This was certainly calculated to develop the fur trade to its utmost extent, yet I am informed that the result was a loss to both parties; and in the following year the companies combined, having found that the trade could not be profitably divided.

I have already said that the statistics are not sufficiently exact for accurate conclusions; nevertheless, it appears to me that a better idea of the value of the trade may be gathered from the general statements I have given than from the statistics of the old companies, which existed under vastly different conditions. At least one deduction may be drawn from the facts: *the amount of trade in furs on the Yukon River will at most furnish a business for one company, and employment on the river for about fifteen men.*

The timber of the Yukon River may in the distant future become of considerable value. It consists principally of spruce, poplar, birch, alder, and willow. The spruce and birch are the only varieties of any value for practical purposes. The former is very abundant upon the upper and middle portions of the river. It does not usually grow to a large or even medium size, and at Fort Yukon, where I had occasion to use a good deal of it, it did not appear to be of very good quality. Birch is comparatively scarce. The lower portion of the river for a distance of about one hundred miles from its mouth is devoid of trees. The timber of the Yukon River cannot for many years become an article of commerce, because large supplies, superior in quality and much more accessible, exist nearer the market.

The waters of the Yukon swarm with a variety of fish, the principal of which is the salmon. This fish is found in almost incredible quantities, especially on the lower portion of the river. The fish of the Yukon cannot, however, at present become an article of commerce, because a sufficient market has not yet been found for the salmon of the Columbia River and Puget Sound, while the southern rivers of Alaska are equally prolific and yet almost untouched. Moreover, the cost of labor is too great; Indian labor is not to be depended upon for this or any other purpose.

The region bordering the Yukon cannot properly be said to have any agricultural resources. I shall not attempt to discuss the question as to what grains or vegetables may, by careful preparation of the soil, be made to grow, because it seems to be a question of little practical consequence. A reference to preceding chapters will prove sufficiently the fact that this portion of the Territory is not of such a character as to invite the immigration of an agricultural population. Hence, agriculture in this region will at best be merely an auxiliary or incidental occupation of persons principally engaged in other pursuits. But the fur-trader is not usually a willing tiller of the earth, and even under the most favorable circumstances the utmost efforts of a dozen or fifteen men would scarcely be sufficient to develop, in this direction, an important industry.

No valuable mineral deposits in workable quantities have been found in the vicinity of the Yukon River up to the present time.

PART II.

OBSERVATIONS AND METHODS OF REDUCTION.

PART I

OBSERVATIONS AND METHODS OF PREDICTION

OBSERVATIONS AND METHODS OF REDUCTION.

CHAPTER I.

ASTRONOMICAL DETERMINATIONS.

I. OBSERVATIONS.

As Fort Yukon was believed to be situated very near the eastern boundary of Alaska, it seemed necessary to make as accurate determinations as possible of its latitude and longitude, in order to fix its position beyond a doubt. Owing to the limited time for preparation, I was unable to obtain suitable instruments from Washington; but, fortunately, I succeeded in obtaining in San Francisco all that were required. The astronomical instruments employed were as follows: Portable transit instrument, by Troughton and Sims, London; an admirable instrument, and in excellent condition. Zenith telescope, by Würdemann, Washington; an old instrument, and in poor condition. Sextants, (2,) by Würdemann, Washington; in excellent condition. Chronometers, (6;) Bond, Nos. 260 and 231, (sidereal;) Bliss and Creighton, Nos. 1155 and 1609; Parkinson and Frodsham, No. 2475; Barraud, (watch,) No. 5149, (mean.)

On several days before our departure Professor George Davidson, of the Coast Survey, kindly gave me comparisons with the sidereal clock in his observatory, of which the error was determined with great accuracy.

Our first astronomical observations were made at Sitka. The weather was exceedingly unfavorable during our stay at this place. On April 28 and 29, and May 1, I observed equal altitudes of the sun for time. East and west stars were also observed on the evening of April 28, but as the atmosphere was saturated with moisture the observations gave poor results.

Our next observations were made in the harbor of Ounalaska, on the extremity of a point of land the position of which had been accurately determined by the Coast Survey. On May 23 and 24, sextant observations were attempted, but failed on account of the weather. On May 25 and 26, equal altitudes of the sun were observed for time.

At St. Michael's Island the weather was again unpropitious. Sextant observations of single altitudes of the sun were obtained, however, on July 1 and 3. I was anxious to make a good determination of the chronometer error at this place, as its position is fairly determined, and there was no well-located point between it and Fort Yukon. The circumstances of the expedition not admitting of delay, I was compelled to content myself with these meager results.

On July 4, during our journey along the coast, we stopped at the mouth of the Pikmiktalik Creek to procure wood. I obtained observations of circum-meridian altitudes of the sun for the determination of latitude.

At Anvic, the next position where the circumstances of travel rendered observations practicable, we obtained, on July 13, sextant observations of equal and circum-meridian altitudes of the sun for determining latitude and longitude.

At Nulato, on July 19, we obtained a few sextant observations for latitude. The sun was too near the meridian at the time of observation to give good results for longitude.

At Fort Adams, on July 23 and 24, sextant observations of equal altitudes of the sun were obtained for the determination of latitude and longitude.

Practically, there was no night during our journey on the river, and consequently stars could not be observed.

Our next observations were made at Fort Yukon. We arrived at this place on the afternoon of July 31, and on the next day we commenced the preparation of our observatory.

The astronomical observatory consisted of two large wall-tents, without flies, which were pitched end to end, and opened one into the other. From each tent a breadth had been removed on both sides of the ridge-pole, leaving two observing-slits, about two feet in width. When not in use these were covered with wider breadths, fastened in place with ties. By means of a system of pulleys, they could be rapidly run up or down as required. This observatory was devised by Mr. Major, and prepared under his direction in San Francisco. It served its purpose admirably, being perfectly tight in bad weather, and affording plenty of interior space. It is more portable than the wooden traveling observatory often used, which is, moreover, inconveniently small.

In the center of the outer tent a sound spruce log, about twenty inches in diameter, was firmly planted. The top was approximately leveled, and upon it was placed the zenith telescope. The inner tent was occupied by the transit instrument. I was unable to obtain a single block of sufficient size for this instrument, although a party was sent a considerable distance up the river in search of one. Finally, two spruce logs were fastened firmly together with wooden tree-nails, and planted about three feet deep in the ground.

The transit instrument employed has at each corner of its stand a screw working in a brass female-screw, the intention being that the latter should be leaded into a stone block. The instrument having been put approximately into position, and the corners marked, it was removed, and the female-screws were firmly leaded into the block. It was then replaced, and being without adjusting foot-screws, it was brought to an approximate level by screwing it down tightly upon thin sheets of lead placed under the bearings.

A meridian-mark was established on the south bank of the river, at a distance of about three-quarters of a mile from the observatory. I was compelled to place it "over water," as the locality did not admit of any other arrangement. It consisted of a square piece of wood, on which two narrow strips of dark cloth were fastened in the form of the letter X, the intersection being marked by a small tack. This was arranged to move east or west in a groove made in a long piece of wood, which was fastened horizontally on two strong posts. The mark was put approximately in the meridian, and its azimuth ascertained by means of the micrometer of the transit instrument.

During the journey the closest attention was paid to the proper transportation of our instruments. Everything was packed and stowed in the most careful manner. The chronometers were placed in a strong basket padded with felt and hair, and covered with a cushion of the same materials. They were transported on one of the large boats which we had in tow, in order that they might not be subjected to the con stant jarring of the steamer. The smaller instruments were kept in the wheel-house. The transit instrument and zenith telescope, in four large boxes, were stowed under cover in the forward part of the boat, as far as possible from the heat of the furnace. We hoped to get all our instruments to Fort Yukon in good condition. By an unfortunate occurrence on the river, however, our endeavors were nearly frustrated. During a stormy night, some of the men who had to sleep on deck, exposed to the weather, conceiving, perhaps with reason, that their bodies had quite as good a right to protection as my boxes, removed the instruments from their shelter, and placing them near the furnace, disposed themselves in their place. This arrangement was soon discovered, and the boxes were replaced; but on our arrival at Fort Yukon I found that considerable mischief had been done. Two of the seven threads had been broken from the reticule of the transit instrument, and both of the levels of the zenith telescope were utterly ruined; so much ether having evaporated that the bubbles could not be read.

As soon as I discovered these injuries I set about repairing them. The reticule-frame was fixed in the tube of the transit instrument in such a way that, in the absence of the proper tools, it could not be removed without danger to the remaining threads. Having procured some fresh thread from a spider, I made a little frame of paper, with a handle bent vertically, and fixing the lines to it, lowered them into position, adjusting them with my pocket-microscope, and finally securing them in place, by means of a little shellac varnish, with which I was fortunately provided. After a great many trials, I finally succeeded in adjusting them to my satisfaction; and I found afterward that the intervals were quite as good as those fixed by the instrument-maker.

I attempted to repair the zenith-telescope levels by the introduction of ether obtained by opening the little levels at the ends of the spare transit level, which are not necessary to its use. This expedient completely failed, and I was finally compelled to make use of the following device: The spare transit level was taken to pieces and its tube was firmly lashed with copper wire upon a piece of wood cut to a suitable shape. The tube of the telescope level having been removed, this was bound tightly in its place. I was compelled to dispense with the striding level, but the horizontal axis was readily leveled by other means.

To return to our observations: During the first week of our stay at Fort Yukon the weather was extremely unfavorable. The occasional appearance of the sun, however, gave us a few opportunities. On August 2, 5, and 6, we obtained sextant observations, which gave us an approximate latitude and chronometer error. During this week we had no opportunity to put our instruments in position.

On August 7 the solar eclipse occurred. The weather was fitful, and the sky partly obscured by floating clouds. But we succeeded in obtaining good observations of equal altitudes of the sun for the determination of the chronometer error.

I had previously made a projection of the eclipse with an assumed longitude, which proved more accurate than I expected, coming within a minute or two of first contact. I observed with the zenith telescope, using the colored glass from a sextant. Mr. Ferdinand Westdahl, a gentleman of the trading party, observed with a pocket-glass, at my request; Mr. Major made the record. Owing to an imperfect arrangement of the colored glass, not discovered until too late, I lost the first contact. It was recorded on Mr. Westdahl's call at $10^h\ 58^m\ 01^s.67$, (local mean time.) The greatest obscuration was recorded at $0^h\ 01^m\ 40^s.00$.

The quantity of the eclipse was about 11 digits. The last contact was recorded at $1^h\ 09^m\ 29^s.58$, both observers calling on the same tenth of a second.

During the eclipse there were quantities of light, fleecy clouds in the north, east, and west, and stratus-cumuli in the south. The temperature at greatest obscuration was 62° F.; at last contact, 70° F.

The next day the chronometer error was computed, and as it was necessary for the steamer to return immediately to the coast, we commenced the computation of longitude on the same evening, finishing it at 6 o'clock on the following morning. We thus obtained an approximate longitude, which proved that we were a considerable distance west of the boundary.

During the early part of August the shortness of the night was the occasion of much embarrassment. On the 8th of August the transit instrument was placed approximately in the meridian, and on the 9th its adjustment was perfected. On the 10th the meridian-mark was placed in position, and observations for time by transit of stars were obtained on the 10th, 11th, 12th, 13th, 14th, and 17th. The weather on the 15th and 16th was unfavorable.

On the 17th, by an unfortunate accident, the level of the transit instrument was broken. I therefore decided to suspend transit observations for a night or two, and make a few observations for latitude with the zenith telescope.

On August 10, the values of single divisions of the two transit levels were determined in terms of the zenith-telescope micrometer. The levels were lashed successively to the tube of the zenith telescope, and the instrument turned on the meridian-mark. The values were then determined in the usual way.

On August 15, the value of one revolution (100 divisions) of the zenith-telescope micrometer in arc was determined by observations on Polaris near its eastern elongation.

On August 16, observations for latitude were commenced with the zenith telescope, but failed on account of unfavorable weather. On the 17th two observations were obtained after the transit observations. On the 18th and 19th observations were obtained; although at the latter date the weather was unfavorable.

With the instrument arranged as I have described, we could not hope for a high degree of accuracy in the results; and, moreover, we found that the micrometer screw was much worn and did not work smoothly. The latitude observations were therefore abandoned, and the spare transit level put together again for use with the transit instrument.

On August 20 we recommenced observations with the transit instrument, and continued them on the 21st, 22d, and 23d. On the 28th, the day of our departure from Fort Yukon, the transit of the sun was observed.

On the 21st, 22d, and 23d, observations of moon culminations were obtained. Much to my regret, the weather and the times of culmination prevented our obtaining more of these observations.

During our journey down the river, the pressing necessity for rapid progress, and the hard physical labor consequent thereon, forced us to abandon our observations, except on a few favorable occasions. At Nulato, on September 8, sextant observations of single altitudes of the sun were obtained for time, and also at Redoubt St. Michael's on September 26.

This concludes the account of the astronomical observations of the expedition.

II. COMPUTATIONS.

1. *Preparatory computations.*

(1.) *From sextant observations.*—The chronometer correction from sextant observations is computed as follows, and on the following dates:

Sitka, April 29, mean noon, by equal altitudes of the sun.
Sitka, May 1, mean noon, by equal altitudes of the sun.
Ounalaska, May 26, mean noon, by equal altitudes of the sun.
St. Michael's Island, July 1, mean noon by single altitudes of the sun.
Anvic, July 13, mean noon, by equal altitudes of the sun.
Fort Adams, July 23, mean noon, by equal altitudes of the sun.
Fort Adams, July 23, midnight, by equal altitudes of the sun.
Fort Yukon, August 6, mean noon, by equal altitudes of the sun.
Fort Yukon, August 7, mean noon, by equal altitudes of the sun.
(See Appendix A, pages 74 and 75.)

At Pikmiktalik and Senati's Village, the chronometer correction could not be well determined, as the observations were all too near the meridian for this purpose. Where observations for equal altitudes had been obtained, it was thought unnecessary to compute from the remaining single altitudes.

The chronometers were compared daily, but, owing to the small number of time observations obtained, the rates could not be well fixed. It would have been desirable to establish from the comparison the relative rate and difference of each pair of chronometers, so as to exclude errors, but this was omitted in order to expedite the preparation of the report. From the indication of one of the chronometers at local mean noon, the corrections of the other chronometers were determined in the usual way. (See Appendix A, page 75.)

(2.) *Level determinations.*—The values of single divisions of transit levels Nos. 1 and 2, in terms of the zenith-telescope micrometer, are computed from the observations of August 10, (see Appendix A, pages 76 and 77,) with the following results:

No. 1, d=1.785 divisions of micrometer.
No. 2, d=5.933 divisions of micrometer.

The condition of the micrometer screw rendered a high degree of accuracy impossible.

The value of one revolution (100 divisions) of the zenith-telescope micrometer has been computed from the observations on Polaris, near its eastern elongation, on August 15, (see Appendix A, page 75,) with the following result:

$$R=62''.029$$

hence for

$$\text{Level No. 1, } d=1''.1067=0^s.0737$$
$$\text{Level No. 2, } d=3''.6734=0^s.245$$

For the level constant we have, (Chauvenet, II, page 172)—

$$b=\frac{(w+w')-(e+e)}{4}$$

hence—

$$\text{Level No. 1, } b=0^s.0184\ [(w+w')-(e+e')]$$
$$\text{Level No. 2, } b=0^s.0612\ [(w+w')-(e+e')]$$

The value of $[(w+w')-(e+e')]$, interpolated between the observations, is given in red figures in the level column of the original transit record.

(3.) *Transit determinations.*—The time-list employed (including moon culminations) comprises forty-six well-determined stars, selected principally from the American Ephemeris, one or two having been taken from the British Almanac. It is not thought necessary to give the names of the stars in this place, as they will be found in the transit record.

(*a.*) *Corrections for rate.*—The approximate rate of the chronometer employed in the observations (231 Bond) was determined at $0^s.15$ gain per hour. The corrections for rate were then determined mechanically, by means of a calculating circle constructed as follows: A circular disk of paper was graduated to hours and minutes. This was made to turn concentrically upon another circle having the same radius. The circumference of the latter was graduated in hours, and these spaces divided into fifteen equal parts, representing hundredths of a second. The "assumed time" being found on the inner circle, and placed at the zero-division of the outer circle, the time corresponding to the mean of the threads on the inner circle will indicate the correction for rate on the outer circle. If this reading is on the left of the zero-division, the correction is positive; if on the right, negative. This contrivance was devised by Mr. Faber du Faur. It is quite as accurate as computation, and less liable to error.

(*b.*) *Reduction of apparent places of stars for transit at Fort Yukon.*—The right ascension and the declination being given in the Ephemeris for every tenth transit at Washington, these quantities must be interpolated for transit at Fort Yukon, adding the difference of longitude in time between Washington and Fort Yukon to the whole number of days between date of observation and date in Ephemeris.

	h.		*d.*
Longitude of Fort Yukon (adopted before final determination)	9.62333	=	0.401
Longitude of Washington	9.13673	=	0.214
Difference in sidereal time			0.18694
Difference in mean time			0.1864

R = ten times the daily rate of motion from Ephemeris; d = difference between R and next following rate; t = number of days from date in Ephemeris to date of observation.

Mean ten days for interpolation—

$$R + \frac{d}{20}(t + 0.1865)$$

Change of right ascension or declination, (upper culmination)—

$$(t+0.1865)\left[\frac{R}{10}+\frac{d}{200}(t+0.1864)\right]=\frac{R}{10}(t+0.1865)+\frac{d}{200}(t+0.1864)^2$$

The values of $\frac{1}{20}(t+0.1864)^2$ have been tabulated (see Appendix A, page 78) with the arguments $\frac{d}{10}$ and t.

For lower culminations the change of position is—

$$\frac{R}{10}(t+0.685)+\frac{d}{200}(t+0.685)^2$$

The values of $\frac{1}{20}(t+0.685)^2$ are also tabulated, (see Appendix A, page 78.)

(*c.*) *Azimuth, level, and collimation factors.*—In the computation of these factors the tables given in the United States Coast Survey Report, 1866, pages 66–71, have been employed.

(*d.*) *The equatorial intervals* from the mean of the threads have been determined from thirty observations for each thread, the time not admitting of a longer series, (see Appendix A, page 79.) The probable error of the mean of the threads is $0^s.038$.

From the equatorial intervals, the corrections for missed threads were determined in the usual way.

(*e.*) *The factors for conditional and normal equations* have been formed and tabulated in the usual way.

(*f.*) *The normal equations*, their solutions, and the determinations of the chronometer correction and of instrumental corrections from deviations in azimuth and collimation thus ascertained have been computed in the usual way. The final results are given in the transit record.

The observations of August 9 and 17 have been rejected. On the former occasion the adjustment of the instrument had not been perfected; and on the latter, the obervations were insufficient to determine the instrumental corrections.

(*g.*) *The chronometer corrections* and their probable errors for each day, as determined by the method of least squares, are given in Appendix A, pages 82 and 83.

$a =$ deviation in azimuth before reversal.
$a' =$ deviation in azimuth after reversal.
$c =$ collimation for indicated position of the lamp.

From the chronometer corrections as found for the several days, the rate and a corrected correction have been determined by the method of least squares, (see Appendix A, page 83,) the assumption being a constant rate from August 10 to August 23.

Chronometer correction at 7 hours face indication at night, August 10, $+ 14^h\ 15^m\ 00^s.2973$. Correction at 7 hours for any other date, $(14^h\ 15^m\ 00^s.2973) - 3^s.5142\,(t)$; in which $t =$ number of days, chronometer time, after 7 at night, August 10.

(4.) *Zenith telescope determinations.*—The stars employed were selected from the British Association Catalogue. In the computation, nine pairs, giving thirteen determinations, have been used.

For a corrected list of the mean positions of these stars for 1869, (January 1,) I am indebted to the kindness of Professor J. E. Hilgard, of the Coast Survey.

2. *Final results.*

(1.) *Longitude of Fort Yukon.*

(*a.*) *By solar eclipse of August* 7.—The contacts were timed with chronometer 231, and the correction of the same; the local sidereal times of contact were found as follows:

First contact	$8^h\ 03^m\ 37^s.00$
Second contact	$10^h\ 15^m\ 26^s.47$

The elements of the eclipse for the hours 7, 8, 9, 10, 11, and 12, Greenwich mean time, were computed and tabulated, and from the values interpolated for the times of contact, the longitude of Fort Yukon was determined as follows:

By first contact	$9^h\ 39^m\ 19^s.27$
By last contact	$9^h\ 41^m\ 23^s.74$

The result by first contact is untrustworthy, owing to the character of the observation, which has been before alluded to. Possibly the wrong minute was recorded, but considering the uncertainty of the observation, I have not thought it worth while to re-compute on this supposition.

(*b.*) *By moon culminations.*—The observed times of transit were corrected for instrumental deviations, and the longitude then determined by the method given in the Coast Survey Report, 1858, pages 188–189. The results are as follows:

August 21	$9^h\ 41^m\ 11^s.11$
August 22	$9^h\ 40^m\ 54^s.70$
August 23	$9^h\ 41^m\ 11^s.18$

The result from the observations of August 22d is rejected, as it differs too much from all the other results, and the instrumental corrections are large.

(*c.*) *By difference between local and Greenwich sidereal times of mean noon.*—The local time of mean noon at Fort Yukon by chronometer 1609, having been determined by sextant observations on August 7, the local sidereal time of mean noon was determined from the comparison of chronometers 1609 and 231, and the correction of the latter for sidereal time by transit observations. The difference between the sidereal times of mean noon at Fort Yukon and Greenwich, divided by the hourly change in right ascension, gives the difference in longitude. Allowing for the probable error of the sextant observations, the result confirms the longitude found by moon culminations. The result thus corrected is $9^h\ 41^m\ 9^s.48$.

(*d.*) *The adopted longitude of Fort Yukon.*—From so small a number of determinations it is, of course, impossible to obtain a probable error of the final result, or to reject doubtful values with certainty. A mean of all the determinations, rejecting only the value by first contact of eclipse, which is undoubtedly erroneous, gives us, as a final result, $9^h\ 41^m\ 10^s.04$; mean of two values from moon culminations, $9^h\ 41^m\ 11^s.145$. Either may be adopted, as the difference is only $1^s.11$, which corresponds in this latitude to a distance less than one-tenth of a mile.

I have thought best to adopt the mean from moon culminations, which makes the longitude of Fort Yukon $9^h\ 41^m\ 11^s.145 = 145^\circ\ 17'\ 47''$.

(2.) *Latitude of Fort Yukon.*—The right ascension and declination of the stars employed have been computed from the values given at the beginning of the year. In consequence of the high declination of most of the stars, the computation has been made by the second method, given on page 260 of the American Ephemeris for 1869.

The observations were reduced in the usual way. The assumed chronometer correction and the rate differ too little from the values finally determined to affect the result, the corrections for reduction to meridian being small.

Latitude of Fort Yukon, $66^\circ\ 33'\ 46''.87$.

The computation is given in Appendix A, page 84.

(3.) *Longitudes of Anvic and Fort Adams.*—The longitudes of St. Michael's Island and Anvic were first determined by five chronometers, the data being the observed chronometer time of local mean noon at these places, and at Sitka and Ounalaska, the known longitudes of the last-named places, and the assumption of a uniform rate from Sitka to Anvic.

The longitudes of Anvic and Fort Adams have been computed upon the supposition of a uniform rate from St. Michael's Island to Fort Yukon, and the results corrected for change of rate determined as follows:

First station—Chronometer time of mean noon	T_1
First station—Rate	R_1
Second station—Chronometer time of mean noon	T_2
Second station—Rate	R_2
Daily increase of rate	r
Difference of longitude	L
Mean rate between stations	$R_0=R_1+\frac{r}{2}D$
Chronometer time between stations (in days)	D
For an intermediate point, difference of longitude from first station	l
Chronometer time of mean noon	t
Chronometer time between stations (in days)	d

Assuming a uniform increase of rate—

$$R_2=R_1+rD;\ r=\frac{R_2-R_1}{D}$$

Also—

$$T_2=T_1-L+S;\ S=T_2-T_1+L$$

in which S=gain of chronometer due to rate, (in seconds.)

$$S=D(R_1+\frac{r}{2}D)$$

$$\frac{S}{D}=R_1+\frac{r}{2}D$$

$$t=T_1-l+d(R_1+\frac{r}{2}d)$$

$$\frac{t-T_1+l}{d}=R_1+\frac{r}{2}d$$

$$\frac{S}{D}+\frac{T_1-t}{d}-\frac{l}{d}=\frac{r}{2}(D-d)$$

$$l=\frac{S}{D}d+(T_1-t)-\frac{r}{2}d(D-d)=R_0d+(T_1-t)-(R_2-R_0)\frac{d}{D}(D-d)$$

since

$$r=2\frac{R_2-R_0}{D}$$

In this formula $[-(R_2-R_0)\frac{d}{D}(D-d)]$ is a correction for the longitude computed under the supposition of a uniform rate.

The rates of the different chronometers were found at Fort Yukon, from mean noon by chronometer 231, (assuming the longitude as $9^h\ 62\frac{1}{3}$, the error of which assumption does not affect the results,) is as follows:

Chronometer (mean) 1609.

Mean noon, August 10	$1^h\ 13^m\ 19^s.44$
Mean noon, August 7	$1^h\ 13^m\ 48^s.63$
Gain	$-29^s.19$
Daily rate	$-\ 9^s.73$

Chronometer (sidereal) 231.

Gain in 24 hours sidereal time $=3^s.5142$, (chronometer time;) 24 hours sidereal time $=24^h\ 00^m\ 3^s.5142$, (chronometer time,) $=24^h-235^s.91$ mean time; $3^s.5142$ (chronometer time) $= 3^s.51$ sidereal time $= 3^s.50$ mean time. Daily rate on mean time $= 235^s.91 + 3^s.50 = + 239.41$, (chronometer time.)

Chronometer (mean) 1155.

Mean noon, August 7	$1^h\ 29^m\ 34^s.60$
Mean noon, August 2	$1^h\ 29^m\ 34^s.63$

No rate on mean time, (changing after this to a positive rate.)

Chronometer (sidereal) 260.

Mean noon, August 10	$6^h\ 54^m\ 20^s.08$
Mean noon, August 8	$6^h\ 46^m\ 33^s.28$
Gain in three mean days..................	$= 7^m\ 46^s.80$
Gain in one mean day............. $= 233^s.40$	$= 0^d.002701$
Gain in 24 hours, chronometer time........	$= + 232^s.76$

Chronometer (mean) 2475

Mean noon, August 10......................	$1^h\ 45^m\ 37^s.8$
Mean noon, August 6......................	$1^h\ 45^m\ 16^s.6$
Gain in 4 days..............................	$+ 21^s.2$
Daily rate	$+ 5^s.3$

The value of $(R_2—R_0)$ for each chronometer is obtained as follows:

Chronometer—	1609.	231.	1155	260.	2475.
	s.	*s.*	*s.*	*s.*	*s.*
R_2	− 9.73	+ 239.41	0.000	+ 232.76	+ 5.3
R_0	−10.21	+ 238.69	− 2.685	+ 233.91	+ 1.6
$R_2—R_0$	+ 0.48	+ 0.72	+ 2.685	− 1.15	+ 3.7

The values of the correction $[—(R_2—R_0)\frac{d}{D}(D—d)]$ being determined and applied to the differences of longitude obtained on the supposition of a uniform rate, we have the following results:

Chronometer.	Difference of longitude of Anvic and St. Michael's by uniform rate.	Correction for change of rate.	Corrected difference of longitude.	Difference of longitude of Fort Adams and St. Michael's by uniform rate.	Correction for change of rate.	Corrected difference of longitude.
	h. m. s.	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*h. m. s.*
1609........................	0 07 03.19	− 4.89	0 06 58.30	0 37 18.31	− 4.28	0 37 14.03
231........................	06 58.96	− 5.86	06 53.10	37 34.24	− 6.44	27.80
1155........................	07 23.16	−21.76	07 01.40	38 00.53	−23.92	36.61
260........................	07 03.95	+ 9.35	07 13.20	37 32.09	+ 10.27	42.36
2475........................	07 44.21	−42.94	07 01.27	38 12.07	−47.21	24.86
Mean			0 07 01.25	Mean..................		0 37 29.13
			° ′ ″			° ′ ″
		=	1 45 18.75		=	9 22 16.95
Longitude of St. Michael's..............		=	161 52 28.00	Long. of St. Michael's	=	161 52 28.00
Longitude of Anvic		=	160 07 10.75	Long. of Fort Adams	=	152 30 11.05

(4.) *Latitudes of Pikmiktalik, Anvic, Nulato, Fort Adams, and Senati's Village.*—The latitudes have been computed in the usual way, from observed circum-meridian altitudes of the sun at these places.

The following table gives a summary of the results from astronomical observations:

Table of latitudes and longitudes.

Station.	Latitude.	Longitude.
	° ′ ″	° ′ ″
Pikmiktalik	63 13 41	....
Anvic	62 37 24	160 07 11
Nulato	64 40 23	....
Fort Adams	65 08 11	152 30 11
Senati's Village	65 20 54	....
Fort Yukon	66 33 47	145 17 47

CHAPTER II.

MAGNETIC OBSERVATIONS.

The magnetic observations which I have to submit are few in number and were obtained with considerable difficulty. The circumstances incident upon our mode of traveling did not permit the use of the magnetic instruments except at Fort Yukon. While at that place my time was so much occupied by more pressing duties that I had few opportunities to give attention to matters outside of my instructions. Appreciating, however, the great importance and interest which would attach to magnetic observations obtained in so high a latitude, I devoted as much time as possible to this subject, and I submit the results, regretting that the data are necessarily so incomplete. The observations were all made by myself without assistance, and I must plead in further extenuation of their many imperfections my inexperience in work of this character.

The magnetic observatory, consisting of a small tent, was pitched about fifty yards east of the astronomical observatory, this being the most distant position which was convenient and available. The poles were without iron pins or fastenings, and the greatest care was taken to remove from the vicinity everything which might affect the position of the magnet.

The instruments employed were theodolite magnetometer No. 2, and dip circle No. 2, both by Mr. William Würdemann, of Washington.

Within the observatory a sound pine post was firmly imbedded. Upon it the declinometer was placed for the observations for magnetic declination and intensity. The observations for variation in declination were made on the 14th and 16th days of August, these being the only days which I could spare for this purpose. The observations of deflection were made on the 14th, and those of vibration, with and without the weight, on the 16th. The observations for magnetic inclination were made on the 26th.

On almost every night during our stay at Fort Yukon brilliant displays of aurora were visible. The presence of aurora undoubtedly seriously affected my magnetic observations. Indeed, variations due to some abnormal agent are plainly apparent.

Apparently the effect of the aurora upon the suspended needle was to draw it strongly to the eastward. To this statement, however, there is one notable exception. An observation taken at $0^h\ 20^m$ a. m. on the 15th, during an interval of the astronomical observations, at which times there were slight indications of aurora in the sky, indicates a very great deflection in the opposite direction. My recollection of the circumstances under which this observation was made do not justify its rejection as an error in the record. Besides this horizontal deflection, the magnet was often agitated vertically. The record shows this to have been the case at $11^h\ 50^m$ p. m. on the 16th, and at $10^h\ 45^m$ a. m. on the same day slight oscillations, both horizontal and vertical, were observed, which I presume were produced by the same cause.

The auroral lights were most brilliant in the northeast or about the magnetic north, and from that quarter traveled in flushes over the sky toward the west and south. They presented the appearance of a series of delicate, transparent, silken curtains of a soft, white color, brilliantly illuminated, and moving through the heavens with a slow, waving motion, with many foldings and unfoldings, as if swayed by gentle breezes. On one occasion they apparently came so near the earth that they seemed almost within the reach of an outstretched hand.

Some persons say that during these displays they have heard a low, sighing sound; but this I have never noticed, and I am inclined to consider it as an acoustic illusion. So impressive is the effect produced by these phenomena that the very stillness seems to be audible.

The record of magnetic observations and also the computation of the various magnetic quantities will be found in Appendix B. The correction in declination for each day has been obtained by taking a mean of the observed variations, rejecting one observation on the 16th, at which time an abnormal motion was noted. The observation on the 15th is also rejected. A mean of the corrected declinations for the two days is assumed as the most probable absolute value.

The experiments of deflection were made in the usual manner, with the deflecting magnet at three distances. The value of the ratio of the magnetic moment of the deflector to the horizontal intensity, determined at the nearest distance, differs so much from the other determinations, even after the rejection of one doubtful observation, that I have thought proper to reject it and take as the most probable value the mean of the other two results.

The other computations do not require explanation. The final results are as follows:

Fort Yukon, Alaska.

φ	=	66° 33′ 47″
λ	=	145° 17′ 47″
Absolute magnetic declination	=	36° 32′ 44″
Absolute magnetic inclination	=	79° 49′ 32″
Horizontal intensity	=	2.73210
Total intensity	=	15.47162

CHAPTER III.

METEOROLOGICAL OBSERVATIONS—ALTITUDE OF FORT YUKON.

I. *Observations.*—The instruments employed in these observations were cistern barometers, Nos. 1609 and 1613, and dry and wet bulb thermometers, by Green of New York, and an aneroid barometer.

The cistern barometers were compared with a standard (No. 1571) at San Francisco; and after the rejection of abnormal observations, the following results were obtained:

No. 1613—Correction to standard, at 32° F.. —0.0269 in.
No. 1609—Correction to standard, at 32° F.. —0.0138 in.
Correction of No. 1609 to No. 1613, at 32° F.. 0.0131 in.

On September 26, 1869, barometers 1609 and 1613 were compared at St. Michael's Island, and the difference at 32° F. was found to be 0.0167 inch, indicating a possible error of 0.0036 inch.

For a set of observations at St. Michael's Island, extending over three months, I am indebted to the voluntary assistance of Captain Riedell, then in charge of the trading-station at that place. These observations were commenced July 3, and terminated on September 26, 1869. They were made four times daily, at the hours most convenient for Captain Riddell, viz: 9 a. m., 12 m., 3 p. m., and 9 p. m. They comprise—

1. Reading of barometer.
2. Reading of attached thermometer.
3. Reading of detached thermometer.
4. Reading of wet-bulb thermometer.
5. Direction of the wind.
6. Force of the wind, (estimated.)
7. Amount of clouds.
8. Kind of clouds.
9. Remarks.

The instrument employed at this station was cistern barometer No. 1613.

During our journey on the river similar observations were made at corresponding hours. When traveling we employed the aneroid barometer. When opportunity offered for observation on shore, the cistern barometer (No. 1609) was used, and the observations were made without regard to hours. The observations were principally made by Mr. J. J. Major, assisted by Private Foley. They extend from July 4 to July 31, 1869.

Observations were made at Fort Yukon from August 3 to August 28, 1869. They comprise the same character of information as that obtained at St. Michael's Island. They extend from 9 a. m. to 9 p. m., and are, as a general rule, recorded hourly. There are some omissions and some observations between the hours, as occasionally we were all simultaneously occupied in other duties. Private Michael Foley, under the direction of Mr. Major, was the observer.

II. *Altitudes.*—The circumstances of the expedition did not permit a series of observations to determine horary corrections, or the height o St. Michael's Island above the level of the sea. During the journey the observations *on shore* at any one place were necessarily few in number. Moreover, the observations are not taken at such hours as to give a reliable mean daily temperature. An attempt to construct a profile of the river from the data obtained would, therefore, be useless; because.

owing to the above considerations and the uncertainty attaching to observations in a high latitude, the error in altitude of any point would probably be as great as its difference in height above the next lower point computed, since the average fall of the river from Fort Yukon to the sea is only about five inches to the mile.

I have, therefore, attempted only to determine from these observations the difference of level between the station on St. Michael's Island and Fort Yukon; and thence approximately the height of Fort Yukon above the level of the sea. For this purpose, observations at corresponding *local* hours (not synchronous) have been compared with each other. With some of the observations the external temperature was not recorded. These have been arranged in a set by themselves, from which the altitude has been computed separately. The remaining observations form a single set from which the altitude has been computed and compared with the first result. For the purpose of distinction, the first set is called A, and the second B.

The formula and tables given by Lieutenant Colonel R. S. Williamson in his "Barometric Hypsometry," (Professional Papers of the Corps of Engineers United States Army, No. 15,) have been employed in the computation. The following is the formula:

$$Z = A \log \frac{h}{H} \times \begin{cases} \left(1 + \frac{t + t' - 64}{982.2647}\right) \\ (1 + 0.0026257 \cos 2L) \\ \left(1 + \frac{Z + 52252}{20886860} + \frac{s}{10443430}\right) \\ (1 + m) \end{cases}$$

The value of $A \log \frac{h}{H}$ was first determined as follows:

From set A—

$$A \log \frac{h}{H} = 358.6 \text{ ft}; \; r_o = 17.5; \; \text{weight, } p_{,} = 1$$

From set B—

$$A \log \frac{h}{H} = 344.0 \text{ ft}; \; r_o = 14.3; \; \text{weight, } p_{,,} = 1.3; \; m = 2; \; (p) = 2.3;$$

$$(n\,p) = 805.8$$

Mean of sets by weight—

$$\frac{(n\,p)}{(p)} = \frac{805.8}{2.3} = 350.4; \; r_o = 0.647\sqrt{\frac{120.49}{(2-1) \times 2.3}} = 4.9 \text{ ft.}$$

A mean of the values obtained by comparing observations at each hour separately, gives—

$$A \log \frac{h}{H} = 349.6$$

The various corrections to the term $A \log \frac{h}{H}$ were then computed from set B, and the following is the final result:

$$A \log \frac{h}{H} = 350.4 \pm 4.9 \text{ feet.}$$

Correction from set B = + 21.6.

Height of Fort Yukon above St. Michael's Island = 372 feet ± 4.9 feet.

Estimated height of St. Michael's Island above the level of the sea = 40 feet.

Height of Fort Yukon above the level of the sea = 412 feet.

All the observations are given in Appendix B, as they have a meteorological interest. The computations of the altitude of Fort Yukon, sets A and B, are also given on page 112 of the same appendix.

CHAPTER IV.

THE MAP.

Four maps of the Yukon River have been published. The first was constructed by Lieutenant Zagoskin, from reconnaissances made by him in the years 1842 and 1843. It extends only to a short distance above Nulato. The photographic copy in my possession is on a very small scale, constructed on Mercator's projection, and is in many respects inaccurate. The second is a map of Alaska, constructed from maps and other information in the possession of the Western Union Telegraph Company, and published in San Francisco in 1869. It is constructed on Mercator's projection. The lower part of the Yukon River is probably taken from Zagoskin's map. The upper portion seems to be altogether imaginary.

In the spring of 1869 the map of Mr. Frederick Whymper appeared. It is on a very small scale, having been constructed to accompany his book. The lower part of the river is principally from the map of Zagoskin, except the Yukon Delta, which is from the reconnaisance of Captain E. E. Smith, one of the explorers of the telegraph company. The upper part of the river is laid down from bearings and estimated distances obtained by Mr. Whymper during a rapid canoe journey from Fort Yukon.

Mr. Whymper published this map simply as a sketch, not claiming for it any degree of accuracy. It possesses, of course, many defects, but, considering the circumstances under which it was produced, it is remarkably good. It is constructed on Mercator's projection.

In 1869 the United States Coast Survey published the map of Mr. William H. Dall, late director of the scientific corps of the telegraph exploration. This map includes the whole Territory of Alaska, and is on a small scale. The lower portion of the Yukon is based, I presume, on the map of Zagoskin, but it has received many corrections. The Yukon Delta is taken from the reconnaissance of Captain Smith, and the upper portion of the river from Mr. Dall's bearings and estimated distances, obtained during a canoe journey from Fort Yukon, in which he was the companion of Mr. Whymper. Mr. Dall also had the benefit of several years' experience on the lower part of the river.

This is the most satisfactory map that has appeared up to the present time, though it contains, of course, some errors which could not well be avoided without astronomical observations. It is constructed on the polyconic projection.

The map which I have the honor to submit with this report is mainly the result of my own labors, and those of Mr. Major, my assistant. We do not claim, however, for our reconnaissance, which was in most respects of the simplest character, the accuracy of a survey. Nevertheless, our advantages, in some particulars, so much exceeded those of previous explorers, that I do not hesitate to claim for our map a greater degree of accuracy than pertains to any that has yet appeared.

I will describe briefly the plan on which the reconnaissance was conducted and the method of construction employed, and endeavor to indicate, in every instance, what assistance has been obtained from other maps and from individuals.

From St. Michael's Island, through the canal along the coast of Norton Sound to the Aphoon mouth, through this mouth and the Kvichpak mouth to the main river, and thence to Fort Yukon, the map is constructed from our observations.

These observations were commenced July 4, when we left St. Michael's Island in the little steamer Yukon, and continued until July 31, when we arrived at Fort Yukon. The observations were all taken by Mr. Major and myself, and were made as follows: Each observer remained on duty four hours, and was then relieved by the other, the observations continuing day and night. The itinerary was kept in ordinary note-books, which could be conveniently carried in the hand or pocket. The left-hand page was ruled in columns. In the first column the date and the time, by an ordinary clock, were noted; in the next the magnetic course traveled, observed with an ordinary boat compass, reading to degrees; in the next the estimated rate of progress per hour, based on the number of revolutions of the steamer's wheel per minute and the rapidity of the current. The latter was estimated usually from the observed time occupied by a small piece of wood floating by the length of the steamer.

On the right-hand page miscellaneous information of every character was noted, such as the width of the river, (estimated;) the position of the boat with reference to the axis of the stream; the positions of islands; the positions of the mouths of tributaries; their names, directions, and general character; the topography on both banks, occasionally illustrated by rough sketches; the timber; the geological characteristics; the positions and names of villages and trading-stations, &c. It was the duty of the observer to obtain and note as much information as possible from natives and other persons acquainted with any portions of the river. When relieved, the observer recorded the whole distance traveled (estimated) during his tour of duty.

The map is constructed on a polyconic projection, the tables published by the Bureau of Navigation, Navy Department, being used. The scale is 1 inch to 50,000 feet, or $\frac{1}{600000}$.

The parallels and meridians having been constructed, the positions of the points known from astronomical observations, namely, Redoubt St. Michael's, Anvic, Nulato, Fort Adams, and Fort Yukon, were carefully located.

The line of travel was then plotted from the itinerary on a large scale, forty sheets being used. The distance (in yards) corresponding to any course was assumed as proportional to the estimated rate per hour. In this preliminary construction sixteen hundred and fifty courses were plotted.

The river was then plotted on the scale of the map, in four sections, viz: from Redoubt St. Michael's to Anvic; from Anvic to Nulato; from Nulato to Fort Adams; and from Fort Adams to Fort Yukon. In this construction the courses shown on the preliminary sheets, being too small to be plotted on the scale of the map, were reduced to longer ones. The shore-lines were then carefully sketched in from the notes, the preliminary sheets being consulted at every step.

The four sections were then reduced (in length) and "swung in" between the determined positions at their extremities. In every instance, the estimated distances were found to be too great. This is owing partly to the fact that many slight changes of direction, taking in the aggregate considerable time, are neglected, and somewhat, probably, to a natural overestimation, in traveling up stream against a strong current.

Under the circumstances of the expedition, described in a previous chapter, we found it difficult to obtain corrections for change in magnetic variation. Owing to the probable position of the magnetic pole the change is not great between Nulato and Fort Yukon. Indeed, the error in measurement of the angle between two courses due to a neglect of this change must be within the error of the reading. This may be regarded as generally true for the lower portion of the river also. The directions of the first section of the river from the mouth to Anvic are probably the most in error. Nevertheless, by this construction Andreavsky and the Mission fall very near the points where they have been heretofore located, and this portion of the river agrees well in other respects with previous maps. The latitudes by construction at Pikmiktalik and Senati's Village agree well with the observed latitudes.

The outline of the coast from Kotzebue Sound to St. Michael's Island is from the map of the United States Coast Survey.

The outlines of St. Michael's and Stuart's Islands, except the side of the latter bordering on "the canal," are from Mr. Dall's map.

The country east of St. Michael's Island, including the flat country bordering the coast, the valley of the Golsova Richka, and the valley of the Upper Anvic, are from notes and a sketch made during our portage to the coast.

The hills parallel to the coast, from St. Michael's to a point near Andreavsky, are merely indicated, as we had no opportunity to note their characteristics, although they could be seen in the distance.

The mouths of the Yukon, with the exception of the Aphoon, and the upper portion of the Kvichpak, are from a traced copy of the sketch-map of Captain E. E. Smith, Western Union Telegraph Company, which I have adapted to my own observations.

The tributaries as far as the Anvic are, with the exception of the mouths, sketched from information obtained from traders and natives.

The country in the vicinity of the portage from the Kouskokvim River to the Yukon is taken from a sketch made at my request by Mr. Zandt, a trader, who traversed it early in the summer of 1869.

The Anvic River is constructed from notes taken during our journey, but details could not be recorded, as we were obliged to keep constantly at work at the paddles.

The Shagelook Slough (with the exception of its entrances, and the cross sloughs, which were observed) and the Shagelook River are taken from the map of Zagoskin, and information from traders.

The tributaries generally, as far as Nulato, with the exception of their mouths, are taken from the reports of traders and natives. The mouth of the Kaiyuh River was not observed, but, as its existence is undoubted, it has been sketched in from the map of Mr. Dall.

The valley of the Unalachleet River, and the topography between that river and the Yukon, except the country bordering the latter, has been indicated generally from Mr. Dall's map and descriptions.

The Kuyukuk River and its tributaries are taken from a rough sketch made by Captain Riedell, superintendent of the trading-station at St.

Michael's Island, and from information collected among the traders and natives; and the Tosekargut River and its branches are obtained from the same source.

The tributaries, generally, from Nulato to Fort Yukon, with the exception of their mouths, are taken from the reports of traders and natives, and the Tananá River is based upon a rough sketch and description obtained from a native.

The islands have generally been carefully located. Between the Ramparts and Fort Yukon, however, the river is so wide, and the islands are so numerous, that accurate determinations of their position was found impracticable. The islands along the channel traveled were noted, and the rest filled in from the descriptions and rough sketches of natives.

The trading-stations and villages are all carefully located from the notes. Even *caches* and graves have been marked, since they may be useful as land-marks to future explorers.

For names in common use among the traders, I have, in every case, adopted the customary orthography. Such names are *Unalachleet*, *Andreavsky*, *Anvic*, *Nulato*, *Nuclucayette*, *Tananá*. Other names (such as those of native villages and small tributaries) were noted in the itinerary and spelled so as to represent the pronunciation as nearly as possible. This spelling has occasionally been subsequently simplified, but generally it has been retained without change. The phonetic system proposed and employed by Mr. Dall has its advantages, but I have not felt at liberty to follow it in cases where other forms are actually in use.

Many names are given which will not be found on other maps, and some which have been given by others are omitted. I have also for a few localities used different names from those heretofore employed. These discrepancies may be accounted for by the fact that the native villages (with a few exceptions) are constantly changing, some being abandoned and others constructed. Another cause of difference in names is the uncertainty of the sources of information. I have in nearly all cases used the names actually recorded in the itinerary; but I cannot claim for them any degree of correctness greater than that of the names employed by others.

An outline map of Alaska and adjacent territory, showing the relative position of the Yukon River, has been constructed in a convenient place upon the map. With the exception of the sketch of the Yukon River from Fort Yukon to the sea, it is taken from the map of the United States Coast Survey, published in 1869, in which, however, all known errors have been corrected.

I have constructed a table of distances on the Yukon River, and along the coast to St. Michael's Island, which will be found in Appendix D, page 113. In these determinations the following method has been employed: The distance (on a great circle) between two points, determined by astronomical observations, was computed first from the known latitudes and longitudes, and, secondly, from the observed courses and estimated distances. It was then assumed that the second computed distance is to the first as the estimated length of any course situated between the determined points is to the true length. The errors were found to be always positive, and consequently the corrections are always negative. The river was divided into five parts and the corrections were determined separately for each part. The average correction is about 0.24 of the estimated distances run. This method involves two sources of inaccuracy. The first is the assumption that for a short distance (say two hundred miles) the errors in estimation are proportional to the distances run. It is thought that the errors arising from this source are not serious, as no attempt has been made to estimate smaller fractions than half a mile. The second is the fact that no correction is applied for errors in direction, the data being insufficient for their determination. It is to be observed, however, that the *constant* error in the measurement of an angle between two courses with a slow-moving needle is positive, requiring a system of positive corrections to be applied to the negative corrections determined for the estimated distances—in other words, the distances as determined are probably a little too small; but as an allowance must be made for unnecessary turnings, and the fact that the shortest course was probably not always taken, I have thought best to neglect this error.

The table gives the *traveled* distances, which are not always measured along the axis of the river. In some places convenient cut-offs materially shorten the route; while in others a tortuous channel, winding among islands, increases it much beyond the distance measured on the map.

To the best of my knowledge the only table of distances on the Yukon River ever before published is given by Mr. Dall, in "Alaska and its Resources." Mr. Dall's character as an observer demands for it a high degree of respect.

A comparison of the distances estimated by Mr. Dall and by myself will exhibit many apparent discrepancies, but I believe that they may all be satisfactorily accounted for by the following circumstances:

1st. Mr. Dall estimated along the *axis* of the river, while I estimated along the traveled channel.

2d. Mr. Dall necessarily assumed erroneous positions for some points which are now located with tolerable accuracy; for instance, Fort Yukon and the mouth of the Tosekargut.

3d. Mr. Dall estimated while traveling down the stream, whereas I estimated against the current.

The differences due to the first two causes named can be approximately ascertained, and I have, in fact, computed them for a large portion of the river; but it seems unnecessary to discuss the subject at length in this place. The general coincidence of the results confirms me in the belief that my table of distances is reasonably accurate.

APPENDIXES.

APPENDIX A.

RECORD AND REDUCTION OF ASTRONOMICAL OBSERVATIONS.

OBSERVATIONS WITH SEXTANT.

NOTE.—Only the observations employed in the computations are given in this appendix.

SITKA, *April* 29, 1869.

Sextant No. 4 and horizon of mercury—M. T. chronometer No. 5149, by Barraud—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

$\phi = 57^\circ\ 02'\ 52''$ N. $\lambda = 135^\circ\ 18'\ 02''$ W.

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	83 40 00	11 03 09.8	Sun's lower limb, p. m ...	86 00 00	2 59 16.0
	50 00	03 37.6		85 50 00	59 57.4
	84 00 00	04 35.8		40 00	3 00 57.2
	10 00	05 55.8		30 00	01 53.2
	20 00	06 29.2		20 00	02 49.0
	30 00	07 19.0		10 00	03 35.0
	40 00	08 17.8		00 00	04 45.0
	50 00	09 12.0		84 50 00	05 40.4
	85 00 00	10 11.7		40 00	06 31.2
	10 00	11 05.8		30 00	07 27.4
	20 00	11 58.8		20 00	08 27.2
	30 00	13 00.8		10 00	09 25.8
	40 00	13 59.8		00 00	10 28.8
	50 00	14 59.0		83 50 00	11 09.2
	86 00 00	15 55.7		40 00	12 08.0

Beginning of observations: Barometer, 30.350; thermometer, 49°.00. End of observations: Barometer, 30.400; thermometer, 55°.50.

SITKA, *May* 1, 1869.

Sextant No. 4 and horizon of mercury—M. T. chronometer No. 5149, by Barraud—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Observed double altitude.	Time of observation	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	84 00 00	10 58 44.8	Sun's lower limb, p. m ...	84 40 00	3 12 54.8
	10 00	59 22.8		30 00	13 30.8
	20 00	11 00 10.4		20 00	14 19.0
	30 00	01 01.8		10 00	15 05.4
	40 00	01 55.4		00 00	16 08.0

Beginning of observations: Barometer, 30.030; thermometer, 53°.00. End of observations: Barometer, 30.010; thermometer, 54°.50.

Observations with sextant—Continued.

OUNALASKA, *May* 26, 1869.

Sextant No. 4 and horizon of mercury—M. T. chronometer No. 5149, by Barraud—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

$\phi = 53° 53' 56''.5$ N. $\lambda = 166° 28' 51''.7$ W.

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	93 00 00	12 43 09.6	Sun's lower limb, p. m ...	98 50 00	5 18 27.0
	10 00	43 44.2		40 00	19 20.2
	20 00	44 32.0		30 00	19 54.2
	30 00	45 08.4		20 00	20 44.8
	40 00	45 55.4		10 00	21 30.2
	50 00	46 36.0		00 00	22 19.2
	94 00 00	47 16.4		97 50 00	22 59.4
	10 00	47 46.4		40 00	26 46.0
	20 00	48 41.2		30 00	24 31.2
	30 00	49 21.4		20 00	25 10.4
	40 00	50 10.2		10 00	26 03.8
	50 00	50 49.6		00 00	26 38.8
	95 00 00	51 24.4		96 50 00	27 28.8
	10 00	52 13.6		40 00	28 06.8
	20 00	52 51.4		30 00	28 47.8
	30 00	53 29.4		20 00	29 26.8
	40 00	54 12.4		10 00	30 16.6
	50 00	54 58.6		00 00	31 08.2
	96 00 00	55 46.4		95 50 00	31 49.0
	10 00	56 28.0		40 00	32 26.8
	20 00	57 09.2		30 00	33 16.2
	30 00	57 55.6		20 00	33 56.2
	40 00	58 38.4		10 00	34 33.2
	50 00	59 14.6		00 00	35 13.6
	97 00 00	1 00 07.6		94 50 00	35 58.6
	10 00	00 56.6		40 00	36 43.6
	20 00	01 35.8		30 00	37 20.6
	30 00	02 15.4		20 00	38 12.6
	40 00	03 03.8		10 00	38 50.6
	50 00	03 46.0		00 00	39 30.6
	98 00 00	04 29.2		93 50 00	40 11.0
	10 00	05 13.4		40 00	40 53.8
	20 00	05 54.2		30 00	41 40.8
	30 00	06 38.0		20 00	42 12.8
	40 00	07 35.6		10 00	42 55.0
	50 00	08 07.4		00 00	43 38.4

Beginning: Barometer, 30.350; thermometer, 54°.50. End: Barometer, 30.450; thermometer, 56°.00.

ST. MICHAEL'S ISLAND, *July* 1, 1869.

Sextant No. 4 and horizon of mercury—M. T. chronometer No. 5149, by Barraud—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

$\phi = 63° 28' 00''$ N. $\lambda = 161° 52' 28''$ W.

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	93 50 00	12 16 44.4	Sun's lower limb, p. m ...	87 40 00	3 53 30.0
	94 00 00	17 51.2		20 00	55 50.4
	10 00	19 25.6		10 00	56 40.4
	20 00	21 01.6		00 00	57 44.4
	30 00	22 29.8		86 50 00	58 54.2
p. m	88 20 00	3 49 30.4		40 00	4 00 01.6
	10 00	50 23.2		30 00	01 07.6
	00 00	51 14.4		20 00	02 06.0
	87 50 00	52 12.8		10 00	03 03.2

Barometer, 30.150; thermometer, 66°.00; index error, 0.

Observations with sextant—Continued.

PIKMIKTALIK, *July* 4, 1869.

Sextant No. 4 and horizon of mercury—M. T. chronometer No. 5149, by Barrand—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

ϕ=63° 13′ 41″ λ=162° 26′ 00″

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	97 00 00	12 56 07.0	Sun's lower limb, p. m ...	98 30 00	1 57 51.8
	05 00	57 05.7		29 30	59 00.4
	10 00	57 44.4		29 00	2 00 55.4
	15 00	59 05.2		27 00	01 12.0
	20 00	1 00 07.0		27 00	01 59.0
	25 00	01 34.0		24 50	02 52.2
	30 00	02 57.2		20 35	03 45.8
	98 38 30	1 50 30.8		18 35	04 38.4
p. m	36 10	54 02.4		15 55	05 40.6

Index error, 0.

ANVIC, *July* 13, 1869.

Sextant No. 4 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

ϕ= 62° 51′ 00″ λ= 159° 43′ 00″

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	81 30 00	11 42 41.8	Sun's upper limb, p. m...	98 39 00	2 37 47.0
	40 00	43 35.0		38 00	39 36.0
	50 00	44 32.0		37 00	40 19.5
	82 00 00	45 37.8		36 00	40 51.5
	10 00	46 27.8		35 00	41 36.0
	20 00	47 26.5	Sun's lower limb, p. m...	84 50 00	4 43 22.5
	30 00	48 24.5		40 00	44 18.5
	50 00	50 15.0		30 00	45 25.5
	83 00 00	51 04.3		20 00	46 22.5
	10 00	52 03.3		10 00	47 36.5
	20 00	53 04.8		00 00	48 30.7
	30 00	53 59.5		83 50 00	49 12.5
	40 00	54 57.0		40 00	50 15.5
	50 00	55 54.0		30 00	51 21.7
	84 00 00	56 57.0		20 00	52 17.5
	10 00	57 59.0		10 00	53 07.5
	20 00	58 45.0		00 00	54 20.0
	30 00	59 50.0		82 50 00	55 10.7
	40 00	12 01 00.0		30 00	56 50.5
	50 00	02 00.0		20 00	57 46.3
Sun's upper limb, p. m	98 49 15	2 28 58.5		10 00	58 44.0
	47 05	31 20.0		00 00	59 31.5
	42 00	34 29.0		81 50 00	5 00 43.3
	41 00	35 25.0		40 00	01 41.5
	40 00	36 26.0		30 00	02 33.5

Beginning: Barometer, 29.952; thermometer, 64°.00. End: Barometer, 29.960; thermometer, 65°.50. Index error, 0.

NULATO, *July* 19, 1869.

Sextant No. 3 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

ϕ= 64° 40′ 23″ λ= 158° 13′ 00″

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	71 30 00	11 02 15.5	Sun's lower limb, a. m ...	72 00 00	11 04 57.0
	40 00	03 05.0		10 00	05 40.0
	50 00	04 03.8			

Barometer, 29.953; thermometer, 74°.00; index error, —3′ 30″.

Observations with sextant—Continued.

FORT ADAMS, *July* 23, 1869.

Sextant No. 3 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

$\phi = 65° 08' 00''$ $\lambda = 152° 30' 11''$

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	71 10 00	10 48 33.2	Sun's lower limb, a. m....	89 11 00	1 53 28.7
	20 00	49 03.2	p. m....	10 30	56 21.2
	30 00	49 51.2		09 20	57 06.0
	40 00	50 46.0		08 05	57 54.5
	50 00	51 44.0		06 35	58 43.5
	72 00 00	52 43.5		77 00 00	4 18 32.3
	10 00	53 43.5		76 55 00	19 18.0
	20 00	54 56.5		50 00	20 06.3
	30 00	56 00.2		45 00	20 25.0
	40 00	56 44.0		40 00	20 57.0
	50 00	57 53.5		35 00	21 32.5
	73 00 00	58 44.5		25 00	22 34.7
	10 00	59 50.0		15 00	23 46.8
	20 00	11 00 46.5		10 00	24 31.0
	30 00	01 43.5		00 00	25 25.7
	40 00	02 55.1		75 50 00	26 33.8
	50 00	03 37.5		74 50 00	32 37.0
	74 00 00	04 40.5		10 00	36 48.0
	10 00	05 42.5		00 00	37 47.5
	50 00	09 59.2		73 50 00	38 44.5
	75 50 00	16 30.0		40 00	39 34.5
	76 00 00	17 25.5		30 00	40 35.0
	10 00	18 32.3		20 00	41 57.5
	15 00	19 12.0		10 00	42 35.5
	25 00	20 12.0		00 00	43 54.5
	35 00	21 07.0		72 50 00	44 34.0
	40 00	21 44.5		40 00	45 28.8
	45 00	22 13.0		30 00	46 32.5
	50 00	22 36.8		20 00	47 28.0
	55 00	23 23.5		10 00	48 35.7
	77 00 00	23 58.8		00 00	49 32.5
	89 08 30	1 43 28.0		71 50 00	50 34.0
	09 35	44 05.7		40 00	51 32.0
	09 55	46 58.0		30 00	52 38.5
	10 00	47 52.5		20 00	53 25.0
	10 25	49 17.0		10 00	54 19.0

Barometer, 29.620; thermometer, 59°.00; index error, —3′ 00″.

FORT ADAMS, *July* 24, 1869.

Sextant No. 3 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	72 20 00	10 57 13.8	Sun's lower limb, a. m....	76 25 00	11 22 19.0
	30 00	57 52.7		35 00	23 28.0
	74 10 00	11 08 11.0		40 00	24 01.2
	50 00	12 13.2		45 00	24 26.3
	75 50 00	18 30.0		50 00	25 00.2
	76 00 00	20 00.8		55 00	25 35.5
	10 00	20 50.0		77 00 00	26 17.2
	15 00	21 08.6			

Index error, —3′ 00″.

Observations with sextant—Continued.

SENATI'S VILLAGE, *July* 25, 1869.

Sextant No. 3 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

ϕ=65° 20′ 54″ λ=151° 10′ 00″

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	87 53 00	1 49 39.0	Sun's lower limb, p. m ...	87 33 30	1 10 18.2
p. m	53 20	50 07.8		32 00	11 04.5
	41 15	2 06 28.5		29 30	12 11.5
	37 03	07 09.2		28 05	12 49.5
	37 00	07 56.5		26 55	13 39.5
	35 25	08 31.3		23 25	41 31.5
	35 00	09 03.0		21 50	15 21.5
	34 05	09 43.5			

Barometer, 29.795; thermometer, 71°.00; index error, —3′ 00″.

FORT YUKON, *August* 6, 1869.

Sextant No. 3 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

ϕ=66° 33′ 17″ λ=145° 17′ 47″

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	69 25 00	10 58 19.4	Sun's lower limb, p. m ...	71 15 00	3 25 36.0
	30 00	59 02.7		10 00	26 17.2
	35 00	59 46.0		05 00	27 04.8
	40 00	11 00 22.5		00 00	27 42.7
	45 00	00 56.5		70 55 00	28 17.8
	50 00	01 33.0		50 00	28 56.5
	55 00	02 16.5		45 00	29 34.5
	70 00 00	02 45.0		40 00	30 10.5
	05 00	03 23.0		35 00	30 53.5
	10 00	04 13.2		30 00	31 26.0
	15 00	04 56.4		25 00	32 04.0
	20 00	05 30.5		20 00	32 51.8
	25 00	06 09.0		15 00	33 35.0
	30 00	06 45.4		10 00	34 02.5
	35 00	07 20.5		05 00	34 46.0
	40 00	07 55.5		00 00	35 29.0
	45 00	08 37.5		69 55 00	36 13.9
	50 00	09 19.0		50 00	36 46.0
	55 00	10 00.7		45 00	37 27.3
	71 00 00	10 37.5		40 00	38 03.2
	05 00	11 17.3		35 00	38 28.8
	10 00	11 58.8		30 00	39 08.0
	15 00	12 35.0		25 00	39 54.5

Index error, —3′ 00″.

Observations with sextant—Continued.

FORT YUKON, *August* 7, 1869.

Sextant No. 3 and horizon of mercury—M. T. chronometer No. 1609, by Bliss and Creighton—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Observed double altitude.	Time of observation.	Object observed.	Observed double altitude.	Time of observation.
	° ′ ″	h. m. s.		° ′ ″	h. m. s.
Sun's lower limb, a. m	65 05 00	10 31 23.2	Sun's lower limb, p. m ...	68 10 00	3 44 50.5
	10 00	32 00.0		05 00	45 30.0
	15 00	32 31.8		00 00	46 04.0
	20 00	32 54.5		67 55 00	46 49.5
	25 00	33 26.8		50 00	47 22.0
	30 00	34 03.7		40 00	48 41.5
	35 00	34 41.8		20 00	50 54.0
	40 00	35 11.3		15 00	51 31.4
	45 00	35 56.4		10 00	52 06.7
	50 00	36 25.2		05 00	52 42.5
	55 00	37 01.5		00 00	53 10.2
	66 00 00	37 32.8		66 55 00	53 46.2
	05 00	38 05.0		50 00	54 25.2
	10 00	38 36.4		45 00	54 58.0
	15 00	39 23.2		40 00	55 32.0
	20 00	39 45.5		35 00	56 15.5
	25 00	40 23.2		30 00	56 43.8
	30 00	41 05.0		25 00	57 17.2
	35 00	41 36.3		20 00	57 43.0
	40 00	42 11.5		15 00	58 18.0
	45 00	42 41.5		10 00	58 50.5
	50 00	43 17.0		05 00	59 39.5
	55 00	44 01.5		00 00	4 00 09.5
	67 00 00	44 28.5		65 55 00	00 39.5
	05 00	45 10.0		50 00	01 05.2
	10 00	45 41.0		45 00	01 48.3
	15 00	46 20.7		40 00	02 17.5
	20 00	46 59.0		35 00	02 48.0
	40 00	49 23.5		30 00	03 27.5
	50 00	50 30.5		25 00	04 02.0
	55 00	51 08.5		20 00	04 37.0
	68 00 00	51 36.0		15 00	05 03.2
	05 00	52 12.3		10 00	05 36.0
	10 00	52 40.5		05 00	06 10.8

Index error, —3′ 00″.

COMPARISON OF CHRONOMETERS.

NOTE.—Only the comparisons which have been employed in the computations are given in this appendix.

CHRONOMETERS.

Mean time.—No. 1609, by Bliss and Creighton; No. 1155, by Bliss and Creighton; No. 5149, by Barraud, (watch;) No. 2475, by Parkinson and Frodsham; No. 245, by Hutton, (ship's chronometer.)

Sidereal time.—No. 260, by Bond & Son; No. 231, by Bond & Son.

Errors and rates at San Francisco, April 1, 1869.

No. of chron.	Fast.	Slow.	Gains daily.	Loses daily.	No. of chron.	Fast.	Slow.	Gains daily.	Loses daily.
	s.	s.	s.	s.		s.	s.	s.	s.
1609	....	23.7	....	2.6	5149	39.3	....	5.6	....
1155	28.0	....	0.8	....	260	....	11.3	....	1.0
2475	....	7.8	1.2	....	231	57.1	....	2.2	....

Comparison of chronometers—Continued.

Station.	Date.	No. of chron.	Face indication of chron.		
	1869.		h.	m.	s.
Sitka	Apr. 27	231	8	06	09.0
		1155	9	32	31.5
		231	8	10	51.0
		1609	9	34	07.0
		260	8	10	06.0
		245	5	24	16.0
		231	8	05	06.0
		2475	9	34	29.0
	Apr. 28	231	7	46	58.5
		2475	9	12	30.0
		231	7	48	27.0
		1155	9	10	57.0
		231	7	49	37.5
		1609	9	09	55.0
		260	7	47	56.5
		1609	9	10	35.0
		260	7	48	52.0
		245	4	58	10.0
		260	3	15	00.0
		5149	4	52	04.8
		260	3	16	25.0
		5149	4	58	29.6
	Apr. 29	231	8	03	00.0
		2475	9	24	48.0
		231	8	06	50.0
		1155	9	25	20.0
		231	8	07	23.0
		1609	9	23	35.0
		260	8	07	27.5
		1609	9	26	02.0
		260	8	06	27.0
		245	5	11	45.0
		260	12	40	30.0
		5149	2	19	01.8
		260	12	41	00.0
		5149	2	19	31.8
	May 1	231	8	19	43.5
		2475	9	33	56.0
		231	8	22	50.0
		1155	9	33	35.0
		231	8	25	55.5
		1609	9	34	00.0
		260	8	27	20.0
		1609	9	37	55.0
		231	8	22	19.0
		245	5	17	15.0
		260	8	28	55.5
		245	5	26	20.0
		260	8	25	45.0
		5149	9	57	22.8
		260	8	26	25.0
		5149	9	58	02.6
	May 2	231	9	51	28.0
		2475	11	01	40.0
		231	9	50	10.0
		1155	10	56	39.0
		231	9	53	00.5
		1609	10	56	46.0
		260	9	52	45.0
		1609	10	59	03.0
		260	10	01	17.0
		245	6	54	30.5
		260	9	54	05.0
		5149	11	26	40.8
Ounalaska Isl'd	May 25	231	11	41	00.0
		2475	11	24	07.5
		231	11	43	30.0
		1155	11	19	39.0
		231	11	43	10.0
		1609	11	13	05.5
		260	11	44	30.0
		1609	11	17	52.5
		260	11	47	30.0
		5149	11	46	23.0
	May 26	231	11	48	40.0
		2475	11	28	57.0
		231	11	50	40.0
		1155	11	21	48.5
Ounalaska Is'd—Cont'd.	1869. May 26	231	11	52	20.0
		1609	11	18	10.0
		260	11	51	35.0
		1609	11	20	52.5
		231	3	20	30.0
		2475	2	59	08.5
		260	11	54	15.0
		245	7	12	57.5
		260	11	35	36.0
		5149	11	50	50.0
		231	3	33	30.0
		1155	2	54	03.5
		231	3	24	20.0
		1609	2	49	34.0
		260	3	22	00.0
		1609	2	50	42.0
		260	3	24	00.0
		245	10	42	08.0
		260	3	16	05.5
		5149	3	10	46.0
	May 27	231	11	46	40.0
		2475	11	22	10.0
		231	11	49	05.0
		1609	11	10	50.0
		260	11	47	45.0
		1609	11	12	59.0
		260	11	50	35.0
		245	7	05	21.5
		260	11	45	08.0
		5149	12	04	12.0
		231	11	48	05.0
		1155	11	15	18.0
Behring Sea	June 29	231	1	38	00.0
		2475	11	07	36.0
		231	1	41	20.0
		1155	10	57	52.5
		231	1	43	50.0
		1609	10	49	43.0
		260	1	40	30.0
		1609	10	51	16.5
		260	1	42	45.0
		245	6	47	32.5
		260	1	41	30.0
		5149	10	04	28.5
St. Michael's Is'd	June 30	231	2	44	25.0
		2475	12	10	03.5
		2475	12	10	40.0
		245	7	40	48.0
		231	2	46	55.0
		1155	11	59	21.0
		1155	11	58	40.0
		245	7	42	00.0
		231	2	49	30.0
		1609	11	51	04.5
		1609	11	50	19.0
		245	7	44	30.0
		260	2	45	55.0
		1609	11	53	26.0
		260	2	48	10.0
		245	7	48	52.0
		260	2	50	21.0
		5149	11	09	00.0
		245	7	53	02.5
		5149	11	11	00.0
	July 1	231	2	09	35.0
		2475	11	31	31.5
		2475	11	39	30.0
		245	7	09	26.5
		231	2	11	30.0
		1155	11	20	05.0
		1155	11	23	00.0
		245	7	06	18.0
		231	2	16	05.0
		1609	11	13	36.0
		1609	11	14	09.0
		245	7	18	30.0
		260	2	14	10.0
		1609	11	16	40.5

Comparison of chronometers—Continued.

Station.	Date.	No. of chron.	Face indication of chron.		
	1869.		*h.*	*m.*	*s.*
St. Michael's Isl'd —Cont'd.	July 1	260	2	17	10.0
		245	7	14	01.0
		260	2	15	47.5
		5149	10	30	20.4
		245	7	13	17.5
		5149	10	30	59.4
	July 2	2475	11	20	07.5
		231	2	02	00.0
		2475	2	21	00.0
		245	6	51	13.0
		231	2	04	50.0
		1155	11	09	23.5
		1155	11	17	10.0
		245	7	00	31.0
		231	2	06	00.0
		1609	11	59	23.5
		245	6	54	54.0
		231	2	07	00.0
		1609	11	04	20.0
		245	6	58	51.0
		231	10	20	00.0
		5149	2	14	42.0
		245	7	04	55.0
		5149	10	21	20.0
Pikmiktalik	July 4	260	4	03	55.0
		1609	12	53	48.0
		231	4	11	45.0
		2475	1	21	50.0
		5149	12	11	50.0
		260	4	14	52.5
		260	4	04	52.5
		1155	1	06	20.0
		231	4	13	00.0
		1609	12	57	43.0
		5149	12	12	50.0
		231	4	15	53.0
Yukon River	July 7	231	3	01	30.0
		2475	11	59	10.0
		231	3	02	20.0
		1155	11	46	38.0
		231	3	04	50.0
		1609	11	37	13.0
		260	3	02	10.0
		1609	11	40	06.0
		260	2	58	24.5
		5149	10	49	00.0
	July 9	231	3	20	20.0
		2475	12	10	09.0
		231	3	22	00.0
		1609	11	46	02.5
		231	3	21	00.0
		1155	11	57	10.5
		260	3	17	15.0
		1609	11	47	00.5
	July 11	260	3	10	36.0
		1155	12	36	55.0
		260	13	38	11.0
		1609	11	59	45.0
		231	3	53	57.0
		2475	12	35	05.0
		260	3	44	38.0
		2475	12	31	40.0
		*5149	9	16	00.0
		231	3	56	05.5
		231	2	48	10.0
		1155	11	07	58.5
		231	2	51	00.0
		2475	11	24	25.0
		231	2	52	20.0
		1609	10	59	53.5
		260	2	48	10.0
		1609	11	01	45.5
		231	2	45	40.0
		1155	11	01	29.0
		231	2	46	10.0
		2475	11	15	50.5
		231	2	45	00.0
		1609	10	48	31.0

Station.	Date.	No. of chron.	Face indication of chron.		
	1869.		*h.*	*m.*	*s.*
Yukon River—Cont'd.	July 11	260	2	42	00.0
		1609	10	51	38.0
		231	2	53	35.0
		2475	11	15	36.5
		231	2	54	20.0
		1155	11	01	58.0
		231	2	57	10.0
		1609	10	52	32.5
		260	2	52	30.0
		1609	10	54	06.5
	July 21	231	2	33	00.0
		1155	10	20	37.5
		260	2	28	30.0
		2475	10	37	22.0
		231	2	33	40.0
		1609	10	08	29.0
		260	2	29	20.0
		1609	10	10	41.5
Fort Adams	July 23	260	2	45	30.0
		2475	10	46	30.0
		260	2	47	50.0
		1155	10	34	04.5
		1155	10	35	11.0
		231	2	56	40.0
		1609	10	23	25.0
		231	2	57	00.0
	July 24	231	3	09	50.0
		2475	11	00	04.0
		231	3	11	10.0
		1155	10	46	38.0
		260	3	05	15.0
		1155	10	47	33.5
		260	3	06	57.0
		1609	10	36	00.0
Yukon River	July 26	260	3	09	50.0
		2475	10	59	12.5
		260	3	05	50.0
		1155	10	45	17.5
		231	3	18	50.0
		1155	10	46	17.5
		231	3	20	00.0
		1609	10	33	52.0
Fort Yukon	Aug. 2	231	4	15	30.0
		2475	11	30	12.0
		231	4	16	15.0
		1155	11	15	37.0
		260	4	11	30.0
		1155	11	18	20.0
		260	4	12	40.0
		1609	11	04	48.0
	Aug. 4	260	3	24	30.0
		1155	10	23	41.5
		260	3	29	00.0
		1609	10	08	05.5
		1609	10	26	45.0
		1155	10	11	50.0
		231	3	34	00.0
		1609	10	10	25.0
		231	3	34	50.0
		2475	10	41	41.0
	Aug. 6	260	4	46	55.0
		2475	11	53	48.5
		260	4	47	35.0
		1609	11	23	13.0
		1609	11	28	30.0
		2475	11	59	45.5
		1609	11	29	54.0
		1155	11	45	25.0
		231	5	02	00.0
		1609	11	29	45.0
	Aug. 7	260	2	58	00.0
		2475	10	01	21.5
		260	2	58	45.0
		1609	9	30	36.0
		231	3	08	00.0
		1609	9	31	54.0
		231	3	09	50.0
		1155	9	49	24.5

* Stopped.

Comparison of chronometers—Continued.

Station.	Date.	No. of chron.	Face indication of chronometer.			Station.	Date.	No. of chron.	Face indication of chronometer.		
	1869.		*h.*	*m.*	*s.*		1869.		*h.*	*m.*	*s.*
Fort Yukon—	Aug. 8	231	3	11	10.0	Fort Yukon—	Aug. 17	231	5	43	18.2
Continued.		1609	9	30	54.5	Continued.		5149	10	12	00.0
		1609	9	32	00.0			231	5	43	48.2
		2475	10	03	45.0			5149	10	12	30.0
		260	3	06	00.0		Aug. 18	260	4	37	40.0
		1609	9	34	46.5			1155	10	37	05.5
		231	3	10	10.0			260	4	40	40.0
		2475	10	01	39.5			1609	10	27	23.0
		260	3	06	10.0			231	4	50	30.0
		1155	9	49	48.0			1609	10	28	20.5
		1609	9	36	30.0			231	4	48	30.0
		1155	9	52	21.5			2475	11	01	07.0
	Aug. 10	231	4	18	00.0			231	4	51	42.5
		2475	11	01	33.5			5149	9	16	30.0
		231	4	19	00.0		Aug. 19	260	4	27	50.0
		1609	10	30	14.5			2475	10	45	36.0
		260	4	11	35.0			260	4	28	40.0
		1609	10	31	02.0			1155	10	29	13.5
		260	4	02	45.0			231	4	41	45.0
		1155	10	48	23.0			1155	10	33	20.0
	Aug. 11	260	4	14	00.0			231	4	39	38.5
		1609	10	29	21.5			5149	9	00	50.0
		260	4	15	10.0			231	4	40	18.0
		1155	10	56	54.0			5149	9	01	01.0
		231	4	26	00.0			231	4	40	58.0
		2475	11	05	39.5			5149	9	01	50.0
		231	4	28	30.0			231	4	43	00.0
		1155	10	51	55.5			1609	10	17	42.0
	Aug. 12	260	5	22	20.0		Aug. 20	231	4	41	00.0
		1609	11	33	25.5			1609	10	10	31.0
		231	5	32	50.0			231	4	43	00.0
		1609	11	35	31.5			5149	9	00	10.5
		260	5	23	10.0			5149	9	00	40.5
		2475	12	07	10.5			231	4	43	30.0
		231	5	35	00.0			231	4	45	00.0
		1155	11	54	16.0			1155	10	32	33.0
	Aug. 13	260	5	25	10.0			260	4	38	00.0
		2475	12	05	24.5			1155	10	34	36.5
		260	5	27	10.0			260	4	37	10.0
		1609	11	34	10.0			2475	10	51	07.5
		231	5	36	40.0			231	5	20	25.0
		1609	11	35	11.0			1609	10	45	38.0
		231	5	35	00.0			231	5	22	45.8
		1155	11	50	16.5			5149	9	35	30.0
	Aug. 14	260	4	34	45.0			231	5	23	05.8
		2475	11	11	19.5			5149	9	35	50.0
		260	4	35	20.0			231	5	25	30.0
		1609	10	38	33.5			1155	11	09	57.5
		231	4	45	00.0			260	5	17	00.0
		1609	10	40	29.0			1155	11	29	25.0
		231	5	26	14.8			260	5	19	20.0
		5149	10	09	00.0			2475	11	29	25.0
		231	4	46	45.0		Aug. 22	260	4	40	50.0
		1155	10	58	11.0			2475	10	47	15.0
	Aug. 15	260	4	22	05.0			231	4	52	00.0
		2475	10	54	55.0			1155	10	31	34.0
		231	4	34	20.0			231	4	54	20.0
		1609	10	41	49.5			5149	9	03	00.0
		260	4	23	00.0			260	4	41	35.0
		1155	10	39	08.5			1155	10	30	23.0
		231	4	33	20.0			231	4	53	00.0
		1609	10	23	41.5			1609	10	13	07.5
	Aug. 16*	260	4	42	00.0		Aug. 23	231	4	59	00.0
		2475	11	11	01.0			2475	10	53	45.0
		231	4	53	40.0			231	5	01	00.0
		1609	10	39	48.0			1609	10	17	55.0
		260	4	42	50.0			5149	9	06	40.0
		1155	10	55	01.0			231	5	02	02.5
		231	4	54	20.0			231	5	03	22.5
		1155	10	57	48.0			5149	9	08	00.0
	Aug. 17	260	5	29	30.0			260	4	56	10.0
		2475	11	53	35.0			1155	10	41	03.5
		260	5	31	40.0			260	4	57	25.0
		1609	11	22	18.5			1609	10	23	40.0
		260	5	31	00.0		Aug. 24	2475	5	21	35.0
		1155	11	39	09.5			231	11	10	43.0
		231	5	41	50.0			231	5	21	55.0
		1609	11	23	40.0			1609	10	34	36.0

* Chronometer 5149, which had again stopped, was started on local time.

Comparison of chronometers—Continued.

Station.	Date.	No. of chron.	Face indication of chron.			Station.	Date.	No. of chron.	Face indication of chron.		
	1869.		*h.*	*m.*	*s.*		1869.		*h.*	*m.*	*s.*
Fort Yukon—Continued.	Aug. 24	5149	9	23	20.0	Fort Yukon—Continued.	Aug. 29	260	5	16	20.0
		231	5	24	38.7			1155	10	37	49.0
		5149	9	24	00.0			260	5	15	15.0
		231	5	25	18.8			5149	9	05	38.4
		260	5	15	30.0		Sept. 3	231	5	23	00.0
		1609	10	37	35.5			2475	10	33	07.0
		260	5	16	25.0			231	5	24	00.0
		1155	10	57	21.0			1155	10	15	43.5
	Aug. 25	260	4	48	20.0			231	5	24	30.0
		2475	10	43	18.0			1609	9	55	22.0
		260	4	49	05.0			260	5	20	00.0
		1155	10	26	13.0			1609	10	01	18.5
		260	4	49	50.0			260	5	17	00.5
		1609	10	07	54.0			5149	8	48	00.0
		231	5	00	00.0		Sept. 4	231	5	15	10.0
		1609	10	08	33.5			2475	10	21	27.0
		231	5	01	14.2			231	5	16	15.3
		5149	8	58	00.0			5149	8	33	00.0
	Aug. 26	231	4	52	30.0			231	5	17	30.0
		1609	9	56	52.5			1155	10	05	15.0
		231	4	53	20.0			260	5	09	20.0
		1155	10	17	01.0			1155	10	07	39.0
		231	4	54	33.2			260	5	10	00.0
		5149	8	47	20.0			1609	9	47	21.0
		260	4	47	00.0	San Francisco ..	Nov. 7	231	10	17	35.0
		1155	10	20	15.0			2475	11	15	29.5
		260	4	48	00.0			231	10	16	09.5
		2475	10	39	09.0			5149	9	21	20.0
	Aug. 27	260	4	59	30.0			231	10	18	00.0
		2475	10	46	45.0			1609	10	20	47.0
		260	4	59	00.0			260	10	02	20.0
		1155	10	28	19.0			1609	10	21	15.0
		231	5	10	50.0			260	10	02	50.0
		1155	10	30	29.0			1155	10	46	59.5
		231	5	10	20.0		Nov. 8	231	10	29	20.0
		1609	10	10	27.5			2475	11	23	04.5
		231	5	11	54.7			231	10	28	15.9
		5149	9	00	30.0			5149	9	29	30.0
		260	5	28	00.0			231	10	30	00.0
		2475	11	11	21.0			1609	10	28	37.0
		260	5	28	40.0			260	10	14	20.0
		1155	10	54	01.0			1609	10	29	11.0
	Aug. 28	231	7	39	50.0			260	10	14	45.0
		1155	10	54	28.0			1155	10	54	52.5
		231	5	40	14.7		Nov. 10	231	11	11	30.0
		5149	9	25	50.0			2475	11	57	13.5
		231	5	41	30.0			231	11	11	59.4
		1609	10	37	23.0			5149	10	05	20.0
	Aug. 29	231	5	21	30.0			231	11	13	20.0
		2475	10	51	09.5			1609	11	03	36.5
		231	5	22	20.0			260	10	57	20.0
		1609	10	14	03.5			1609	11	04	00.5
		231	5	23	30.0			260	10	58	20.0
		1155	10	35	09.0			1155	11	30	24.5

TIME BY EQUAL ALTITUDES.

Station.	Date.	Latitude, N.	Longitude, W.	No. of observations.	No. of chronometer.	Time. Local apparent noon.			Time. Local mean noon.			r_0
	1869.	° ′ ″	° ′ ″	*Pairs.*		*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*s.*
Sitka	April 29	57 02 52	135 18 02	15	5149	1	07	12.49	1	10	03.84	....
Sitka	May 1	....	....	5	5149	1	07	03.53	1	10	10.50	....
Ounalaska ..	May 26	53 53 56.5	166 28 51.7	36	5149	3	13	15.57	3	16	26.71	± 0.34
Anvic	July 13	62 37 24	160 07 11	20	1609	2	22	48.70	2	17	19.55	....
Fort Adams..	July 23	65 08 11	152 30 11	31	1609	1	51	33.67	1	45	22.60	0.814
Fort Adams..	J'ly 23,24	....	....	14	1609	1	51	27.62	1	45	15.94	0.930
Fort Yukon..	Aug. 6	66 33 47	145 17 47	23	1609	1	19	31.68	1	13	58.37	0.460
Fort Yukon..	Aug. 7	....	....	33	1609	1	19	14.62	1	13	48.40	0.496

TIME BY SINGLE ALTITUDES.

Station.	Date.	Latitude, N.	Longitude, W.	No. of observations.	No. of chronometer.	Chronometer time of local mean noon.
St. Michael's Island.	July 1, 1869	63° 28′ 00″	161° 52′ 28″	18	5149	1*h* 38*m* 27*s*.33

CHRONOMETER TIME OF LOCAL MEAN NOON BY COMPARISON.

Station.	Date.	Chronometer used in observations.	Chronometer time of local mean noon.					
			260.	231.	5149.	1609.	1155.	2475.
	1869.		*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
Ounalaska	May 26	5149	3 21 47.16	3 25 15.36	3 16 26.71	2 50 29.20	2 55 48.57	3 03 59.01
St. Michael's Island.	July 1	5149	5 24 27.06	5 29 27.47	1 38 27.33	2 26 25.14	2 37 29.75	2 50 52.47
Anvic	July 13	1609	6 04 16.53	6 10 19.56	....	2 17 19.55	2 29 34.38	2 43 13.38
Fort Adams	July 23	1609	6 12 48.91	6 19 32.72	....	1 45 22.60	1 58 30.22	2 13 15.62
Fort Yukon	Aug. 6	1609	6 38 39.31	6 47 25.96	....	1 13 58.37	1 29 30.14	1 45 15.00

VALUE OF A REVOLUTION OF THE Z. T. MICROMETER.

FORT YUKON, *August* 15, 1869.

Observations on Polaris, near eastern elongation—Zenith telescope, by Würdemann—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major—Chronometer time of elongation, $T_0 = 5h\ 09m\ 55s.0$—One division of level = 0.05933 turns.

Temp., F.	No. of obs.	Micr. M., (turns.)	Level. N.	Level. S.	L	T	$T-T_0$	$z-z_0$
°						*h. m. s.*	*h. m. s.*	″
62.0	1	0.5	59.0	65.0	—3.0	5 31 31.2	0 21 36.2	471.60
	2	1.0	59.0	65.0	—3.0	32 49.6	22 54.6	500.06
	3	1.5	59.0	65.0	—3.0	34 16.5	24 21.5	531.57
	4	2.0	59.0	65.0	—3.0	35 41.8	25 46.8	562.47
	5	2.5	59.0	65.0	—3.0	37 22.5	27 27.5	598.92
	6	3.0	59.0	65.0	—3.0	38 38.5	28 43.5	626.41
	7	3.5	59.0	65.0	—3.0	40 02.8	30 07.5	656.76
	8	4.0	59.0	65.0	—3.0	41 37.2	31 42.2	690.96
	9	4.5	59.0	65.0	—3.0	42 52.8	32 57.8	718.23
	10	5.0	59.0	65.0	—3.0	44 12.1	34 17.1	746.82
	11	5.5	59.0	65.0	—3.0	45 47.2	35 52.2	781.72
	12	6.0	59.0	65.0	—3.0	47 08.2	37 13.2	810.21
	13	6.5	59.0	65.0	—3.0	48 40.1	38 45.1	843.24
	14	7.0	59.0	65.0	—3.0	50 04.7	40 09.7	873.62
	15	7.5	59.0	65.0	—3.0	51 29.0	41 34.0	902.81
	16	8.0	59.0	65.0	—3.0	52 58.0	43 03.0	935.73
	17	8.5	60.0	65.0	—2.5	54 29.3	44 34.3	968.39
	18	*9.0	60.0	65.0	—2.5	55 55.1	46 00.1	999.05
	19	9.5	60.0	65.0	—2.5	57 23.5	47 28.5	1050.60
	20	10.0	60.0	65.0	—2.5	58 47.0	48 52.0	1060.35
57.0	21	10.5	60.0	65.0	—2.5	6 00 12.1	50 17.1	1090.62
	22	11.0	60.0	65.0	—2.5	01 41.5	51 46.5	1122.41
	23	11.5	60.0	65.0	—2.5	03 13.0	53 18.0	1154.88
	24	12.0	60.0	65.0	—2.5	04 32.1	54 37.1	1182.91
	25	†12.5	60.0	65.0	—2.5	05 55.0	56 00.0	1212.25
	26	13.0	60.0	65.0	—2.5	07 25.5	57 30.5	1244.19
	27	13.5	60.0	65.0	—2.5	08 50.0	58 55.0	1274.02
	28	14.0	60.0	65.0	—2.5	10 22.8	1 00 27.8	1306.70
	29	14.5	60.0	65.0	—2.5	11 56.0	02 01.0	1339.46
	30	15.0	60.0	65.0	—2.5	13 24.0	03 29.0	1370.02
	31	15.5	60.0	65.0	—2.5	14 50.3	04 55.3	1400.55
	32	16.0	60.0	65.0	—2.5	16 14.5	06 19.5	1429.99
	33	16.5	60.0	65.0	—2.5	17 44.2	07 49.2	1461.28
	34	17.0	60.0	65.0	—2.5	19 13.3	09 18.3	1492.31
	35	17.5	60.0	65.0	—2.5	20 42.7	10 47.7	1523.73
	36	18.0	60.0	65.0	—2.5	22 12.8	12 17.8	1554.62
	37	18.5	60.0	65.0	—2.5	23 48.8	13 53.8	1586.84
	38	19.0	60.0	65.0	—2.5	25 23.3	15 28.3	1620.46
	39	19.5	60.0	65.0	—2.5	26 50.2	16 55.2	1650.40
	40	20.0	60.0	65.0	—2.5	28 26.6	18 31.6	1683.50

* Changed lamp; observation uncertain; reject. † Focus deranged; reject.

Value of a revolution of the Z. T. micrometer—Continued.

Observations compared.	(M′—M)+(L′—L)*d*.	$(z-z_0)-(z'-z_0)$	R	*v*	v^2
			″		
1 and 21	+10. 029665	619. 02	61. 719	—0. 280	0. 07840
2 and 22	+10. 029665	622. 35	62. 051	+0. 052	0. 00270
3 and 23	+10. 029665	623. 31	62. 146	0. 147	0. 02161
4 and 24	+10. 029665	620. 44	61. 861	—0. 138	0. 01904
6 and 26	+10. 029665	617. 78	61. 595	0. 404	0. 16322
7 and 27	+10. 029665	617. 26	61. 543	0. 456	0. 20794
9 and 29	+10. 029665	621. 23	61. 939	0. 060	0. 00360
10 and 30	+10. 029665	623. 20	62. 136	+0. 137	0. 01877
11 and 31	+10. 029665	618. 83	61. 700	—0. 299	0. 08940
12 and 32	+10. 029665	619. 78	61. 795	0. 204	0. 04162
13 and 33	+10. 029665	618. 04	61. 621	0. 378	0. 14288
14 and 34	+ 9. 940670	618. 69	62. 237	+0. 238	0. 05664
15 and 35	+ 9. 940670	620. 92	62. 462	0. 463	0. 21437
16 and 36	+ 9. 940670	618. 89	62. 258	0. 259	0. 06708
17 and 37	+ 9. 911005	618. 45	62. 400	0. 401	0. 16080
19 and 39	+ 9. 911005	619. 80	62. 536	0. 537	0. 28837
					[*v v*]=1. 57644

R. (uncorrected) .... = 61.″999
Correction for rate .... = + 00.″05
Correction for refraction .... = — 00.″02

R .... = 62.″029

Probable error .... $r_0=\frac{2}{3}\sqrt{\frac{1.57644}{16\times15}}=0.''054$

VALUE OF ONE DIVISION OF TRANSIT LEVEL NO. 1, IN TERMS OF Z. T. MICROMETER.

FORT YUKON, *August* 10, 1869.

Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. F. Westdahl.

T.	No. of obs.	Readings of— Micrometer.	Readings of— Level. N.	Readings of— Level. S.	Difference. Micr.	Difference. Level.	*d*	*v*	*v v*
°									
71. 0	1	28. 9	24. 0	79. 0					
		130. 0	85. 0	18. 5	101. 1	60. 75	1. 664	0. 121	0. 0146
71. 0	2	90. 4	12. 0	90. 0					
		219. 4	85. 0	16. 0	129. 0	73. 50	1. 755	0. 030	0. 0009
71. 0	3	285. 8	11. 5	84. 5					
		410. 7	87. 5	13. 0	124. 9	73. 75	1. 695	0. 090	0. 0081
71. 0	4	1130. 0	20. 5	78. 0					
		1244. 2	81. 0	19. 0	114. 2	59. 75	1. 911	0. 126	0. 0159
71. 5	5	1355. 7	29. 0	69. 0					
		1454. 4	82. 5	15. 5	98. 7	53. 50	1. 845	0. 140	0. 0196
71. 5	6	1573. 3	25. 0	71. 5					
		1684. 4	82. 0	15. 0	111. 1	56. 75	1. 958	0. 173	0. 0299
72. 0	7	2443. 7	27. 0	68. 0					
		2550. 8	85. 0	11. 5	107. 1	57. 25	1. 871	0. 096	0. 0092
72. 5	8	2438. 0	24. 0	71. 0					
		2556. 7	88. 0	7. 0	118. 7	64. 00	1. 855	0. 070	0. 0049
72. 5	9	1166. 7	14. 0	81. 0					
		1284. 8	82. 5	12. 5	118. 1	68. 50	1. 724	0. 061	0. 0037
72. 5	10	3166. 0	16. 0	78. 0					
		3290. 0	88. 0	6. 5	124. 0	71. 75	1. 728	0. 057	0. 0032
72. 5	11	2213. 7	34. 0	60. 0					
		2300. 7	84. 5	13. 0	87. 0	48. 75	1. 785	0. 000	0. 0000
72. 5	12	2180. 2	8. 0	87. 0					
		2273. 5	65. 5	30. 0	93. 3	57. 25	1. 630	0. 155	0. 0240
72. 5	13	1371. 5	18. 0	76. 5					
		1468. 4	74. 0	21. 0	96. 9	55. 75	1. 738	0. 047	0. 0022
73. 0	14	1364. 7	13. 5	81. 5					
		1468. 5	74. 0	21. 5	103. 8	60. 25	1. 723	0. 062	0. 0038
73. 0	15	1027. 4	13. 5	81. 0					
		1147. 5	85. 0	10. 0	120. 1	71. 25	1. 686	0. 099	0. 0098

Value of one division of transit level No. 1, *&c.*—Continued.

T.	No. of obs.	Readings of— Micrometer.	Level. N.	Level. S.	Difference. Micr.	Difference. Level.	d	v	vv
°									
73.0	16	1040.0	23.0	71.0					
		1141.1	81.5	13.0	101.1	58.75	1.721	0.064	0.0041
73.0	17	690.5	19.0	76.0					
		793.0	81.5	13.5	102.5	62.50	1.640	0.145	0.0210
73.0	18	696.6	23.5	70.5					
		798.3	81.0	13.0	101.7	57.50	1.769	0.016	0.0003
73.5	19	875.4	28.0	71.0					
		982.0	77.0	17.0	106.6	51.50	2.069	0.284	0.0807
73.5	20	887.6	22.0	72.0					
		989.8	75.0	19.0	102.2	53.00	1.928	0.143	0.0204

$x_0=1.785$ $[vv]=0.2763$

$r=0.6745\sqrt{\frac{0.2763}{20\times19}}=0.018$ $d=1.785\pm0.018$

$R=62''.00$ $d=1''.1067$

VALUE OF ONE DIVISION OF TRANSIT LEVEL NO. 2, IN TERMS OF Z. T. MICROMETER.

FORT YUKON, *August* 10, 1869.

Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. F. Westdahl.

T.	No. of obs.	Readings of— Micrometer.	Level. N.	Level. S.	Difference. Micr.	Difference. Level.	d	v	vv
°									
64.0	1	329.0	5.0	93.5					
		105.5	88.0	12.0	223.5	82.25	2.717	Rejected	....
66.0	2	658.9	5.0	92.0					
		1171.1	93.0	4.5	512.2	87.75	5.837	0.096	0.0092
68.0	3	1452.3	9.0	87.0					
		1921.3	89.0	5.5	469.0	80.75	5.808	0.125	0.0156
69.0	4	2050.9	7.0	89.5					
		2532.2	88.0	8.0	481.3	81.25	5.924	0.009	0.0001
70.0	5	2602.4	14.0	81.5					
		3048.5	91.0	5.5	446.1	73.75	6.049	0.116	0.0135
71.0	6	3154.6	10.0	81.0					
		3615.0	90.0	7.0	460.4	77.00	5.979	0.046	0.0022
72.0	7	51.5	24.5	70.5					
		469.0	78.0	16.0	417.5	54.00	7.732	Rejected	....
72.0	8	435.4	17.0	75.5					
		792.4	77.0	16.0	357.0	59.75	5.975	0.042	0.0018
73.0	9	808.3	27.0	65.0					
		1111.6	78.0	13.0	303.3	51.50	5.889	0.044	0.0019
73.0	10	1202.4	15.0	75.5					
		1550.5	75.0	16.0	348.1	59.75	5.826	0.107	0.0114
74.0	11	1612.3	26.0	63.5					
		1884.1	72.5	17.5	271.8	46.25	5.877	0.056	0.0031
74.5	12	1930.9	26.0	63.0					
		2197.9	72.0	11.5	267.0	48.75	5.477	0.456	0.2079
74.5	13	2281.9	8.0	80.0					
		2679.5	76.5	10.5	397.6	69.00	5.762	0.171	0.0292
74.0	14	2752.2	9.0	79.0					
		3168.4	73.0	15.5	416.2	63.75	6.529	0.596	0.3553
73.5	15	3256.6	12.5	71.0					
		3609.9	72.0	17.0	353.3	56.75	6.402	0.469	0.2200
73.0	16	3770.6	20.0	69.0					
		4027.3	64.0	25.5	256.7	43.75	5.865	0.068	0.0046

Value of one division of transit level No. 2, &c.—Continued.

T.	No. of obs.	Readings of— Micrometer.	Level. N.	S.	Difference. Micr.	Level.	d	v	vv
°									
72.5	17	1147.8	17.0	73.0					
		1498.9	77.0	14.0	351.1	59.50	5.901	0.032	0.0010
72.0	18	1521.7	12.0	79.0					
		1880.6	73.0	18.0	358.9	61.00	5.884	0.049	0.0024
71.5	19	1986.5	13.0	77.5					
		2366.3	77.5	14.0	379.8	64.00	5.934	0.001	0.0000
71.5	20	2366.3	16.0	75.0					
		2751.4	82.0	10.0	385.1	65.50	5.879	0.054	0.0026

$x_0 = 5.933$ $\qquad [v\,v] = 0.8821$

$r = 0.6745\sqrt{\frac{0.8821}{18 \times 17}} = 0.115$ $\qquad d = 5.933 \pm 0.115$

$R = 62''.00$ $\qquad d = 3''.673$

CHANGE OF RIGHT ASCENSION AND DECLINATION.*

Upper Transit.

$$\frac{R}{10}(t+0.1865)+\frac{d}{200}(t+0.1864)^2$$

Tabulated values of $\frac{1}{20}(t+0.1864)^2$ $\qquad$ Arguments, $\frac{d}{10}$, t.

$\frac{d}{10}$	t: 1	2	3	4	5	6	7	8	9
1	0.070377	0.239017	0.507657	0.876297	1.344937	1.913577	2.582217	3.350857	4.219497
2	0.140754	0.478034	1.015314	1.752594	2.689874	3.827154	5.164434	6.701714	8.438994
3	0.211131	0.717051	1.522971	2.628891	4.034811	5.740731	7.746651	10.052571	12.658491
4	0.281508	0.956068	2.030628	3.505188	5.379748	7.654308	10.328868	13.403428	16.877988
5	0.351886	1.195086	2.538286	4.381486	6.724686	9.567886	12.911086	16.754286	21.097486
6	0.422263	1.434103	3.045943	5.257783	8.069623	11.481463	15.493303	20.105143	25.316983
7	0.492640	1.673120	3.553600	6.134080	9.414560	13.395040	18.075520	23.456000	29.536480
8	0.563017	1.912137	4.061257	7.010377	10.759497	15.308617	20.657737	26.806857	33.755977
9	0.633395	2.151155	4.568915	7.886675	12.104435	17.222195	23.239955	30.157715	37.975475

Lower Transit.

$$\frac{R}{10}(t+0.685)+\frac{d}{200}(t+0.685)^2$$

Tabulated values of $\frac{1}{20}(t+0.685)^2$ $\qquad$ Arguments, $\frac{d}{10}$, t.

$\frac{d}{10}$	t: 1	2	3	4	5	6	7	8	9
1	0.141961	0.360461	0.678961	1.097461	1.615961	2.234461	2.952961	3.771461	4.689961
2	0.283922	0.720922	1.357922	2.194922	3.231922	4.468922	5.905922	7.542922	9.379922
3	0.425883	1.081383	2.036883	3.292383	4.847883	6.703383	8.858883	11.314383	14.069883
4	0.567845	1.441845	2.715845	4.389845	6.463845	8.937845	11.811845	15.085845	18.759845
5	0.709806	1.802306	3.394806	5.487306	8.079806	11.172306	14.764806	18.857306	23.449806
6	0.851767	2.162767	4.073767	6.584767	9.695767	13.406767	17.717767	22.628767	28.139767
7	0.993728	2.523228	4.752728	7.682228	11.311728	15.641228	20.670728	26.400228	32.829728
8	1.135690	2.883690	5.431690	8.779690	12.927690	17.875690	23.623690	30.171690	37.519690
9	1.277651	3.244151	6.110651	9.877151	14.543651	20.110151	26.576651	33.943151	42.209651

* Explanation and notation in Part II, Chapter I, of the report.

TRANSIT INSTRUMENT—EQUATORIAL INTERVALS FROM THE MEAN OF THE WIRES.

Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major—Station, Fort Yukon.

Star observed.	Date—Aug., 1869.	Number of wire—lamp east. VII.	VI.	V.	IV.	III.	II.	I.
		s.	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*
3 Ursæ Majoris	10	—41.49	—27.85	—14.03	—0.47	+13.61	+28.43	+41.78
ε Draconis	11	.84	.98	13.88	.50	.80	.76	.69
3 Ursæ Majoris	11	.44	.95	14.06	.35	.33	.55	.90
9 Draconis	11	.67	.79	13.71	.24	.83	.35	.23
ε Draconis	12	.74	.84	13.95	.23	.49	.58	.69
3 Ursæ Majoris	12	.69	.77	14.06	+0.01	.72	.62	.17
6² Ursæ Majoris	12	.50	28.16	13.79	—0.26	.61	.62	.47
9 Draconis	12	.73	.07	.72	.23	.68	.61	.46
ε Draconis	13	.68	27.96	.89	.34	.48	.61	.78
3 Ursæ Majoris	13	.49	.96	.89	.22	.60	.50	.49
6² Ursæ Majoris	13	—41.81	—27.67	—14.03	—0.38	+13.68	+28.62	+41.62
9 Draconis	13	.51	.79	.04	.01	.74	.35	.25
6² Ursæ Majoris	14	.66	.75	13.87	.19	.84	.39	.24
δ Draconis	17	.63	.78	.81	.19	.93	*27.44	42.02
ε Draconis	17	.69	*28.31	.90	.11	.78	28.67	41.56
3 Ursæ Majoris	17	.57	27.94	*14.26	+0.10	.34	.74	.59
6² Ursæ Majoris	20	.47	.60	13.95	—0.19	.49	.51	.20
δ Draconis	20	.62	.73	14.18	+0.09	.64	.64	.15
ε Draconis	20	.47	.93	13.76	—0.14	.41	.60	.30
3 Ursæ Majoris	20	.62	.77	.98	.20	.54	.55	.47
β Cephei	20	—41.75	—27.86	—13.69	—0.24	+13.58	+28.60	+41.37
δ Draconis	21	.83	28.09	.74	.08	.39	.70	.67
ε Draconis	21	*42.00	.10	.90	.35	.88	.97	.49
3 Ursæ Majoris	21	41.54	27.90	.90	.23	.45	.64	.48
6² Ursæ Majoris	21	.54	.79	.87	.15	.61	.39	.35
β Cephei	21	.78	.71	14.06	.10	.49	.78	.37
4163 Groombridge	22	.67	.93	13.85	.25	.51	.60	.58
9 Draconis	23	.60	.83	14.06	.33	.49	.72	.62
4 Draconis	23	.43	.80	13.76	.22	.38	.57	.25
2 Cephei	23	.61	.81	.96	.37	.35	.77	.62
Sums	......	—1207.07	—808.11	—403.29	—6.37	+407.67	+829.44	+1244.86
Adopted intervals	......	—41ˢ.62	—27ˢ.87	—13ˢ.91	—0ˢ.21	+13ˢ.59	+28ˢ.60	+41ˢ.50
Probable errors	......	0.081	0.091	0.086	0.098	0.115	0.094	0.150

Mean error of a single wire, 0.107. Probable error of the mean of the wires, 0.038.

* Rejected.

TRANSIT OBSERVATIONS.

FORT YUKON, *August* 10, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

$\phi = 66° 33' 47''$ $\lambda = 145° 17' 47''$

Object observed.	Declination.	Tabular A.R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	*h. m. s.*	*h. m. s.*	*h. m. s.*	
α Aquilæ	8 31 43.5 N.	19 44 25.77	5 29 25.51	14 15 00.26	Steady.
ε Draconis	69 56 18.3 N.	19 48 40.11	5 33 38.36	01.75	Steady.
3 Ursæ Majoris	68 51 08.7 N.	7 59 42.78	5 44 42.12	00.66	Unsteady.
ε Delphini	10 51 49.9 N.	20 26 59.59	6 11 59.09	00.50	Unsteady.
α Cygni	44 49 03.1 N.	20 37 00.75	6 22 00.57	00.18	Flaring.
2 Ursæ Majoris	48 33 07.5 N.	8 50 12.80	6 35 11.54	01.26	
ζ Cygni	29 41 40.75 N.	21 07 24.23	6 52 23.65	00.58	
1 Draconis	81 53 58.6 N.	9 18 03.25	7 03 02.82	00.43	
β Aquarii	6 08 30.4 S.	21 24 42.07	7 09 41.98	00.09	Flaring.
β Cephei	69 59 17.7 N.	21 27 02.41	7 12 01.61	00.80	Flaring.
ε Pegasi	9 16 46.9 N.	21 37 47.54	7 22 46.90	00.64	
α Aquarii	0 57 03.0 S.	21 59 05.64	7 44 05.84	14 59.80	
32 Ursæ Majoris	65 45 35.14 N.	10 08 27.19	7 53 25.65	15 01.54	Lamp east.
32 Ursæ Majoris	65 45 35.14 N.	10 08 27.19	7 53 26.28	00.91	Lamp west.
ζ Pegasi	10 09 07.4 N.	22 34 58.03	8 19 57.54	00.49	High wind during observations.

Transit observations—Continued.

FORT YUKON, *August* 11, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
α Aquilæ	8 31 43.5 N.	19 44 25.76	5 29 29.27	14 14 56.49	Flaring.
ε Draconis	69 56 18.6 N.	19 48 40.08	5 33 43.13	56.95	
3 Ursæ Majoris	68 51 08.45 N.	7 59 42.82	5 44 46.64	56.18	
ε Delphini	10 51 50.2 N.	20 26 59.59	6 12 03.16	56.43	
α Cygni	44 49 03.37 N.	20 37 00.74	6 22 04.72	56.02	
2 Ursæ Majoris	48 33 07.4 N.	8 50 12.82	6 35 16.52	56.30	
σ² Ursæ Majoris	67 39 39.4 N.	8 58 47.68	6 43 51.34	56.34	
ζ Cygni	29 41 41.0 N.	21 07 24.23	6 52 28.19	56.04	
1 Draconis	81 53 58.3 N.	9 18 03.28	7 03 06.64	56.64	Lamp east; lamp west rejected.
β Aquarii	6 08 30.4 S.	21 24 42.08	7 09 45.81	56.27	
β Cephei	69 59 18.0 N.	21 27 02.41	7 12 06.00	56.41	
ε Pegasi	9 16 47.0 N.	21 37 47.55	7 22 51.05	56.50	
α Aquarii	0 57 02.9 S.	21 59 05.65	7 44 09.57	56.08	
32 Ursæ Majoris	65 45 34.9 N.	10 08 27.19	7 53 31.31	55.88	
9 Draconis	76 23 08.9 N.	10 23 48.49	8 08 51.87	56.62	
ζ Pegasi	10 09 07.6 N.	22 34 58.04	8 20 01.51	56.58	

FORT YUKON, *August* 12, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
ε Delphini	10 51 50.35 N.	20 26 59.59	6 12 06.67	14 14 52.92	
α Cygni	44 49 03.7 N.	20 37 00.74	6 22 07.59	53.15	
ν Cygni	40 40 05.3 N.	20 52 20.09	6 37 26.35	53.74	
σ² Ursæ Majoris	67 39 39.1 N.	8 58 47.70	6 43 53.04	54.66	
ζ Cygni	29 41 41.27 N.	21 07 24.24	6 52 31.40	52.84	
1 Draconis	81 53 58.0 N.	9 18 03.32	7 03 11.10	52.22	Lamp west.
1 Draconis	81 53 58.0 N.	9 18 03.32	7 03 08.07	(?) 55.25	Lamp east.
β Aquarii	6 08 30.3 S.	21 24 42.08	7 09 48.31	53.77	
β Cephei	69 59 18.4 N.	21 27 02.41	7 12 08.16	54.25	
ε Pegasi	9 16 47.2 N.	21 37 47.55	7 22 54.49	53.06	
α Aquarii	0 57 02.8 S.	21 59 05.66	7 44 12.67	52.99	
32 Ursæ Majoris	65 45 34.6 N.	10 08 27.20	7 53 35.87	51.33	
9 Draconis	76 23 08.6 N.	10 23 48.49	8 08 56.60	51.89	
ζ Pegasi	10 09 07.7 N.	22 34 58.06	8 20 05.26	52.80	

FORT YUKON, *August* 13, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
δ Draconis	67 26 10.6 N.	19 12 34.25	4 57 43.63	14 14 50.61	
δ Aquilæ	2 51 35.5 N.	19 18 55.77	5 04 06.17	49.60	
γ Aquilæ	10 18 01.9 N.	19 40 04.14	5 25 14.39	49.75	
α Aquilæ	8 31 43.9 N.	19 44 25.76	5 29 35.96	49.80	
ε Draconis	69 56 19.2 N.	19 48 40.02	5 33 48.60	51.42	
3 Ursæ Majoris	68 51 07.9 N.	7 59 42.90	5 44 53.93	48.97	
ε Delphini	10 51 50.5 N.	20 26 59.59	6 12 09.93	49.66	
α Cygni	44 49 04.0 N.	20 37 00.74	6 22 11.26	49.48	
2 Ursæ Majoris	48 33 07.0 N.	8 50 12.85	6 35 23.76	49.09	
ν Cygni	40 40 05.6 N.	20 52 20.09	6 37 30.98	49.11	
σ² Ursæ Majoris	67 39 38.8 N.	8 58 47.73	6 43 58.90	48.83	
ζ Cygni	29 41 41.5 N.	21 07 24.24	6 52 33.48	50.76	
1 Draconis	81 53 57.6 N.	9 18 03.36	7 03 11.14	52.22	(?) Lamp east.
1 Draconis	81 53 57.6 N.	9 18 03.36	7 03 12.73	50.63	Lamp west.
β Cephei	69 59 18.8 N.	21 27 02.40	7 12 12.38	50.02	
ε Pegasi	9 16 47.4 N.	21 37 47.56	7 22 57.80	49.76	
α Aquarii	0 57 02.7 S.	21 59 05.67	7 44 15.69	49.98	
32 Ursæ Majoris	65 45 34.3 N.	10 08 27.20	7 53 37.60	49.60	
9 Draconis	76 23 08.3 N.	10 23 48.49	8 08 59.26	49.23	
ζ Pegasi	10 09 07.9 N.	22 34 58.07	8 20 07.58	50.49	

Transit observations—Continued.

FORT YUKON, *August* 14, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
ι Ursæ Majoris	48 33 06.8 N.	8 50 12.87	6 35 26.43	14 14 46.44	Light clouds.
σ² Ursæ Majoris	67 39 38.5 N.	8 58 47.75	6 44 02.18	45.57	Light clouds.
1 Draconis	81 53 57.3 N.	9 18 03.41	7 03 17.15	46.26	Lamp west.
1 Draconis	81 53 57.3 N.	9 18 03.41	7 03 17.32	46.09	Lamp east.
β Aquarii	6 08 38.1 N.	21 24 42.10	7 09 56.15	45.95	
ε Pegasi	9 16 47.5 N.	21 37 47.57	7 23 01.39	46.18	Flaring. Strong wind during the observations.

FORT YUKON, *August* 20, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
51 Cephei	87 14 05.9 N.	6 38 04.45	4 23 38.93	14 14 25.52	Very cloudy.
δ Draconis	67 26 12.5 N.	19 12 33.99	4 58 08.40	25.59	Strong south wind.
γ Aquilæ	10 18 02.6 N.	19 40 04.11	5 25 38.54	25.57	
α Aquilæ	8 31 44.8 N.	19 44 25.73	5 30 00.17	25.56	
ε Draconis	69 56 21.2 N.	19 48 39.77	5 34 13.51	26.26	
3 Ursæ Majoris	68 51 06.2 N.	7 59 43.21	5 45 18.51	24.70	
ε Delphini	10 51 51.5 N.	20 26 59.58	6 12 33.90	25.68	
α Cygni	44 49 06.0 N.	20 37 00.69	6 22 35.04	25.65	
ι Ursæ Majoris	48 33 05.6 N.	8 50 12.98	6 35 47.62	25.36	
ν Cygni	40 40 07.6 N.	20 52 20.07	6 37 54.38	25.69	
σ² Ursæ Majoris	67 39 36.7 N.	8 58 47.92	6 44 21.67	26.25	
ζ Cygni	29 41 43.3 N.	21 07 24.25	6 52 58.26	25.99	Very dim.
1 Draconis	81 53 55.3 N.	9 18 03.72	7 03 36.69	27.03	Lamp east; dim.
1 Draconis	81 53 55.3 N.	9 18 03.72	7 03 38.00	25.72	Lamp west.
β Cephei	69 59 21.3 N.	21 27 02.35	7 12 36.39	25.70	

FORT YUKON, *August* 21, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
δ Draconis	67 26 12.7 N.	19 12 33.94	4 58 13.23	14 14 20.71	
δ Aquilæ	2 51 36.1 N.	19 18 55.72	5 04 34.55	21.17	
γ Aquilæ	10 18 02.7 N.	19 40 04.10	5 25 42.66	21.44	
α Aquilæ	8 31 44.9 N.	19 44 25.72	5 30 04.43	21.29	
ε Draconis	69 56 21.5 N.	19 48 39.73	5 34 18.68	21.05	
3 Ursæ Majoris	68 51 06.0 N.	7 59 43.26	5 45 22.02	21.24	
ε Delphini	10 51 51.6 N.	20 26 59.58	6 12 37.89	21.69	
α Cygni	44 49 06.3 N.	20 37 00.69	6 22 38.54	22.15	
ι Ursæ Majoris	48 33 05.4 N.	8 50 13.00	6 35 51.62	21.38	
ν Cygni	40 40 07.9 N.	20 52 20.06	6 37 57.81	22.25	
σ² Ursæ Majoris	67 39 36.4 N.	8 58 47.95	6 44 26.64	21.31	
ζ Cygni	29 41 43.6 N.	21 07 24.25	6 53 02.10	22.15	
1 Draconis	81 53 55.0 N.	9 18 03.78	7 03 42.22	21.56	Lamp west.
1 Draconis	81 53 55.0 N.	9 18 03.78	7 03 42.02	21.76	Lamp east.
β Cephei	69 59 21.6 N.	21 27 02.34	7 12 40.31	22.03	
ξ Aquarii*	8 26 09.2 S.	21 30 49.03	7 16 27.76	21.27	
γ Capricorni*	17 15 00.0 S.	21 32 52.39	7 18 31.26	21.13	
ε Pegasi	9 16 48.6 N.	21 37 47.59	7 23 26.22	21.37	
δ Capricorni*	16 43 00.0 S.	21 39 50.95	7 25 29.68	21.27	
α Aquarii	0 57 01.9 S.	21 59 05.72	7 44 44.39	21.33	
θ Aquarii	8 25 48.0 S.	22 09 57.62	7 55 36.17	21.45	
Moon's I			8 03 07.45		
Moon's II			8 05 13.69		
σ Aquarii*	11 21 00.0 S.	22 23 45.12	8 09 23.84	21.28	
η Aquarii*	0 47 14.7 S.	22 28 39.87	8 14 18.53	21.34	
ι Cephei	65 30 49.6 N.	22 45 05.81	8 30 44.17	21.64	

* Moon-culminators.

Transit observations—Continued.

FORT YUKON, *August* 22, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
ε Pegasi	9 16 48.7 N.	21 37 47.60	7 23 29.56	14 14 18.04	Clouds.
11 Cephei	70 42 42.6 N.	21 40 04.66	7 25 46.71	17.95	
α Aquarii	0 57 01.8 S.	21 59 05.72	7 44 47.87	17.85	
θ Aquarii	8 25 47.9 S.	22 09 57.62	7 55 39.74	17.88	
ξ Pegasi	10 09 09.5 N.	22 34 58.16	8 20 40.14	18.02	
τ^2 Aquarii	14 17 00.0 S.	22 42 41.66	8 28 23.64	18.02	
λ Aquarii	8 16 17.2 S.	22 45 49.07	8 31 31.10	17.97	
Moon's II	....	....	8 53 09.25	....	
ψ^2 Aquarii	9 54 00.0 S.	23 11 08.05	8 56 49.80	18.22	
ι Piscium	4 55 13.3 N.	23 33 15.20	9 18 57.28	17.92	
4163 Groombridge	73 40 53.3 N.	23 48 35.47	9 34 17.50	17.97	

FORT YUKON, *August* 23, 1869.

Transit instrument, by Troughton & Sims—Sidereal chronometer No. 231, by Bond & Son—Observer Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Object observed.	Declination.	Tabular A. R.	Transit by chronometer.	Error of chronometer.	Remarks.
	° ′ ″	h. m. s.	h. m. s.	h. m. s.	
1 Draconis	81 53 54.3 N.	9 18 03.90	7 03 49.32	14 14 14.58	Lamp east.
β Aquarii	6 08 29.6 S.	21 24 42.14	7 10 27.92	14.22	
ε Pegasi	9 16 48.8 N.	21 37 47.60	7 23 33.59	14.01	
α Aquarii	0 57 01.7 S.	21 59 05.73	7 44 51.56	14.17	
9 Draconis	76 23 04.9 N.	10 23 48.54	8 09 35.39	13.15	
η Aquarii	0 47 14.5 S.	22 28 39.89	8 14 25.74	14.15	
ζ Pegasi	10 09 09.6 N.	22 34 58.17	8 20 43.88	14.29	
ι Cephei	65 30 50.4 N.	22 45 05.83	8 30 51.34	14.49	
φ Aquarii	6 45 00.0 S.	23 07 34.69	8 53 19.66	15 02	
ι Piscium	4 55 13.4 N.	23 33 15.22	9 19 00.45	14.77	
Moon's II	....	....	9 39 41.33	....	
4 Draconis	78 20 41.9 N.	12 05 56.06	9 51 41.03	15.03	
α Cassiopeæ	55 49 07.7 N.	0 33 08.87	10 18 54.60	14.27	

TIME BY TRANSIT OBSERVATIONS.

FORT YUKON.

Date, August, 1869.	No. of observations after rejection.	Hour.	Chronometer correction.	Probable error.	a	a′	c	Lamp.	Chronometer correction at 7 hours of each day = V.	Chronometer correction, 60s.20—3s.5 × t, assumed = C′.	Difference = d.
			h. m. s.	s.	s.	s.	s.		h. m. s.	h. m. s.	s.
10	15	7	14 15 00.61	0.10	+27.6281	+27.3868	+0.1079	E.	14 15 00.61	14 15 00.20	+0.41
11	16	7	14 56.35	0.05	26.6862	26.7249	—0.5262	E.	14 56.35	14 56.70	—0.35
12	13	7	53.14	0.23	6.7394	6.9389	+0.3756	W.	53.14	53.20	—0.06
13	19	7	49.95	0.18	5.5268	6.3829	—0.4126	E.	49.95	49.70	+0.25
14	6	7	46.08	0.14	5.5950	5.8890	+0.4473	W.	46.08	46.20	—0.12
20	15	6	25.73	0.10	3.6842	3.6492	—0.3620	E.	25.58	25.20	+0.38
21	21	7	21.50	0.06	4.8933	5.4198	+0.1996	W.	21.50	21.70	—0.20
22	8	8	17.95	0.02	3.8327	4.1092	—0.3046	E.	18.10	18.20	—0.10
23	11	8	14.28	0.11	0.0285	....	—0.5666	E.	14.43	14.70	—0.27

Time by transit observations—Continued.

Date, August, 1869.	Weight = w.	Time elapsed, days = t.	$t\,d$	t^2	$t\,w$	$d\,w$	$t\,d\,w$	$t^2\,w$	Chronometer correction corrected 60s.2973 — 3s.5142 × t = C.	Difference = v.	v^2	$w\,v^2$
									h. m. s.			
10	0. 50	0	0.	0	0.	+0. 2050	0.	0.	14 15 00. 2973	+0. 31	0. 0961	0. 0480, 5
11	0. 50	1	—0. 35	1	0. 50	—0. 1750	—0. 1750	0. 50	14 56. 7831	—0. 43	0. 1849	0. 0924, 5
12	0. 19	2	—0. 12	4	0. 38	—0. 0114	—0. 0228	0. 76	53. 2689	—0. 13	0. 0169	0. 0032, 11
13	0. 31	3	+0. 75	9	0. 93	+0. 0775	+0. 2325	2. 79	49. 7547	+0. 20	0. 0400	0. 0124
14	0. 51	4	—0. 48	16	2. 04	—0. 0612	—0. 2448	8. 16	46. 2405	—0. 16	0. 0256	0. 0130, 56
20	1. 00	10	+3. 80	100	10. 00	+0. 3800	+3. 8000	100. 00	25. 1553	+0. 42	0. 1764	0. 1764
21	1. 00	11	—2. 20	121	11. 00	—0. 2000	—2. 2000	121. 00	21. 6411	—0. 14	0. 0196	0. 0196
22	1. 00	12	—1. 20	144	12. 00	—0. 1000	—1. 2000	144. 00	18. 1269	—0. 03	0. 0009	0. 0009
23	0. 83	13	—3. 51	169	10. 79	—0. 2241	—2. 9133	140. 27	14. 6127	—0. 18	0. 0324	0. 0268, 92
	5. 84	...	....	....	47. 64	—0. 1092	—2. 7234	517. 48	....	....	....	0. 3929, 59

Probable error of chronometer correction, ε_0—$0.6745\sqrt{\dfrac{0.393}{(9-2)5.84}}$=0s.066

Let x=correction at a fixed epoch, (August 10, at 7 hours.)
y=rate.
t=time elapsed in days.
C=correction at time t.
V=value found by observation.

$x+y\,t$=C=V ± error; $p+q\,t$=C′. Assumed values: p=14h 15m 00s.20; q=—3s.50

$(x-p)+(y-q)t$=C — C′=V — C′ ± error=d ± error;

$x-p=m$; $x=m+p$; $y-q=r$; $y=r+q$

Conditional equation, $m+r\,t=d$

Normal equations, (1) $\Sigma\,d\,w=m\,\Sigma\,w+r\,\Sigma\,t\,w=-0.1092=5.84\,m+47.64\,r$

(2) $\Sigma\,d\,t\,w=m\,\Sigma\,t\,w+r\,\Sigma\,t^2\,w=-2.7234=47.64\,m+517.48\,r$

	h. m. s.		s.
m=	+00.0973	r=	—0.0142
p=	14 15 00.20	q=	—3.5
x=	14 15 00.2973	y=	—3.5142

REMARKS.

August 11.—Mean of two stars with smallest correction in azimuth and collimation gives 14*h* 14*m* 56*s* 68.
August 13.—Level interpolations unreliable.
August 20.—No level readings near time of reversal.
August 21.—Observations extend over 3¼ hours. Instrumental disturbance probable.
For errors of 0s.10 and less, weight assumed, 1.00.
August 10, 11.—Weight assumed at 0.50 in consideration of large deviation in azimuth.

LONGITUDE BY SOLAR ECLIPSE.

FORT YUKON, *August* 7, 1869.

Zenith telescope, by Würdemann; and pocket glass; chronometer No. 1609, by Bliss & Creighton—Observers, Captain Charles W. Raymond, United States Engineers; Mr. Ferdinand Westdahl—Recorder, Mr. J. J. Major.

	First contact.	Last contact.
Astronomical date	August 6.	August 7.
	h. m. s.	h. m. s.
Face indication of chronometer	12 11 50. 50	2 23 17. 50
Local mean time of observation	10 58 01. 67	1 09 29. 58
Sidereal time of observation	8 03 37. 00	10 15 26. 47
Longitude of Fort Yukon	*9 39 19. 65	9 41 24. 06

* Rejected; see Part II, Chapter I, of the report.

LONGITUDE BY MOON-CULMINATION.

FORT YUKON, *August*, 1869.

Date.	No. of culminators employed.	Deduced A. R. of moon's II.	Greenwich sidereal time.	Longitude.
1869.		*h. m. s.*	*h. m. s.*	*h. m. s.*
August 21	7	22 19 34. 990	32 00 46. 10	9 41 11. 11
August 22	5	23 07 27. 245	32 48 21. 94	*9 40 54. 70
August 23	2	23 53 56. 230	33 35 07. 41	9 41 11. 18

*Rejected; see Part II, Chapter I, of the report.

LATITUDE BY TALCOTT'S METHOD.

FORT YUKON, *August*, 1869.

Zenith telescope, by Würdemann—Sidereal chronometer No. 231, by Bond & Son—Observer, Captain Charles W. Raymond, United States Engineers—Recorder, Mr. J. J. Major.

Date.	Star. No. B. A. C.	Star. N. or S.	Time by chronometer.	Reading of micrometer.	Level. N.	Level. S.	Latitude.
1869.			*h. m. s.*	*t. d.*			° ′ ″
August 14	6976	S.	5 56 02. 0	00 27. 5	73. 0	56. 0	
	7005	N.	58 25. 0	20 78. 0	49. 0	81. 0	66 33 46. 42
August 17	7438	N.	7 04 07. 0	35 31. 0	65. 0	66. 0	
	7545	S.	20 55. 5	49 21. 0	69. 0	65. 0	43. 74
	7605	S.	7 29 36. 5	40 85. 1	67. 0	68. 0	
	7654	N.	35 37. 5	37 09. 1	65. 0	70. 0	16. 11
August 18	6976	S.	5 56 12. 0	48 32. 0	53. 0	70. 0	
	7005	N.	57 44. 0	27 24. 5	72. 0	51. 5	46. 66
	7153	S.	6 19 15. 0	45 74. 0	61. 0	62. 0	
	7178	N.	22 03. 5	23 33. 1	67. 0	55. 0	30. 51
	7230	N.	6 26 59. 0	28 76. 1	62. 0	62. 0	
	7243	S.	31 04. 5	48 98. 6	57. 0	67. 0	39. 57
	7230	N.	6 26 59. 0	28 76. 1	62. 0	62. 0	
	7294	S.	39 50. 0	28 20. 1	68. 0	59. 0	34 20. 35
	7438	N.	7 02 03. 5	32 63. 0	66. 0	65. 0	
	7545	S.	20 18. 0	45 52. 1	61. 0	71. 0	03. 25
	7708	S.	7 46 31. 5	38 13. 5	67. 0	68. 0	
	7758	N.	57 30. 5	25 33. 1	72. 0	62. 5	33 55. 20
							x_0=66 33 46. 87

APPENDIX B.

RECORD AND REDUCTION OF MAGNETIC OBSERVATIONS.

STATION, FORT YUKON, ALASKA—LATITUDE, 66° 33′ 47″ NORTH—LONGITUDE, 145° 17′ 47″ WEST FROM GREENWICH.

EXPERIMENTS WITH MAGNETIC DECLINOMETER.

Theodolite magnetometer No. 2, by William Würdemann.

AUGUST 12, (P. M.,) 1869.

The instrument was placed on a firmly imbedded spruce post, about fifty yards east of astronomical station. It was leveled, collimation examined, and "vertical" wire made vertical. The wooden box was used.

The instrument was then turned on a meridian-mark. Reading of the verniers, E. 29° 00′; W. 209° 00′.

The brass detorsion-cylinder was placed in the stirrup, and the torsion was approximately removed. (Stirrup suspended by two fibers, which were in position when the instrument was received, and had probably been used for several years.)

AUGUST 13, 1869.

The torsion-cylinder was removed, the declination-magnet was jammed, and the value of one division of its scale determined as follows:

E. vernier.	W. vernier.	Difference.	
° ′ ″	° ′ ″	′ ″	
58 35 30	238 35 30	....	
59 25 00	239 25 00	49 30	One division $= \frac{49' \ 30''}{20} = 2' \ 28''.5.$
59 25 00	239 25 00	....	
58 35 30	238 35 30	49 30	
	Mean	49 30	

Removed the declination-magnet, jammed the collimation-magnet, and determined the value of one division of its scale as follows:

E. vernier.	W. vernier.	Difference.	
° ′ ″	° ′ ″	′ ″	
55 28 00	235 28 00	....	
54 30 00	234 30 00	58 00	One division $= \frac{58'}{20} = 2' \ 54''.$
54 30 00	234 30 00	....	
55 28 00	235 28 00	58 00	
	Mean	58 00	

Removed the collimator and suspended the declination-magnet; determined the zero of its scale as follows:

Scale numbers.	Scale readings.	Alternate means.	Zeros.	Mean zero.
Direct	9.00	....	....	....
Inverted	11.40	9.10	10.25	....
Direct	9.20	11.10	10.15	....
Inverted	10.80	8.90	9.85	10.03
Direct	8.70	11.00	9.85	....
Inverted	11.30	....	....	....

Removed the declination-magnet and suspended the collimation-magnet. Determined the zero of its scale as follows:

Scale numbers.	Scale readings.	Alternate means.	Zeros.	Mean zero.
Direct	17.60			
Inverted	17.50	17.70	17.60	
Direct	17.90	18.00	17.90	
Inverted	18.60	18.00	18.30	18.05
Direct	18.11	18.70	18.40	
Inverted	18.80			

The collimator was removed, the declination-magnet suspended, and the instrument turned in azimuth until the vertical wire bisected the 10.03 division of the scale. The line of collimation is now in the direction of the magnetic axis of the magnet, and nearly in the magnetic meridian.

Removed the declination-magnet and suspended the collimation-magnet; torsion-circle moved until the vertical wire of the telescope bisected the 18.05 division of the scale. Line of detorsion now in the magnetic meridian. Torsion-circle, 3.95.

Collimator removed and declination-magnet suspended; the vertical wire made to bisect the 10.03 division of the scale by moving the instrument in azimuth. Line of collimation now accurately in the magnetic meridian.

Thermometer .... 72°.20 F.
Time of observation .... 6^h 50^m p. m.
Verniers .... E. 63° 54′ 00″; W. 243° 54′ 00″.

Determined the coefficient of torsion as follows:

Circle reads—	Scale reads—	Difference of arc.	Difference of scale.	Mean for 90°.
3.95	10.25			
30.95	6.10	90°	4.15	
12.95	15.90	180	9.80	4.71
3.95	11.00	90	4.90	

$w = 90°$ $u = 697''.435$

Instrument then left in adjustment for observations of magnetic declination. Examined what movement an increase of the figures* denoted. Found the north end move to the eastward. The observer at this instrument looks northward. Tabulated the following data:

DATA FOR MAGNETIC DECLINATION.

1. Zero of declination magnet, 10.03.
2. Angular value of one division of scale of declination-magnet, 2′ 28″.5.
3. Difference of scale-readings for 90° of torsion, 4.71=697″.435.
4. Angular value of scale corrected for ratio of torsion and magnetic force, $a\left(1+\frac{H}{F}\right)=2'\ 28''.76$.
5. An increase of scale-readings denotes a movement of the north end of the magnet to the eastward.
6. Reading of verniers when the instrument is turned on the meridian-mark, (south,) E. 29° 00′; W. 209° 00′.

* This scale is not *marked* with figures, but was assumed to read in the ordinary way.

7. Geographical position of magnetometer: Latitude, 66° 33′ 47″ north; longitude, 145° 17′ 47″ west.
8. Instrument put in position, details made and recorded by Captain Charles W. Raymond, United States Engineers.

OBSERVATIONS OF MAGNETIC DECLINATION.

FORT YUKON, ALASKA.

Theodolite magnetometer No. 2, by William Würdemann—Observer, Captain Charles W. Raymond, United States Engineers.

Date.	Time.	Temp. (F.)	Scale.	Remarks.
	h. m.	°		
August 14, 1869	8 00 a. m.	63.0	18.90	Weather cool and clear; very little wind.
	8 15 a. m.	63.0	18.80	
	8 30 a. m.	63.0	18.00	
	8 45 a. m.	68.5	17.00	
	9 00 a. m.	70.0	17.40	
	9 15 a. m.	71.0	16.10	
	9 30 a. m.	72.5	14.70	
	9 45 a. m.	75.0	14.70	Observed by Mr. F. Westdahl.
	10 00 a. m.	74.5	15.80	Observed by Mr. F. Westdahl.
	10 15 a. m.	74.5	14.20	
	10 30 a. m.	76.0	14.50	
	10 45 a. m.	76.5	13.50	
	11 00 a. m.	76.5	13.00	
	11 15 a. m.	78.5	12.00	
	11 30 a. m.	80.0	11.00	
	11 45 a. m.	80.5	11.40	
	12 00 m.	81.5	10.90	
	12 15 p. m.	82.0	11.10	
	12 30 p. m.	82.5	11.10	
	12 45 p. m.	82.0	10.60	
	1 00 p. m.	83.0	10.60	From 1 to 6 p. m. engaged in experiments of deflection
	1 34 p. m.	78.5	11.20	Taken during experiments of deflection; thermometer
	3 45 p. m.	87.0	12.00	attached.
	6 00 p. m.	82.0	11.70	I have strongly suspected the presence of aurora all
	6 15 p. m.	82.0	11.70	day, and went to the observatory at midnight, as
	6 30 p. m.	80.0	11.80	there seemed to be some slight indications of it in the
	7 00 p. m.	77.0	11.00	sky. A little cloudy and occasionally a sudden, brisk
	7 30 p. m.	69.0	13.00	breeze, which dies away immediately.—C. W. R.
	8 00 p. m.	62.0	13.50	
	8 30 p. m.	58.0	13.00	
	9 10 p. m.	58.0	10.00	
August 15, 1869	12 20 a. m.	56.0	4.90	Sunday, August 15, no observations during the day
August 16, 1869	10 30 a. m.	75.0	19.00	very bright aurora at night.
	10 45 a. m.	79.0	20.00	Magnet slightly oscillating, without apparent cause.
	11 00 a. m.	79.0	11.90	
	11 15 a. m.	80.0	8.00	
	11 30 a. m.	80.0	15.10	
	11 45 a. m.	80.0	9.90	Stopped readings to make experiments of vibration.
	1 45 p m.	85.0	11.60	
	2 00 p. m.	84.5	12.00	
	3 00 p. m.	87.0	16.00	
	4 00 p. m.	86.5	16.00	
	5 00 p. m.	85.0	17.90	

OBSERVATIONS FOR ABSOLUTE HORIZONTAL INTENSITY.

FORT YUKON, *August* 14, 1869.

Theodolite magnetometer No. 2, by William Würdemann—Observer, Captain Charles W. Raymond, United States Engineers.

DETAILS.

The instrument was retained in the same position, and the wooden box used for the experiments of deflection as well as vibration.

The bell-metal deflecting bar was placed in position and secured, and the support for the deflecting magnet put on. To this was attached a thermometer quite close to the magnet. The instrument was moved very slightly in azimuth until the vertical wire bisected the 10.03 division of the scale. The verniers were then read and the time noted, in order to follow the changes of declination during the experiments of deflection. The collimation-magnet was then placed upon the east end of the deflecting bar, at a distance of 0.65 foot from the suspended magnet. The magnet was quieted and allowed to take its normal direction, when the vertical wire of the telescope was made to bisect the 10.03 division of the scale. The thermometer and time were noted and the verniers read.

The deflector was then moved to 0.87 foot, and a similar operation gone through, and the same at 1.90 feet. The marked end of the deflector was then reversed at 1.90 feet, the instrument moved in azimuth, the suspended magnet quieted, and the vertical wire of the telescope made to bisect the 10.03 division of the scale, &c.

The deflector was then removed successively to 0.87 and 0.65 foot, when it was reversed and an exactly similar operation performed as from the first, in order to obtain a double set of results. One observation was taken on the west before the deflector was removed.

The deflector was then taken away, the suspended needle quieted, the vertical wire of the telescope made to bisect the 10.03 division of the scale, the verniers read, and the time noted, in order to show the changes of declination during the experiments.

The deflector was then placed upon the opposite end of the deflecting bar, and a similar set of observations made. At the close the deflector was removed, the suspended needle quieted, the vertical wire of the telescope made to bisect the 10.03 division of the scale, and the verniers read for changes of declination, noting temperature and time.

EXPERIMENTS OF DEFLECTION.

FORT YUKON, ALASKA, *August* 14, 1869.

Magnet at 0′.65 east and west.

Position of defl.	Marked end.	Temp., F.	Verniers E. and W.	Means of Verniers.	Time.	Means corr. for change of declination.	Arc of deflection, semi-arc.
		°	° ′ ″	° ′ ″	h. m. s.	° ′ ″	° ′ ″
E. 1	E.	79.0	101 35 00	191 35 00	1 46 00	191 34 49	
			281 35 00				76 48 53.0
6	W.	81.0	24 45 00	114 45 00	2 36 00	114 45 56	38 24 26.5
			204 45 00				77 10 59.0
7	E.	81.0	101 58 00	191 58 00	2 45 00	191 56 55	38 35 29.5
			281 58 00				77 47 10.0
12	W.	81.0	24 08 00	114 08 00	3 30 00	114 09 45	*38 53 35.0
			204 08 00				
						Mean	38 29 58.0
W. 13	E.	86.0	102 31 00	192 31 00	3 33 00	192 29 12	
			282 31 00				79 08 59.0
18	W.	87.0	23 20 30	113 20 30	4 37 00	113 20 13	39 34 29.5
			203 20 30				79 00 10.0
19	E.	86.0	102 20 00	192 20 00	4 54 00	192 20 23	39 30 05.0
			282 20 00				77 56 06.0
24	W.	82.0	24 25 00	114 25 00	5 54 00	114 24 17	38 58 03.0
			204 25 00				
Mean for E. and W				38 55 25.5		Mean	39 20 52.5

* Reject.

Remarks.—1h. 34m. p. m.—Turned instrument on 10.03 decl. scale. Verniers, E. 63° 51′; W. 243° 51′. Temp., 78°.5 F., (attached.) 3h. 45m. p. m.—Deflector away to show changes of declination. Temp., 87° F. Verniers, E. 63° 49′; W. 243° 49′. 6h. 00m. p. m.—End of experiments. Temp., 82° F. Scale, 11.70. Verniers, E. 63° 54′; W. 243° 54′.

Experiments of deflection—Continued.

Magnet at 0′.87 east and west.

Position of defl.	Marked end.	Temp., F.	Verniers E. and W.	Means of Verniers.	Time.	Means corr. for change of declination.	Arc of deflection, semi-arc.
		°	° ′ ″	° ′ ″	h. m. s.	° ′ ″	° ′ ″
E. 2	E.	80.0	78 50 00	168 50 00	2 00 00	168 49 36	
			258 50 00				30 52 46.0
5	W.	82.0	47 56 00	137 56 00	2 29 00	137 56 50	15 26 23.0
			227 56 00				30 58 55.0
8	E.	81.0	78 57 00	168 57 00	2 56 00	168 55 45	15 29 27.5
			258 57 00				30 51 11.0
11	W.	81.5	48 03 00	138 03 00	3 17 00	138 04 34	15 25 35.5
			228 03 00				
						Mean	15 27 08.6
W. 14	E.	87.0	79 28 00	169 28 00	4 03 00	169 28 06	
			259 28 00				31 45 21.0
17	W.	88.0	47 43 00	137 43 00	4 30 00	137 42 45	15 52 40.5
			227 43 00				31 33 45.0
20	E.	85.0	79 16 00	169 16 00	5 16 00	169 16 30	15 46 52.5
			259 16 00				31 16 09.0
23	W.	83.0	48 01 00	138 01 00	5 43 00	138 00 21	15 38 04.5
			228 01 00				
Mean for E. and W				15 36 30.5		Mean	15 45 52.5

Magnet at 1′.09 east and west.

Position of defl.	Marked end.	Temp., F.	Verniers E. and W.	Means of Verniers.	Time.	Means corr. for change of declination.	Arc of deflection, semi-arc.
		°	° ′ ″	° ′ ″	h. m. s.	° ′ ″	° ′ ″
E. 3	E.	81.0	71 18 05	161 18 05	2 10 00	161 17 32	
			251 18 05				15 43 52.0
4	W.	82.0	55 33 00	145 33 00	2 18 00	145 33 40	7 51 56.0
			235 33 00				15 46 00.0
9	E.	81.0	71 21 00	161 21 00	3 02 00	161 19 40	7 53 00.0
			251 21 00				15 43 15.0
10	W.	82.0	55 35 00	145 35 00	3 08 00	145 36 25	7 51 37.5
			235 35 00				
						Mean	7 52 11.2
W 15	E.	85.5	71 34 00	161 34 00	4 13 00	161 34 09	
			251 34 00				16 04 21.0
16	W.	87.0	55 30 00	145 30 00	4 22 00	145 29 48	8 02 10.5
			235 30 00				16 06 44.0
21	E.	84.0	71 36 00	161 36 00	5 22 00	161 36 32	8 03 22.0
			251 36 00				15 55 08.0
22	W.	85.0	55 42 00	145 42 00	5 35 00	145 41 24	7 57 34.0
			235 42 00				
Mean for E. and W				7 56 36.7		Mean	8 01 02.2

REMARKS.—Throughout all this set of experiments the needle was very sensitive, and it took a long time to quiet it.

After these experiments the deflector was removed. The torsion was then tested as follows:

Circle reads—	Scale reads—	Diff. of arc.	Diff. of scale.	Mean for 90°.
3.95 30.95 12.95 3.95	11.70 6.60 16.60 11.20	90° 180 90	5.10 10.00 5.40	5.13

Details, observations, and record by Captain Charles W. Raymond, United States Engineers.

MONDAY, *August* 16, 1869.

The following experiments of vibration were made. The chronometer used was No. 1609 M. T., by Bliss and Creighton. The thermometer was outside the box, but near it, and on the opposite side from the lamp.

The collimation-magnet was suspended for the experiments of vibration. Instrument turned in azimuth until the vertical wire bisected the 10.00 division of the scale.

Scale-reading taken just before the 200th vibration to show changes of declination. Reading, 13.00. Time, 12h. 15m. p. m.

Just before the 300th vibration the scale-reading changed to 5.00, there being no apparent cause. The vibrations had become so small that the assumed zero-division did not pass the vertical wire. The instrument was therefore moved slightly in azimuth to correct this change of declination, and the 300th vibration timed. No further vibrations could be timed, as it was found impossible to make the magnet vibrate any longer.

At the end of the experiments, the instrument was moved in azimuth to its original position, in order to observe changes in declination.

Approximate time of six vibrations at the beginning, 35^s.

Approximate time of ten vibrations at the 200th, 59^s. Stopped at 1^h 42^m p. m.

VIBRATIONS.

Observations without weight.

No. of osc.	Times by chronometer.	Temp., F.	No. of osc.	Times by chronometer.	Temp., F.
	h. m. s.	°		*h. m. s.*	°
0	1 16 05.0	82.5	42	1 20 15.5	82.5
6	16 40.8	82.5	48	20 51.3	82.5
12	17 16.5	82.5	54	21 27.0	82.5
18	17 52.3	82.5	60	22 02.8	82.5
24	18 28.3	82.5	100	26 01.5	81.0
30	19 04.0	82.5	200	35 57.5	81.0
36	19 39.7	82.5	300	45 47.8	84.5

To determine coefficient of torsion.

Circle reads—	Scale reads—	Diff. of arc.	Diff. of scale.	Mean for 90°.
3.95 30.95 12.95 3.95	17.70 10.60 21.00 17.70	90° 180 90	7.10 10.40 3.30	5.20

The observations with weight were then made. The collimation-magnet remained suspended, and the inertia-ring was balanced on it.

Approximate time of six vibrations at the beginning..............53s.
Inertia-ring, outside diameter............................1.999 inches.
inside diameter............................1.601 inches.
weight..................................507.02 grains.
Scale-reading at beginning......................................10.00.

VIBRATIONS.

Observations with weight.

No. of osc.	Times by chronometer.	Temp., F.	No. of osc.	Times by chronometer.	Temp., F.
	h. m. s.	°		h. m. s.	°
0	7 31 49.8	80.0	200	8 01 11.8	69.0
6	32 42.8	80.0	300	15 49.0	69.0
12	33 35.0	80.0	306	16 41.5	69.0
18	34 28.7	80.0	312	17 34.0	69.0
24	35 21.8	80.0	318	18 26.7	69.0
30	36 14.5	80.0	324	19 19.1	67.0
36	37 07.5	80.0	330	20 11.5	67.0
42	38 00.5	80.0	336	21 04.2	67.0
48	38 53.5	80.0	342	21 57.0	67.0
54	39 46.4	80.0	348	22 49.5	67.0
60	40 39.5	80.0	354	23 42.0	67.0
100	46 31.3	80.0	360	24 35.0	66.0

Wind from the east. Reading of scale at end of experiments, 3.40.
Details and observations by Captain Charles W. Raymond, United States Engineers. Record by Mr. J. J. Major.

NOTE.—August 16. At 11*h.* 50*m.* p. m. a brilliant display of aurora took place. It lasted about an hour. It was most brilliant in the east. The magnet was drawn completely out of the limits of the scale. I turned the instrument in azimuth, and then saw that the magnet was greatly agitated, both vertically and horizontally. It was drawn strongly to the eastward.—C. W. R.

AUGUST 25, 1879.—*To determine coefficient of torsion.*

Circle reads—	Scale reads—	Diff. of arc.	Diff. of scale.	Mean for 90°.
3.95	10.40			
30.95	5.00	90°	5.40	
12.95	15.80	180	10.80	5.38
3.95	10.50	90	5.30	

Instrument turned on meridian-mark, the position of which had been changed.
Reading of verniers, E. 29° 06′ 30″; W. 209° 06′ 30″.

OBSERVATIONS FOR ABSOLUTE MAGNETIC INCLINATION.

AUGUST 26, 1869.

The observations to determine the absolute magnetic inclination were made with dip-circle No. 2, by Würdemann.

Previous to the observations the needles were re-charged. Readings of vernier when the instrument is in magnetic meridian, face east, 255° 41′ 00″; face west, 75° 41′ 00″.

Details, observations, and record by Captain Charles W. Raymond, United States Engineers.

NEEDLE No. 1.—MARKED END NORTH.

Face of vertical circle.	Face of needle.	Means of north and south ends.	Means.	Means.	Temp., F.
		° ′ ″	° ′ ″	° ′ ″	°
E	E	79 57 00	79 55 00		69.0
	E	53 00		79 57 30	69.5
	W	55 00	80 00 00		69.0
	W	80 05 00			69.5
W	E	79 52 30	79 45 00		72.0
	E	57 00		79 49 00	66.0
	W	53 00	79 53 00		72.0
	W	53 00			71.0
Mean				79 53 15	

NEEDLE No. 1.—MARKED END SOUTH.

Face of vertical circle.	Face of needle.	Means of north and south ends.	Means.	Means.	Temp., F.
		° ′ ″	° ′ ″	° ′ ″	°
E	E	80 12 00	80 09 00		70.0
	E	06 00		79 47 45	70.0
	W	79 25 00	79 26 30		70.0
	W	28 00			70.0
W	E	80 12 00	79 58 30		70.0
	E	79 45 00		79 45 15	70.0
	W	42 00	79 32 00		70.0
	W	22 00			70.0
Mean				79 46 30	

NEEDLE No. 2.—MARKED END NORTH.

Face of vertical circle.	Face of needle.	Means of north and south ends.	Means.	Means.	Temp., F.
		° ′ ″	° ′ ″	° ′ ″	°
E	E	80 03 00	80 04 00		69.0
	E	05 00		79 54 45	69.0
	W	79 41 00	79 45 30		69.0
	W	50 00			69.0
W	E	35 00	79 42 30		69.0
	E	50 00		79 32 30	69.0
	W	13 00	79 22 30		69.0
	W	32 00			69.0
Mean				79 43 37.5	

Observations for absolute magnetic inclination—Continued.

NEEDLE No. 2.—MARKED END SOUTH.

Face of vertical circle.	Face of needle.	Means of north and south ends.	Means.	Means.	Temp., F.
		° ′ ″	° ′ ″	° ′ ″	°
E	E	80 08 00	80 12 00		70.0
	E	16 00		80 11 00	70.0
	W	79 57 00	80 10 00		70.0
	W	80 23 00			70.0
W	E	79 40 00	79 46 30		70.0
	E	53 00		79 49 30	70.0
	W	80 08 00	79 52 30		70.0
	W	79 37 00			70.0
Mean				80 00 15	

NEEDLE No. 3.—MARKED END NORTH.

Face of vertical circle.	Face of needle.	Means of north and south ends.	Means.	Means.	Temp., F.
		° ′ ″	° ′ ″	° ′ ″	°
E	E	79 43 00	79 51 00		68.0
	E	59 00		79 57 30	68.0
	W	80 08 00	80 04 00		68.5
	W	00 00			68.0
W	E	79 15 00	79 15 30		69.0
	E	16 00		79 32 15	69.0
	W	59 00	79 49 00		69.0
	W	39 00			69.0
Mean				79 44 52.5	

NEEDLE No. 3.—MARKED END SOUTH.

Face of vertical circle.	Face of needle.	Means of north and south ends.	Means.	Means.	Temp., F.
		° ′ ″	° ′ ″	° ′ ″	°
E	E	80 35 00	80 13 30		70.0
	E	79 52 00		80 08 00	70.0
	W	80 05 00	80 02 30		70.5
	W	00 00			70.0
W	E	79 41 00	79 40 00		68.5
	E	39 00		79 29 15	68.5
	W	27 00	79 18 30		68.5
	W	10 00			68.5
Mean				79 48 37.5	

COMPUTATIONS.

MAGNETIC DECLINATION.

To determine the angular value of one division of the scale of the declination-magnet, corrected for ratio of torsion and magnetic force, a mean of the observations of August 14 and 16 is employed. The computation is as follows:

m=mean of scale-readings for 90°; u=same reduced to angular value; w=mean of circle-readings for 90°; a=angular value of one division of scale=148″.5.

$$m\times a=u=766''.26;\ w=324000'';\ w-u=323233''.74$$

$$\log u=2.8843762$$

$$\log (w-u)=5.5095167$$

$$\log \frac{H}{F}=7.3748595$$

$$\frac{H}{F}=0.0023706$$

$$1+\frac{H}{F}=1.0023706$$

$$a\left(1+\frac{H}{F}\right)=148''.85=2'\ 28''.85$$

Mean declination, August 14, 1869.

Scale 10.03—Verniers...........................	E. 63° 54′	W. 243° 54′
Meridian-mark	29 00	209 00
	34 54	
Corr. for azimuth of mark....................	+1 30	
Mean of scale-readings................ 13.36		
13.36−10.03=+3.33; 3.33×2′ 48″=8′.2584=	8 15′ .5	
Mean declination=	36 32 15 .5	

Mean declination, August 16, 1869.

Reject observation at $10^h\ 45^m$ a. m.

Mean of scale-readings=13.74.

13.74−10.03=+3.71

3.71×2′.48=9′.2008=+9′ 12″.05

Mean declination=36° 33′ 12″.05.

Mean of values for August 14 *and* 16, 1869.

Magnetic declination=36° 32′ 44″.

RATIO OF MAGNETIC MOMENT OF DEFLECTING MAGNET TO HORIZONTAL INTENSITY.

r=distance between centers of magnets in feet.
u=corrected angle of deflection.

$r=0.65$; $u=38°\ 55''\ 25'.5$ $\log \tan u=9.9071634$

$$\text{ar. co. } \log (2)=9.6989700$$

$\log r=9.8129134$ $\log (r^3)=9.4387402$

$$\log \frac{m}{X}=9.0448736$$

$$\frac{m}{X}=0.1108852$$

$r=0.87$; $u=15° \, 36' \, 30''.5$ $\quad \log \tan u=9.4461711$

$$\log (r^3)=9.8185579$$
$$\text{ar. co.} \log (2)=9.6989700$$
$$\log \frac{m}{X}=8.9636990$$
$$\frac{m}{X}=0.0919814$$

$r=1.09$; $u=7° \, 56' \, 36''.7$ $\quad \log \tan u=9.1446858$

$$\log (r^3)=0.1122795$$
$$\text{ar. co.} \log (2)=9.6989700$$
$$\log \frac{m}{X}=8.9559353$$
$$\frac{m}{X}=0.0903515$$

Mean at 0.87 and 1.09, $\frac{m}{X}=0.0911664$; $\log=8.9598348$

PRODUCT OF MAGNETIC MOMENT OF VIBRATING MAGNET AND HORIZONTAL INTENSITY.

Correction of times of vibration.

The correction for rate and arc being inappreciable, the correction of the times is computed by the following formula:

$$T^2=T'^2\times(1+\frac{H}{F})[1-(t'-t)q]$$

in which T and T′ are the true and observed times of vibration respectively; $\frac{H}{F}$, the ratio of the torsion and magnetic forces; t, the temperature of the magnet while deflecting; t', the temperature of the magnet while vibrating; and q, the change of magnetic moment for one degree of temperature.

Having had no opportunity to obtain the value of q by experiment, it is assumed 0.00015.

I. Time without weight.

$t'=82°.7$; $t=83°.3$; $t'-t=0°.06$; $(t'-t)q=1.00009$

$$\log [1-(t'-t)q]=0.0000391$$
$$\log (T'^2)=1.5503176$$
$$\log (1+\frac{H}{F})=0.0010283$$
$$\log (T^2)=1.5513850$$
$$\log T=0.7756925$$
$$T=5^s.9661$$

II. Time with weight.

$$t'=82^\circ.7;\ t=72^\circ.4;\ t'-t=10^\circ.3;\ (t'-t)\,q=0.001545;$$

$$1-(t'-t)q=0.998455$$

$$\log\,[1-(t'-t)q]=9.9993285$$
$$\log\,(T'^2)=1.8885704$$
$$\log\,(1+\frac{H}{F})=0.0010283$$
$$\log\,(T^2)=1.8889272$$
$$\log T=0.9444636$$
$$T=8^s.800$$

Moment of inertia of weight.

The inertia-ring is of bell-metal. Its moment of inertia is computed by the following formula:

$$K'=\tfrac{1}{2}\,(r^2+r'^2)\,w$$

in which—

r = outer radius in feet = 0.083290
r' = inner radius in feet = 0.066708
w = weight in grains... = 507.02
r^2 = 0.0069372241
r'^2 = 0.0044499573

$r^2+r'^2$ = 0.0113871814 log = 8.0564162
$\tfrac{1}{2}$ w=253.51 log = 2.4039951
log K′ = 0.4604113

Moment of inertia of suspended magnet and stirrup.

This quantity is computed by the following formula:

$$K=K'\left(\frac{T^2}{T'^2-T^2}\right)$$

in which T′ and T are the corrected times of vibration with and without weight respectively.

T'^2 = 77.440000
T^2 = 35.593156 log = 1.5513850
T'^2-T^2 = 41.846844; log = 1.6216627; ar. co. log = 8.3783373
$t'-t=10^\circ.9$; $2e=0.0000136$ log K′ = 0.4604113
$1+2e\,(t'-t)=1.00014824$ log = 0.0000644
log K = 0.3901980

The product of the horizontal intensity into the magnetic moment is computed by the following formula:

$$mX=\frac{\pi^2 K}{T^2}$$

in which K = moment of inertia of magnet and stirrup, and T = corrected time of vibration.

$$\log(\pi^2) = 0.9942997$$
$$\log K = 0.3901980$$
$$\log(T^2) = 1.5513850; \quad \text{ar. co. log} = 8.4486150$$
$$\log mX = 9.8331127$$

HORIZONTAL INTENSITY AND MAGNETIC MOMENT OF SUSPENDED MAGNET.

The quantities are computed by the following formulæ:

$$X = \sqrt{\frac{B}{A}}; \quad m = \sqrt{AB}$$

in which

$$A = \frac{m}{X}; \quad B = mX$$

$$\log B = 9.8331127$$
$$\log A = 8.9598348 \quad \text{ar. co. log} = 1.0401652$$
$$\log(X^2) = 0.8732779$$
$$\log X = 0.43663895$$
$$X = 2.73210$$

$$\log A = 8.9598348$$
$$\log B = 9.8331127$$
$$\log(m^2) = 8.7929475$$
$$\log m = 9.39647375$$
$$m = 0.24916$$

ABSOLUTE MAGNETIC INCLINATION.

Needle No. 1—Mean of observations......	79°	49′	52″.5
Needle No. 2—Mean of observations......		51	56 .3
Needle No. 3—Mean of observations......		46	48 .0
Sum..............................	239	28	36 .8
Mean..........	79	49	32

TOTAL INTENSITY.

The following formula is employed:

$$I = \frac{X}{\cos D}$$

in which X = horizontal intensity, and D = the inclination.

$$\log X = 0.4366390$$
$$\log \cos D = 9.24710314 \quad \text{ar. co. log} = 0.7528969$$
$$\log I = 1.1895359$$
$$I = 15.47162$$

Computations by Captain Charles W. Raymond, United States Engineers.

APPENDIX C.

RECORD AND REDUCTION OF METEOROLOGICAL OBSERVATIONS.

COMPARISON OF BAROMETERS.

REDOUBT ST. MICHAEL'S, *September* 26, 1869.

Cistern barometers Nos. 1609 and 1613, by James Green, New York—Observer, Mr. J. J. Major.

Hour.	Barometer uncorrected.		Att. thermometer.		Errors of barometers.		Errors of thermometers.	
	1613.	1609.	1613.	1609.	1613.	1609.	1613.	1609.
h. m.			°	°				°
10 30 a. m	29. 645	29. 632	55. 5	56. 5	0. 000	+0. 013	0. 00	—1. 0
11 30 a. m	. 653	. 644	57. 0	58. 5	. 000	. 009	. 00	1. 5
12 30 p. m	. 652	. 630	55. 0	55. 5	. 000	. 022	. 00	0. 5
1 30 p. m	. 650	. 630	53. 5	54. 2	. 000	. 020	. 00	0. 7
2 00 p. m	. 650	. 638	55. 5	56. 5	. 000	. 012	. 00	1. 0
3 00 p. m	. 659	. 651	55. 5	57. 0	. 000	. 008	. 00	1. 5
4 00 p. m	. 663	. 650	53. 5	54. 5	. 000	. 013	. 00	1. 0
Sum						+0. 097	....	—7. 2
Mean=part of correction due to difference of barometers						0. 0139	....	—1. 03
Part of correction due to difference of att. thermometers						—0. 0028	....	....
Instrumental difference						+0. 0167	....	....

SAN FRANCISCO.

Cistern barometers Nos. 1571, 1609, and 1613, by James Green, New York—Aneroid barometer—Observer, Mr. J. J. Major.

Date.	Hour.	Barometer uncorrected.				Att. thermometer.			Errors of barometers.				Errors of thermometers.		
		1571.	1609.	1613.	Aneroid.	1571.	1609.	1613.	1571.	1609.	1613.	Aneroid.	1571.	1609.	1613.
1869.	*h. m.*					°	°								
Nov. 17	9 30 a.m.	30.360	30.374	30.395	.. ...	62.5	62.5	62.0	0.000	—.014	—.035	... .	0.0	0.0	+0.5
Dec. 1	12 m.	.228	.244	.255	.. ...	63.5	63.5	63.5	.000	.016	.027	....	.0	.0	.0
	3 00 p.m.	.191	.2[illegible]7	.221	30.350	67.0	67.0	67.0	.000	.016	.030	—.159	.0	.0	.0
2	9 00 a.m.	.126	.193	.157	.290	58.0	58.0	58.0	.000	.067	.031	.164	.0	.0	.0
	3 00 p.m.	.028	.013	.045	.190	66.5	66.5	66.5	.000	+.015	.017	.162	.0	.0	.0
3	9 00 a.m.	29.967	29.975	.000	.125	58.5	58.0	58.0	.000	—.008	.033	.158	.0	+0.5	+0.5
	3 00 p.m.	.937	.949	29.970	.090	67.5	67.5	67.5	.000	.012	.033	.153	.0	0.0	.0
4	9 00 a.m.	30.187	30.170	30.192	.340	61.5	61.5	61.0	.000	+.017	.005	.153	.0	.0	+0.5
Sum										—0.133	—0.211	—0.949	.. ..	+0.5	+1.5
Mean=part of correction due to error of barometers										— .0222	— .0264	— .1582	.. ..	+0.06	+0.19
Part of correction due to error in att. thermometers										+ .0016	+ .0005	....	.. ..	.... .	.... .
Instrumental error										— .0138	— .0269	....	.. ..	. ....	. ....

METEOROLOGICAL OBSERVATIONS AT REDOUBT ST. MICHAEL'S.

Cistern barometer No. 1613, and thermometers, by James Green, New York—Observer, Captain Riedell, superintendent of trading-station.

Date.	Hour.	Att. thermometer.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind. Direction.	Wind. Force.	C ouds. Amount.	C ouds. Kind.	Detached thermometers. Dry.	Detached thermometers. Wet.
1869.		°							°	°
July 3	2 p. m.	64. 5	29. 919	29. 795	S. E.	2	10	Cir. nim	64. 5	......
	9 p. m.	55. 2	. 872	. 773	E.	2	10	Cir. strat	56. 5	......
4	9 a. m.	64. 0	29. 808	29. 686	N.	3	4	Cir	65. 0	......
	12 m.	61. 3	. 772	. 659	N.	5	4	Cir. cum	62. 5	......
	3 p. m.	61. 0	. 758	. 645	N.	5	4	Cir. cum	62. 0	......
	9 p. m.	61. 8	. 698	. 583	N.	4	3	Cir. strat	62. 0	......
5	9 a. m.	67. 5	29. 735	29. 605	S. E.	4	8	Cum	69. 0	......
	12 m.	63. 8	. 757	. 637	N.	4	9	Nim	66. 0	......
	3 p. m.	61. 8	. 739	. 624	E. N. E.	3	10	Rain	64. 0	......
	9 p. m.	60. 2	. 718	. 607	E. S. E.	4	9	Nim	62. 5	......
6	9 a. m.	66. 2	29. 796	29. 668	E.	6	9	Nim. cum	67. 0	......
	12 m.	67. 0	. 785	. 655	E.	6	10	Nim	65. 8	......
	3 p. m.	65. 0	. 778	. 653	E.	6	10	Rain	66. 5	......
	9 p. m.	62. 0	. 771	. 656	E.	5	10	Rain	64. 5	......
7	9 a. m.	63. 6	29. 754	29. 634	E. S. E	6	9	Rain	64. 0	......
	12 m.	65. 2	. 769	. 645	E. S. E.	5	9	Nim	66. 5	......
	3 p. m.	66. 2	. 766	. 640	E. S. E.	5	10	Nim	66. 5	......
	9 p. m.	61. 5	. 719	. 605	E. S. E.	6	10	Rain	63. 5	......
8	9 a. m.	62. 0	29. 730	29. 615	S.	3	10	Rain	63. 5	......
	12 m.	64. 0	. 730	. 609	S.	3	10	Rain	52. 0	......
	3 p. m.	61. 2	. 744	. 631	N. W.	3	8	Nim	53. 5	......
	9 p. m.	58. 0	. 820	. 714	W.	4	8	Cum.; squally	44. 5	......
9	9 a. m.	57. 0	29. 928	29. 825	N. E.	5	8	Cum. cir	56. 5	47. 0
	12 m.	57. 0	. 924	. 821	N. N. E.	5	8	Nim	55. 5	47. 5
	3 p. m.	55. 5	. 924	. 825	N.	5	8	Nim	56. 0	47. 0
	9 p. m.	55. 5	. 942	. 843	N. N. W.	5	5	Strat	56. 5	40. 5
10	9 a. m.	62. 5	30. 025	29. 907	N. W.	4	3	Cum	55. 0	47. 5
	12 m.	59. 5	. 024	. 914	N. W.	4	1	Cum	78. 0	55. 0
	3 p. m.	58. 5	. 018	. 911	N. W.	5	1	Cum	64. 5	54. 5
	9 p. m.	58. 0	. 030	. 924	W.	2	0	Clear	49. 0	43. 0
11	9 a. m.	62. 5	30. 052	29. 934	N. E.	2	0	Clear	54. 0	48. 5
	12 m.	60. 7	. 054	. 941	N.	4	0	Clear	60. 5	50. 5
	3 p. m.	58. 5	. 042	. 935	N.	4	0	Clear	63. 5	53. 5
	9 p. m.	55. 2	. 040	. 941	W.	3	0	Clear	49. 0	43. 5
12	9 a. m.	64. 2	30. 028	29. 905	S. W.	4	9	Cum	53. 5	46. 5
	12 m.	63. 8	. 008	. 886	S. W.	3	1	Cum	63. 0	53. 0
	3 p. m.	62. 0	29. 998	. 881	S. W.	5	0	Clear	62. 0	51. 5
	9 p. m.	57. 5	30. 020	. 915	S. W.	3	0	Clear	53. 0	48. 0
13	9 a. m.	63. 5	30. 012	29. 891	S. E.	5	9	Cir. cum	54. 0	46. 5
	12 m.	......	. 008	. 887	......	...	...	......	......	......
	3 p. m.	61. 5	29. 998	. 883	S. E.	4	1	Cir. strat	70. 0	59. 5
	9 p. m.	60. 0	30. 030	. 919	S. W.	3	0	Cir. strat	52. 0	46. 5
14	9 a. m.	61. 0	30. 092	29. 978	S.	6	10	Nim	53. 0	47. 5
	12 m.	61. 5	. 090	. 975	S.	6	10	Nim	54. 0	49. 0
	3 p. m.	61. 5	. 080	. 965	S.	6	10	Nim	54. 5	49. 5
	9 p. m.	61. 8	. 078	. 962	S.	6	10	Rain	51. 0	48. 0
15	9 a. m.	61. 5	30. 144	30. 029	S.	5	10	Fog	52. 0	48. 5
	12 m.	64. 0	. 160	. 038	S.	5	10	Rain	55. 0	51. 0
	3 p. m.	62. 5	. 177	. 059	S. W.	4	10	Fog	55. 0	51. 0
	9 p. m.	61. 8	. 210	. 104	S. W.	4	10	Cum	53. 0	49. 0
16	9 a. m.	62. 4	30. 220	30. 102	S.	6	10	Fog; rain	50. 0	47. 0
	12 m.	62. 0	. 216	. 099	S.	6	10	Fog; rain	50. 5	47. 5
	3 p. m.	59. 6	. 218	. 108	S.	5	10	Nim	52. 0	48. 0
	9 p. m.	61. 2	. 186	. 071	S.	5	10	Fog; rain	50. 0	47. 0
17	9 a. m.	61. 4	30. 126	30. 011	S.	5	10	Fog; rain-squalls	51. 0	47. 5
	12 m.	61. 0	. 120	. 006	S.	4	10	Fog; rain-squalls	53. 0	49. 0
	3 p. m.	60. 0	. 126	. 015	S.	3	10	Cum	56. 0	51. 0
	9 p. m.	58. 8	. 124	. 016	E.	3	8	Cir. cum	58. 0	49. 0
18	9 a. m.	63. 4	30. 114	29. 994	S. W.	3	10	Strat	54. 5	50. 0
	12 m.	62. 4	. 124	30. 006	S.	3	9	Strat	56. 5	51. 0
	3 p. m.	61. 0	. 088	29. 974	E.	2	9	Cum. strat	57. 5	53. 5
	9 p. m.	59. 0	. 062	. 953	N. W.	2	8	Cum. strat	54. 0	50. 0
19	9 a. m.	61. 5	30. 030	29. 915	N. E.	3	8	Cum	59. 0	54. 5
	12 m.	60. 0	. 032	. 921	N. N. E.	3	9	Cum	60. 5	56. 0
	3 p. m.	60. 4	. 022	. 909	N. N. E.	3	8	Cum. cir	61. 5	56. 0
	9 p. m.	60. 6	. 000	. 887	S. E.	2	10	Fog	55. 0	52. 0
20	9 a. m.	60. 0	29. 974	29. 863	N.	2	9	Nim	57. 5	52. 5
	12 m.	61. 0	. 976	. 862	N.	2	9	Strat	59. 5	54. 0
	3 p. m.	60. 5	. 966	. 853	N.	3	8	Strat	60. 0	54. 0
	9 p. m.	59. 5	. 976	. 866	N.	1	8	Cir. strat	54. 0	49. 0

Meteorological observations at Redoubt St. Michael's—Continued.

Date.	Hour.	Att. thermometer.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind.		Clouds.		Detached thermometers.	
					Direction.	Force.	Amount.	Kind.	Dry.	Wet.
1869.		°							°	°
July 21	9 a. m.	64. 0	29. 962	29. 840	W. S. W.	1	9	Cum.; baffling wind	57. 0	51. 5
	12 m.	64. 5	. 950	. 826	W.	2	9	Cum	61. 5	54. 2
	3 p. m.	63. 5	. 954	. 833	S. W.	5	9	Cum. nim	56. 0	50. 5
	9 p. m.	63. 4	. 952	. 831	S. W	4	9	Cum. nim	50. 0	47. 3
22	9 a. m.	6[illegible]. 8	29. 932	29. 816	S. S. W.	7	9	Rain	50. 6	48. 3
	12 m.	63. 3	. 924	. 804	S. W.	5	8	Little rain	51. 3	40. 4
	3 p. m.	63. 2	. 930	. 810	W.	3	8	Little rain	54. 3	51. 0
	9 p. m.	58. 0	. 934	. 828	W. S. W.	2	6	Nim	48. 0	43. 8
23	9 a. m.	61. 3	29. 916	29. 801	S. W.	1	8	Strat	50. 7	47. 0
	12 m.	54. 9	. 846	. 748	N. W.	2	6	Strat	54. 3	50. 0
	3 p. m.	56. 9	. 842	. 739	N. W.	4	2	Strat	59. 0	51. 9
	9 p. m.	55. 0	. 856	. 758	W.	[illegible]	6	Strat	50. 0	45. 3
24	9 a. m.	65. 3	29. 930	29. 804	N. N. W.	5	4	Cir	52. 9	46. 8
	12 m.	57. 0	. 964	. 861	N. N. W.	4	3	Cir	61. 0	50. 9
	3 p. m.	54. 3	. 928	. 822	N. N. W.	3	2	Cir	65. 8	54. 8
	9 p. m.	63. 1	. 948	. 828	N. W.	2	4	Cir	48. 9	42. 8
25	9 a. m.	59. 5	30. 004	29. 894	N. N. W.	5	1	Cir	53. 7	47. 4
	12 m.	58. 3	. 062	. 955	N. N. W.	4	1	Cir	64. 0	53. 0
	3 p. m.	57. 3	. 080	. 976	N. W.	4	1	Cir	65. 0	53. 3
	9 p. m.	58. 1	. 146	30. 040	W.	4	1	Cir	50. 9	45. 0
26	9 a. m.	59. 6	30. 342	30. 230	W. N. W.	4	1	Cir	57. 7	50. 5
	12 m.	59. 8	. 322	. 210	N. W.	4	1	Cir	64. 0	54. 5
	3 p. m.	57. 5	. 310	. 204	N. W.	2	5	Cum. strat	65. 0	54. 9
	9 p. m.	54. 5	. 392	. 194	S. S. E.	2	6	Cum. strat	52. 5	46. 0
27	9 a. m.	59. 7	30. 226	30. 115	E. S. E.	4	6	Strat. cum	57. 5	49. 6
	12 m.	62. 8	. 228	. 109	S.	4	8	Cum. nim	60. 0	50. 5
	3 p. m.	60. 4	. 190	. 077	S. S. E.	3	9	Little rain	57. 5	48. 7
	9 p. m.	58. 8	. 190	. 082	S.	3	9	Little rain	54. 5	49. 5
28	9 a. m.	60. 9	30. 192	30. 078	E. S. E.	3	9	Nim. strat	51. 5	48. 3
	12 m.	61. 8	. 148	. 032	S. E.	5	8	Rain	56. 2	50. 5
	3 p. m.	60. 8	. 116	. 002	S.	1	7	Nim	59. 5	53. 7
	9 p. m.	61. 6	. 050	29. 934	E.	4	8	Nim	57. 0	52. 8
29	9 a. m.	60. 8	29. 922	29. 808	S. S. E.	4	9	Strat	56. 3	51. 5
	12 m.	61. 4	. 862	. 747	S. E.	1	5	Strat	61. 3	56. 0
	3 p. m.	59. 8	. 770	. 659	N. N. W.	6	3	Cir. strat	63. 8	56. 2
	9 p. m.	59. 8	. 968	. 857	N. N. W.	3	5	Cir. strat	57. 6	53. 5
30	9 a. m.	65. 9	29. 612	29. 485	S. E.	2	4	Nim	63. 0	57. 0
	12 m.	65. 7	. 606	. 479	E. S. E.	4	7	Nim	61. 5	55. 5
	3 p. m.	65. 3	. 611	. 485	E. N. E.	3	6	Cir. cum	62. 0	57. 0
	9 p. m.	59. 5	. 626	. 516	E. N. E.	2	7	Cir. cum	59. 0	55. 0
31	9 a. m.	68. 2	29. 636	29. 503	S.	1	4	Cir. cum	63. 0	58. 1
	12 m.	61. 8	. 627	. 511	N. E.	2	8	Cum	64. 5	58. 5
	3 p. m.	60. 5	. 594	. 481	N. N. E.	2	7	Cir. cum	69. 0	60. 0
	9 p. m.	60. 0	. 606	. 495	....	0	5	Cir. strat	60. 0	54. 8
Aug. 1	9 a. m.	67. 5	29. 662	29. 532	....	0	9	Cir. strat	62. 0	59. 0
	12 m.	64. 1	. 668	. 547	N. N. W.	2	7	Strat	79. 1	64. 3
	3 p. m.	61. 5	. 668	. 554	N. N. W.	2	7	Strat	70. 0	62. 0
	9 p. m.	62. 5	. 668	. 551	....	0	9	Cir. nim	62. 0	56. 2
2	9 a. m.	66. 8	29. 760	29. 632	S. W.	4	9	Cir. nim	60. 0	55. 5
	12 m.	64. 5	. 760	. 638	S. W.	5	10	Nim	58. 0	53. 0
	3 p. m.	69. 0	. 760	. 626	S. W.	5	10	Nim	57. 5	52. 0
	9 p. m.	......	......	......	....	....	....	....	......	......
3	9 a. m.	61. 5	29. 664	29. 550	N. N. W.	5	9	Fine rain	61. 5	51. 7
	12 m.	61. 1	. 688	. 575	N. N. W.	4	8	Nim	57. 0	50. 5
	3 p. m.	61. 5	. 686	. 572	N. N. W.	4	5	Nim	62. 0	53. 7
	9 p. m.	60. 5	. 686	. 572	N. N. W.	4	6	Nim	54. 0	59. 0
4	9 a. m.	63. 5	29. 676	29. 557	S. W.	3	5	Cir	55. 5	47. 5
	12 m.	63. 2	. 664	. 546	S. W.	5	4	Cir	61. 5	50. 0
	3 p. m.	61. 8	. 620	. 505	S. W.	5	10	Nim. rain	52. 0	48. 8
	9 p. m.	61. 5	. 590	. 476	S. W.	5	10	Nim. rain	51. 5	48. 5
5	9 a. m.	64. 0	29. 582	29. 461	S. W.	2	10	Strat	......	......
	12 m.	63. 0	. 582	. 464	....	0	9	Strat	......	......
	3 p. m.	64. 0	. 582	. 461	W.	3	10	Strat. cum	55. 0	49. 5
	9 p. m.	59. 5	. 594	. 485	W. S. W.	2	9	Nim	51. 0	45. 5
6	9 a. m.	61. 8	29. 682	29. 567	W. S. W.	3	7	Cir. cum	61. 8	51. 0
	12 m.	61. 2	. 741	. 628	W. S. W.	3	9	Cir. cum	61. 2	49. 0
	3 p. m.	56. 3	. 746	. 646	S. W.	3	9	Cir. cum	56. 3	49. 5
	9 p. m.	57. 3	. 672	. 569	S.	6	9	Nim. rain	57. 3	46. 5
7	9 a. m.	57. 8	29. 536	29. 432	S.	5	2	....	57. 8	48. 3
	12 m.	58. 5	. 584	. 478	N. W.	4	2	Rain	58. 5	53. 2
	3 p. m.	56. 3	. 642	. 542	N.	6	3	Fog and rain	56. 3	57. 0
	9 p. m.	59. 0	. 716	. 609	N. W.	5	9	Hard rain	59. 0	47. 0
8	9 a. m.	59. 0	29. 754	29. 647	N.	5	10	Heavy rain	45. 0	42. 0
	12 m.	55. 5	. 764	. 666	N.	5	10	Rain	46. 5	42. 9

Meteorological observations at Redoubt St. Michael's—Continued.

Date.	Hour.	Att. thermometer.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind.		Clouds.		Detached thermometers.	
					Direction.	Force.	Amount.	Kind.	Dry.	Wet.
1869.		°							°	°
Aug. 8	3 p. m.	55. 0	29. 778	29. 680	E. N. E.	4	4	Cir. cum	56. 0	50. 2
	9 p. m.	54. 9	. 816	. 718	N. W.	3	6	Cir. cum	51. 0	47. 3
9	9 a. m.	59. 5	29. 910	29. 800	E. N. E.	4	3	Cir. cum	59. 0	55. 0
	12 m.	59. 5	. 910	. 800	N. E.	4	3	Cir. cum	66. 0	64. 5
	3 p. m.	60. 2	. 920	. 808	N. N. E.	4	3	Cir. cum	70. 0	64. 5
	9 p. m.	60. 0	. 931	. 820	N. N. E.	2	3	Strat	57. 0	54. 5
10	9 a. m.	64. 0	29. 986	29. 864	N.	4	3	Cir	58. 0	53. 5
	12 m.	61. 5	. 984	. 869	N.	4	2	Cir	66. 0	60. 5
	3 p. m.	61. 0	. 986	. 872	N.	3	2	Cir	.....	.....
	9 p. m.	61. 7	. 996	. 880	S.	5	5	Cir	55. 5	51. 5
11	9 a. m.	63. 9	30. 020	29. 898	S.	2	5	Cir. cum	52. 3	48. 9
	12 m.	60. 9	. 018	. 904	N. W.	2	1	Cir	68. 5	63. 3
	3 p. m.	63. 9	. 040	. 918	N. N. W.	3	1	Cir	67. 3	62 5
	9 p. m.	61. 3	29. 992	. 877	N.	1	2	Cir	57. 9	55. 3
12	9 a. m.	64. 3	29. 906	29. 783	N.	2	7	Strat	60. 1	55. 7
	12 m.	62. 9	. 876	. 757	N. E.	5	8	Nim	63. 0	59. 0
	3 p. m.	64. 0	. 868	. 746	N. E.	1	9	Rain	66. 5	61. 3
	9 p. m.	62. 8	. 830	. 711	N.	4	9	Rain	58. 5	55. 0
13	9 a. m.	64. 0	29. 850	29. 728	E.	4	9	Strat. cum	59. 5	54. 5
	12 m.	64. 5	. 864	. 740	S. E.	5	9	Strat. cum	63. 2	57. 0
	3 p. m.	65. 5	. 872	. 746	S. S. E.	4	9	Cir. strat	65. 0	58. 5
	9 p. m.	62. 7	. 890	. 771	N. E.	1	7	Cir. strat	58. 5	55. 9
14	9 a. m.	63. 0	29. 944	29. 825	E. N. E.	5	3	Cum. cir	58. 0	53. 0
	12 m.	63. 2	. 970	. 850	N. E.	4	2	Cum. cir	72. 0	65. 0
	3 p. m.	62. 5	. 970	. 852	N. E.	5	4	Cum. cir	65. 5	59. 5
	9 p. m.	64. 0	. 970	. 848	....	0	2	Cum. cir	54. 0	50. 0
15	9 a. m.	67. 0	30. 058	29. 928	....	0	3	Cir. cum	64. 0	58. 0
	12 m.	66. 0	. 062	. 934	N. E.	3	3	Cir. cum	69. 0	61. 0
	3 p. m.	66. 0	. 062	. 934	N. E.	3	3	Cir. cum	73. 0	65. 5
	9 p. m.	62. 3	. 060	. 942	....	0	3	Cum	58. 0	53. 5
16	9 a. m.	70. 0	30. 079	29. 941	S. W.	2	5	Strat. cir	62. 0	55. 0
	12 m.	67. 5	. 070	. 938	E.	1	2	Strat. cir	75. 5	66. 2
	3 p. m.	61. 5	. 037	. 922	N. E.	3	2	Cum. strat	76. 5	67. 5
	9 p. m.	.....	....	....	....	...	...	....	.....	.....
17	9 a. m.	69. 0	29. 968	29. 832	S. E.	4	2	Cum. strat	63. 7	55. 5
	12 m.	69. 3	. 942	. 806	S. E.	3	1	Cum. strat	73. 3	66. 5
	3 p. m.	66. 5	. 940	. 811	....	0	2	Cum. strat	76. 0	68. 0
	9 p. m.	63. 0	. 906	. 787	S.	2	8	Strat. nim	62. 0	55. 8
18	9 a. m.	66. 7	29. 992	29. 863	S. E.	5	9	Nim. rain	57. 0	52. 0
	12 m.	64. 0	. 990	. 868	S. E.	6	9	Nim	58. 0	52. 0
	3 p. m.	66. 5	. 994	. 865	S. E.	5	9	Nim	58. 0	52. 0
	9 p. m.	60. 0	. 756	. 646	N. E.	6	10	Nim. rain	57. 0	52. 5
19	9 a. m.	62. 5	29. 520	29. 403	S. E.	7	10	Nim.; light fog	55. 5	50. 0
	12 m.	61. 0	. 548	. 435	S.	8	10	Drizzly rain	54. 3	50. 0
	3 p. m.	63. 0	. 620	. 502	S. W.	6	9	Nim. cum	56. 3	51. 0
	9 p. m.	63. 5	. 700	. 581	S.	6	10	Nim	53. 0	49. 5
20	9 a. m.	64. 0	29. 872	29. 750	S.	5	10	Nim	53. 5	50. 0
	12 m.	63. 3	. 924	. 804	S.	5	10	Nim. strat	54. 3	50. 5
	3 p. m.	62. 7	. 930	. 811	S. E.	5	10	Strat. cum	55. 0	50. 5
	9 p. m.	60. 5	. 918	. 805	S. E.	5	10	Strat. cum	52. 8	49. 3
21	9 a. m.	58. 7	29. 834	29. 726	S. S. W.	2	10	Fine rain	53. 0	49. 9
	12 m.	61. 5	. 910	. 795	S. S. W.	4	7	Fine rain	55. 0	50. 3
	3 p. m.	64. 0	. 942	. 820	S. W.	3	7	Fine rain	56. 3	52. 0
	9 p. m.	60. 7	30. 064	. 951	S. W.	3	10	Fine rain	52. 0	48. 5
22	9 a. m.	61. 7	30. 250	30. 134	S. W.	3	9	....	49. 0	45. 3
	12 m.	62. 3	. 254	. 136	S. W.	2	5	....	54. 3	50. 0
	3 p. m.	63. 0	. 262	. 143	S. W.	2	5	....	58. 5	53. 0
	9 p. m.	63. 7	. 260	. 139	E. N. E.	3	6	....	55. 0	51. 0
23	9 a. m.	64. 5	30. 195	30. 071	E.	2	10	Nim	54. 3	49. 3
	12 m.	64. 2	. 140	. 017	E. S. E.	3	10	Nim. strat	57. 5	51. 5
	3 p. m.	61. 2	. 068	29. 953	N. N. E.	4	10	Strat	59. 0	53. 0
	9 p. m.	60. 0	29. 898	. 787	N. E.	6	10	Strat	57. 5	53. 0
24	9 a. m.	63. 8	29. 796	29. 674	N.	6	10	Nim. rain	57. 5	54. 0
	12 m.	64. 0	. 796	. 674	N.	4	10	Strat	58. 5	54. 5
	3 p. m.	64. 0	. 796	. 674	N.	2	10	Strat	61. 0	56. 0
	9 p. m.	65. 0	. 858	. 733	S. W.	3	10	Nim	52. 0	47. 5
25	9 a. m.	64. 0	29. 868	29. 746	S. E.	3	10	Strat	51. 6	46. 2
	12 m.	62. 2	. 866	. 749	S. E.	2	10	Strat	53. 8	49. 0
	3 p. m.	62. 5	. 816	. 699	....	0	10	Strat.; nim. fog	54. 8	51. 0
	9 p. m.	60. 8	. 812	. 698	....	0	8	Cir. strat	52. 0	47. 8
26	9 a. m.	66. 0	29. 886	29. 758	S.	1	4	Cum. cir	55. 0	50. 0
	12 m.	64. 5	. 910	. 786	W. S. W.	3	7	Cum. nim. cir	58. 0	52. 5
	3 p. m.	64. 8	. 910	. 786	W. S. W.	3	10	Cum. nim. cir	56. 5	52. 0
	9 p. m.	64. 2	. 934	. 811	W. S. W.	4	10	Cum. cir	52. 0	47. 2

Meteorological observations at Redoubt St. Michael's—Continued.

Date.	Hour.	Att. thermometer.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind.		Clouds.		Detached thermometers.	
					Direction.	Force.	Amount.	Kind.	Dry.	Wet.
1869.		°							°	°
Aug. 27	9 a. m.	64.0	29.978	29.856	S.	2	8	Cum. nim	54.0	49.0
	12 m.	59.2	.978	.869	S. E.	3	9	Cum	58.0	53.0
	3 p. m.	60.0	.976	.865	W.	2	10	Nim	57.0	51.0
	9 p. m.	64.8	.972	.848	S. W.	3	9	Strat	53.0	49.0
28	9 a. m.	62.5	29.938	29.820	S. E.	4	9	Nim	53.5	49.5
	12 m.	62.5	.930	.812	N.	3	9	Strat. nim	56.2	51.8
	3 p. m.	59.0	.870	.761	W. N. W.	4	8	Strat. cir. nim	57.2	52.8
	9 p. m.	59.0	.770	.662	W. N. W.	3	9	Strat. cir. nim	53.0	49.5
29	9 a. m.	58.0	29.664	29.559	E. N. E.	5	9	Strat. nim	53.0	49.0
	12 m.	59.0	.606	.499	E. N. E.	5	10	Strat. nim	56.8	51.0
	3 p. m.	58.5	.576	.470	E.	6	9	Strat	56.5	50.5
	9 p. m.	59.0	.566	.459	E. N. E.	6	9	Strat	52.5	49.0
30	9 a. m.	59.0	29.536	29.429	N. E.	5	9	Nim	54.0	50.5
	12 m.	60.2	.528	.417	N. E.	3	10	Nim	57.0	53.5
	3 p. m.	61.8	.564	.439	E. N. E.	2	10	Fog	57.0	53.0
	9 p. m.	60.0	.566	.456	E. N. E.	3	10	Nim. rain	56.0	52.0
31	9 a. m.	60.5	29.500	29.389	E.	6	9	Nim. cum	55.7	51.0
	12 m.	62.0	.502	.387	E. S. E.	6	10	Nim.; rain-squalls	58.0	53.0
	3 p. m.	63.0	.508	.390	E. S. E.	5	9	Strat. nim	57.0	50.5
	9 p. m.	63.0	.534	.416	S.	3	9	Strat. nim	53.5	48.0
1	9 a. m.	65.0	29.540	29.417	S. S. E.	3	10	Nim	......	......
	12 m.	64.0	.540	.419	S S. W.	4	9	Strat. nim	......	......
	3 p. m.	65,0	.544	.421	S. W.	2	5	Cir. strat	56.0	48.0
	9 p. m.	60.0	.618	.508	S. W.	4	6	Cum. strat	50.0	45.2
2	9 a. m.	57.0	29.728	29.626	S. S. E.	7	8	Cum. cir	52.0	46.0
	12 m.	60.0	.760	.650	S. S. E.	6	9	Cum. cir. nim.; rain	52.0	46.5
	3 p. m.	59.2	.818	.709	S.	5	10	Cum. cir.; rain-squalls	52.0	47.5
	9 p. m.	60.0	.828	.717	S. E.	4	9	Cum. nim	51.0	47.0
3	9 a. m.	57.5	29.900	29.795	E. S. E.	6	4	Cum. cir	50.0	45.0
	12 m.	56.0	.854	.753	E. N. E.	5	6	Cum. cir	55.8	50.0
	3 p. m.	56.2	.758	.657	E. N. E.	7	8	Cum. cir	55.8	48.8
	9 p. m.	55.0	.524	.526	E. N. E.	7	10	Cum. nim.; rain	52.5	47.0
4	9 a. m.	57.0	29.336	29.233	N.E. byE.	5	10	Nim.; fine rain	53.5	49.0
	12 m.	58.0	.348	.242	N.E. byE.	5	10	Scotch mist	55.0	50.5
	3 p. m.	59.5	402	.292	E. S. E.	6	10	Scotch mist	54.0	50.0
	9 p. m.	58.8	.604	.496	S. E.	6	10	Cum. nim	51.0	46.0
5	9 a. m.	60.0	29.726	29.616	E. S. E.	4	7	Cir. strat. nim	52.5	47.0
	12 m.	59.5	.766	.657	E. S. E.	4	4	Cir. strat	56.2	49.0
	3 p. m.	61.5	.766	.652	S. W.	2	6	Cir. cum	55.0	49.5
	9 p. m.	......	......	......	......	...	...	......	......	......
7	9 a. m.	60.3	29.792	29.680	S. W.	3	9	Cum. nim	49.3	44.0
	12 m.	61.5	.956	.841	S. W.	3	9	Cum. cir	50.2	46.3
	3 p. m.	59.8	.968	.857	W.	3	4	Cir. cum	52.0	45.5
	9 p. m.	......	......	......	......	...	...	......	......	......
8	9 a. m.	......	......	......	......	...	...	......	......	......
	12 m.	60.0	29.900	29.789	N. E.	2	5	Cir. cum	54.5	48.0
	3 p. m.	58.5	.758	.651	N. E.	3	4	Cir. cum	55.0	48.0
	9 p. m.	58.5	.820	.713	N. E.	4	4	Cir. cum	48.0	42.0
9	9 a. m.	57.5	29.754	29.651	N.E. byE.	4	....	Clear sky	49.0	43.0
	12 m.	56.0	.700	.600	N.E. byE.	5	2	Cir. cum	56.0	48.0
	3 p. m.	57.0	.690	.588	E. N. E.	5	5	Cum. cir	48.0	48.0
	9 p. m.	59.5	.688	.579	S. E.	4	10	Cum. nim.; rain	51.0	46.0
10	9 a. m.	60.0	29.704	29.594	S. E.	2	8	Strat. cir	52.2	47.5
	12 m.	56.0	.712	.612	E. S. E.	4	7	Strat. cir	53.0	48.0
	3 p. m.	57.0	.728	.626	E. S. E.	3	9	Strat	54.0	49.0
	9 p. m.	63.0	.726	.608	E. S. E.	4	9	Strat	52.5	47.0
11	9 a. m.	61.5	29.692	29.578	E. N. E.	1	9	Strat. nim	51.5	48.0
	12 m.	58.5	.690	.584	N. N. E.	4	5	Strat. nim	58.5	53.0
	3 p. m.	58.0	690	.585	N.	4	4	Strat. nim	56.5	50.5
	9 p. m.	58.0	.662	.557	N.	5	7	Strat. nim	51.5	49.5
12	9 a. m.	57.0	29.684	29.582	N. N. W.	5	6	Cum. cir	54.0	49.0
	12 m.	57.5	.604	.501	N.	4	7	Cum. cir	55.0	49.5
	3 p. m.	58.0	.516	.411	....	0	6	Cum. cir	55.0	49.5
	9 p. m.	60.5	.600	.289	....	0	7	Cum	50.0	45.5
13	9 a. m.	58.5	29.776	29.669	S. E.	3	10	Cum. nim	50.0	45.0
	12 m.	58.5	.772	.665	....	0	9	Cum. nim	51.0	45.5
	3 p. m.	58.0	.834	.728	S. W.	2	9	Cum. nim	50.3	44.7
	9 p. m.	59.5	.870	.760	N. E.	1	3	Cum. nim	48.5	43.5
14	9 a. m.	57.5	29.638	29.535	N. E.	1	....	Clear sky	50.3	45.5
	12 m.	57.5	.604	.501	N. E.	4	....	Clear sky	60.3	53.5
	3 p. m.	56.5	.516	.415	N. E.	2	4	Cum. cir	58.0	52.0
	9 p. m.	61.5	.600	.486	N. E.	2	5	Cum. cir	52.0	48.3
15	9 a. m.	52.7	29.776	29.685	N.	6	8	Nim. cum	49.0	43.5
	12 m.	52.3	.772	.682	N.	5	6	Nim. cum. cir	50.0	45.0

Meteorological observations at Redoubt St. Michael's—Continued.

Date.	Hour.	Att. thermometer.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.	Detached thermometers. Dry.	Detached thermometers. Wet.
1869.		°							°	°
Sept. 15	3 p. m.	54. 0	29. 834	29. 739	N. W.	3	9	Nim. cum	48. 5	42. 0
	9 p. m.	53. 2	. 870	. 777	S.	5	9	Nim. cum	44. 0	39. 0
16	9 a. m.	52. 0	30. 070	29. 980	S. S. E.	4	9	Nim	46. 5	42. 0
	12 m.	51. 7	. 074	. 985	S. W.	1	10	Nim	47. 0	43. 0
	3 p. m.	52. 0	. 080	. 990	S.	3	10	Nim	47. 7	43. 5
	9 p. m.	54. 8	. 076	. 978	S.	4or5	10	Nim	46. 2	42. 0
17	9 a. m.	55. 3	29. 962	29. 863	S. S. E.	3	9	Cum. nim	48. 3	44. 2
	12 m.	56. 2	. 966	. 865	S. S. W.	3	7	Cum. nim	50. 0	45. 0
	3 p. m.	58. 0	. 966	. 860	S. S. W.	3	6	Cir. cum	50. 0	45. 0
	9 p. m.	61. 2	. 966	. 851	S. S. W.	2	4	Cir. cum	48. 0	43. 0
18	9 a. m.	59. 0	30. 062	29. 953	S.	3	8	Cum. nim	50. 0	45. 0
	12 m.	59. 0	. 070	. 961	N. N. E.	3	4	Cir. cum	52. 5	47. 0
	3 p. m.	58. 0	. 074	. 968	N. N. E.	4or5	1	Cir	52. 0	46. 0
	9 p. m.	......	....	....	....	...	...	....	......	......
19	9 a. m.	57. 0	29. 982	29. 879	E. N. E.	4	4	Cir. strat	48. 0	42. 0
	12 m.	57. 0	. 990	. 887	E.	3	7	Strat. nim	52. 0	46. 0
	3 p. m.	58. 5	30. 004	. 897	....	0	9	Nim. ; light mist	53. 0	47. 0
	9 p. m.	60. 0	. 004	. 893	S. E.	2	10	Nim. ; rain	50. 0	44. 0
20	9 a. m.	59. 0	29. 960	29. 851	N. E.	3	9	Strat. nim	50. 5	46. 0
	12 m.	58. 0	. 900	. 794	N. E.	4	9	Strat	53. 5	47. 5
	3 p. m.	57. 0	. 892	. 789	N. E.	5	8	Strat. cir	53. 5	46. 5
	9 p. m.	59. 0	. 886	. 777	N. E.	5	2	Cir	49. 8	45. 0
21	9 a. m.	57. 5	29. 822	29. 717	N. E.	5	8	Cum. cir	49. 7	43. 3
	12 m.	58. 0	. 814	. 708	N. E.	5	7	Cum. cir	52. 3	47. 5
	3 p. m.	61. 0	. 808	. 694	N. E.	4	9	Cum. cir	52. 0	46. 5
	9 p. m.	56. 5	. 808	. 706	N. E.	1	7	Cum	50. 5	46. 0
22	9 a. m.	54. 8	29. 860	29. 762	N. E.	1	7	Strat. nim	51. 0	45. 7
	12 m.	55. 3	. 884	. 785	N.	2	6	Strat. nim	54. 5	48. 7
	3 p. m.	56. 3	. 888	. 786	N.	1	7	Nim	54. 0	48. 0
	9 p. m.	55. 5	. 914	. 815	N.	2	6	Nim	49. 7	45. 5
23	9 a. m.	53. 3	29. 960	29. 866	S. E.	4	9	Strat. cir	47. 5	43. 5
	12 m.	53. 7	. 964	. 869	S.	3	5	Strat. cir	52. 5	46. 3
	3 p. m.	55. 6	. 966	. 893	S.	4	6	Cir. strat	51. 3	45. 4
	9 p. m.	57. 3	. 968	. 863	S.	3	7	Cir	48. 0	42. 5
24	9 a. m.	63. 3	29. 906	29. 786	S. E.	3	7	Cir	51. 0	46. 0
	12 m.	62. 7	. 860	. 741	S.	2	6	Cum. cir	52. 0	46. 5
	3 p. m.	61. 5	. 753	. 638	N.	2	7	Cum. cir. ; light baffling wind.	52. 0	47. 0
	9 p. m.	62. 5	. 634	. 516	N. N. W.	1	8	Cum. nim. ; rain-squalls	48. 0	43. 0
25	9 a. m.	60. 0	29. 526	29. 415	N. E.	2	0	Clear sky	50. 0	45. 0
	12 m.	60. 0	. 524	. 413	N. E.	3	0	Clear sky	54. 0	48. 0
	3 p. m.	62. 0	. 520	. 403	N. N. E.	5	1	Cir. cum	51. 5	44. 5
	9 p. m.	......	....	....	....	...	...	....	......	......

Meteorological observations at Redoubt St. Michael's—Concluded.

Date.	Hour.	Att. therm. 1613.	Att. therm. 1609.	Reading of barom'r No. 1613.	Reading of barom'r No. 1609.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.	Detached thermometers. Dry.	Detached thermometers. Wet.
1869.		°	°							°	°
Sept. 26	9 a. m.	60. 0	......	29. 630	....	N. N. E.	4	2	Strat. cir	47. 0	41. 0
	10.5a.m.	55. 5	56. 5	. 645	29. 632	N. N. E.	3	2	Strat. cir	52. 0	45. 0
	11.5a.m.	57. 0	58. 5	. 653	. 644	N N. E.	3	2	Strat. cir	52. 5	45. 0
	12.5p m	55. 0	55. 5	. 652	. 630	N. N. E.	3	2	Strat. cir	53. 0	45. 5
	1.5p.m.	53. 5	54. 2	. 650	. 630	N. N. E.	3	2	Strat. cir	53. 0	45. 5
	2 p. m.	55. 5	56. 5	. 650	. 638	N. N. E.	2	2	Strat. cir	53. 0	45. 5
	3 p. m.	55. 5	57. 0	. 659	. 651	N. N. E.	4	2	Cir. strat	53. 5	45. 5
	4 p. m.	53. 5	54. 5	. 663	. 650	N. N. E.	4	2	Cir. strat	52. 5	46. 0

METEOROLOGICAL OBSERVATIONS EN ROUTE.

Cistern barometer No. 1609 and thermometers, by James Green, New York—Aneroid barometer—Observers, Mr. J. J. Major and Private Michael Foley, United States Army.

Station.	Date.	Time.	Barometer.	Thermometers. Attached.	Thermometers. Detached.	Reading of barometer.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
	1869.	A. M. *h. m.*		°	°					
Pikmiktalik	July 4	9 00	An.	......	57.0	29.810	N. N. W.	3	4	Cir. strat. cum.; mild.
		P. M. 4 00	An.	......	66.5	.790	N.	3	6	Cir. strat. cum.; mild.
		9 30	An.	......	65.0	.600	....	0	6	Cir. nim.
Coatlik	July 5	A. M. 9 00	An.	......	68.0	29.800	S. W.	2	8	
Aphoon Outlet	July 5	P. M. 3 00	An.	......	68.0	.755	S. S. E.	4	8	
		9 00	An.	......	65.0	.700	S.	3	8	Nim.; rain.
Yukon River	July 6	A. M. 9 00	An.	......	70.5	29.825	....	0	7	Cir. nim. cum.
		12 M.	An.	......	66.0	.810	S. E.	1	8	Raining slightly; nim.
		P. M. 3 00	An.	......	64.5	.800	S. E.	3	6	Raining slightly; nim. cir. cum.
		9 00	An.	......	60.0	.800	S. E.	1	8	
Right bank of Yukon, near Andreavsky.	July 7	A. M. 6 30	1609	54.5	55.0	29.729	S. E.	3	8	Nim.; raining slightly.
		6 30	An.	......	......	.790				
		7 00	1609	53.5	55.5	.728	S. E.	4	8	Nim.
		7 00	An.	......	......	.790				
		7 30	1609	53.5	55.5	.732	S. E.	5	8	Nim.
		7 30	An.	......	......	.800				
		8 00	1609	54.0	56.0	.732	S. E.	5	8	Nim.
		8 00	An.	......	......	.800				
Right bank of Yukon, above Andreavsky.	July 7	P. M. 2 30	An.	......	62.0	.820	S. E.	4	8	Nim.
Yukon River	July 7	9 00	An.	......	62.0	.820	S. W.	2	8	Nim.
Right bank of Yukon	July 8	A. M. 9 00	An.	......	68.0	29.800	S. E.	4	8	Nim.
		12 M.	An.	......	62.0	.800	S. E.	2	8	Nim.; rain.
Yukon River	July 8	P. M. 3 00	An.	......	62.5	.790	S. E.	1	8	Rain'g very hard.
		6 00	An.	......	54.5	.810	S.	1	8	Nim.
Right bank of Yukon	July 8	8 00	1609	49.0	50.5	.767	N. W.	3	5	Cum. cir.
		8 15	1609	49.0	50.0	.770	N. W.	3	5	Cum. cir.
		8 30	1609	48.5	49.5	.772	N. W.	4	5	Cum. cir.
		9 00	1609	48.0	49.0	.774	N. W.	4	3	Cum. cir. strat.
Yukon River	July 9	A. M. 9 00	An.	......	62.5	29.950	....	0	3	Cum. cir. strat.
		12 M.	An.	......	......	.925				
		P. M. 3 00	An.	......	58.0	.910	N. E.	1	8	Nim.; rain.
		6 00	An.	......	54.5	.900	....	0	8	Nim.; rain.
Right bank of Yukon, near Mission.	July 9	9 00	1609	47.0	48.5	.841	....	0	8	Nim.; sprinkl'g.
		9 15	1609	46.0	47.0	.843	....	0	8	Nim.; sprinkl'g.
		9 30	1609	45.5	47.0	.843				
Yukon River	July 10	A. M. 9 00	An.	......	61.0	30.250	N.	3	4	Cum. cir.
Right bank of Yukon, above Mission.	July 10	10 30	1609	57.0	60.0	29.933	N.	3	7	Cum. nim.
		10 45	1609	57.0	60.0	.930	N.	2	7	Cum. nim.
		11 00	1609	58.0	61.0	.936	N.	2	7.5	Cum. nim.
		11 15	1609	56.5	60.5	.933	N.	2	7.5	Cum. nim.
		12 M.	An.	......	74.0	30.000	N.	1	7	Cum.
Yukon River	July 10	P. M. 3 00	An.	......	65.0	30.000	N.	2	7	Cum. nim.
		6 00	An.	......	66.5	.010	....	0	7	Cir. strat.
Right bank of Yukon.	July 10	7 15	1609	59.0	63.0	29.929	....	0	7	Cir. strat.
		7 45	1609	55.5	58.5	.913	....	0	6	Cir. strat.
		8 00	1609	54.0	57.0	.913	....	0	6	Cir. strat.
		8 30	1609	53.5	56.0	.912	....	0	6	Cir. strat.
		9 00	An.	......	72.0	30.048	....	0	8	Cir. strat.
Left bank of Yukon, near Anvic.	July 11	A. M. 9 00	An.	......	75.0	30.048	N. W.	2	2	Cum. strat.
		12 M.	An.	......	72.0	.040	....	0	2	Cum. strat.

Meteorological observations en route—Continued.

Station.	Date.	Time.	Barometer.	Thermometers. Attached.	Thermometers. Detached.	Reading of barometer.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
	1869.	*h. m.*		°	°					
Yukon River	July 11	P. M. 9 00	An.	......	62. 5	30. 000	N. W.	2	1	Strat.
	July 12	A. M. 9 00	An.	......	66. 0	30. 040	N.	3	0	
		12 M.	An.	......	67. 0	30. 000	N. W.	3	3	Cum.
		P. M. 3 30	An.	......	71. 0	. 975	N. W.	1	1	Cum. strat. N. E.
Anvic	July 12	9 00	An.	......	64. 0	29. 960	S. W.	2	2	Strat.
	July 13	A. M. 9 00	An.	......	63. 5	30. 030	S. S. W.	3	2	Cum. cir.
		10 00	1609	61. 0	60. 5	29. 937	S. W.	4	3	Cum. strat.
		11 00	1609	60. 0	60. 5	. 959	S. S. W.	3	4	Cum. strat.
		12 M.	1609	60. 0	64. 0	. 952	S. S. W.	3	4	Cum. strat.
		P. M. 12 30	An.	......	64. 0	30. 030	S. S. W.	3	3	Cum. strat.
		2 30	1609	65. 0	65. 5	29. 960	S. S. W.	2	3	Cum. strat.
(Thermometer in sun, 69°. 5.)	....	4 00	An.	......	65. 5	30. 075	S. S. W.	4	3	Cum. strat. cir.
		4 00	1609	65. 5	......	29. 965				
(Thermometer in sun, 70°. 5.)	....	6 00	An.	......	64. 5	30. 050	S. W.	2	2	Cir. strat.
		6 00	1609	64. 5	......	29. 913				
(Thermometer in sun, 66°. 0.)	....	7 00	1609	61. 5	61. 5	. 965	S. W.	2	2	Cir. strat.
		9 00	An.	......	53. 0	30. 075	....	0	2	Strat.
		9 00	1609	50. 5	......	29. 967				
Right bank of Yukon, above Anvic.	July 14	A. M. 9 00	An.	......	62. 5	30. 180	....	0	8	Nim. cir. strat.
		9 00	1609	54. 5	......	. 091				
		9 30	1609	52. 0	61. 0	. 060	S. E.	2	8	Nim. cir. strat.
		9 30	An.	......	74. 0	. 190	S.	3	6	Nim. cir. strat.
Yukon River	July 14	12 M.	An.	......	67. 0	. 175	S.	2	8	Nim. cir. strat.
		P. M. 3 00	An.	......	67. 0	. 150	S.	3	8	Nim. strat.
		9 00	An.	......	64. 0	. 120	S.	2	7. 5	Nim. strat.
	July 15	A. M. 9 00	An.	......	67. 5	30. 175	S.	4	8	Nim.; rain.
		P. M. 3 00	An.	......	67. 0	. 200	S.	4	8	Nim.
		6 00	An.	......	67. 0	. 210	S.	3	6	Nim. cum.
		10 00	An.	......	61. 0	. 217	S.	2	4	Nim. strat.
Right bank of Yukon	July 16	A. M. 9 00	An.	......	69. 5	30. 260	S.	2	8	Nim.
		12 M.	An.	......	68. 0	. 250	S.	2	8	Nim.
		P. M. 6 00	An.	......	63. 0	. 200	S.	3	8	Nim.
		9 00	An.	......	65. 0	. 190	S.	2	8	Nim.
Yukon River	July 17	A. M. 9 00	An.	......	60. 0	30. 080	S.	1	8	Nim.
Right bank of Yukon, Native Village.	July 17	12 M.	An.	......	62. 0	. 110	S.	2	8	Nim.
Nulato	July 18	A. M. 9 00	An.	......	63. 0	30. 060	S. S. E.	3	5	Cum. nim.
		10 00	1609	62. 0	64. 0	29. 986	S. S. E.	3	7	Cum. nim.
		11 00	1609	62. 0	64. 0	. 985	S. E.	3	7	Cum. nim.
		12 M.	1609	62. 0	65. 0	. 974	S. E.	3	7	Cum. nim.
		12 M.	An.	......	......	30. 060				
		P. M. 2 00	1609	60. 0	63. 0	29. 954	S. E.	4	7	Cum. nim.
		2 30	1609	60. 5	63. 0	. 935	S. E.	4	7	Cum. nim.
		3 00	An.	......	63. 5	30. 050	S. E.	4	7	Cum. nim. strat.
		3 00	1609	60. 5	......	29. 933				
		5 00	1609	59. 0	61. 5	. 913	S. E.	3	7	Cum. nim. strat.
		6 00	1609	59. 5	62. 5	. 910	S. E.	3	8	Cum. nim. strat.
		6 00	An.	......	......	30. 010				
		7 00	1609	58. 5	60. 0	29. 907	S. E.	1	5	Cum. cir. strat.
		8 00	1609	56. 0	59. 0	. 907				
		9 00	An.	......	58. 0	30. 010	S.	1	6	Cir. cum.
		9 00	1609	55. 5	......	29. 898				
	July 19	A. M. 8 45	1609	73. 5	74. 0	29. 953	S.	1	4	Cir. cum.
		8 45	An.	......	......	30. 060				
Att. therm. in sun.)	....	9 20	1609	77. 0	72. 0	29. 927	S.	1	4	Cir. cum.
		10 00	1609	71. 0	70. 0	. 909	S.	1	4	Cir. cum.
		11 30	1609	68. 5	71. 0	. 896	S.	1	4	Cir. cum.
		12 M.	An.	......	70. 0	30. 010	S.	1	4	Cir. cum.

Meteorological observations en route—Continued.

Station.	Date.	Time.	Barometer.	Thermometers. Attached.	Thermometers. Detached.	Reading of barometer.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
	18	P. M. *m.*		°	°					
Yukon River	July 19	3 00	An.	......	78.0	29.990	....	0	4	Cum. nim.
		9 09	An.	......	65.0	.909	N.	2	8	Nim. cum. strat.
Sakadelontin	July 20	A. M. 9 00	An.	......	76.0	29.927	S. W.	1	8	Nim. cum. strat.
Right bank of Yukon	July 20	12 M.	An.	......	81.0	.925	S. W.	1	4	Cum. cir. strat.
Yukon River	July 20	P. M. 3 00	An.	......	72.0	.870	S. W.	1	6	Cum. cir. strat.
Right bank of Yukon	July 20	6 00	An.	......	70.5	.860	S. W.	2	2	Cum. cir. strat.
Yukon River	July 20	9 00	An.	......	67.0	.850	S. W.	1	7	Cum. nim. strat.
	July 21	A. M. 9 00	An.	......	75.0	29.850	....	0	5	Cir. cum.
		12 M.	An.	......	74.0	.825	....	0	5	Cum. nim.; spr'kling.
		P. M. 3 00	An.	......	76.5	.800	....	0	6	Cum. cir. strat.
Right bank of Yukon, Native Village.	July 21	6 00	An.	......	69.0	29.740	....	0	4	Cum. cir. strat.
Yukon River	July 22	A. M. 9 00	An.	......	63.0	29.710	S. S. W.	3	6	Cum. cir. nim.
		P. M. 3 00	An.	......	56.0	.700	S. W.	7	8	Nim.; rain.
		6 00	An.	......	55.0	.690	S. E.	3	8	Nim.
Fort Adams	July 22	6 00	1609	54.0	......	.599				
Station about 30 feet above river.	....	8 00	1609	53.0	......	.553	S. E.	3	8	Nim.
		9 00	1609	47.5	50.5	.560	S. E.	1	8	Nim.; rain.
	July 23	A. M. 8 00	1609	48.0	49.0	29.620	S. W.	2	4	Cum.
		9 30	1609	55.0	57.0	.628	S. W.	1	4	Cir. cum.
		11 00	1609	58.0	61.0	.622	S. W.	1	4	Cir. cum.
		P. M. 2 00	1609	60.0	63.0	.620	S. W.	1	4	Cir. cum.
		3 00	1609	58.0	59.0	.590	S. W.	1	4	Cir. cum.
		4 00	1609	58.0	60.0	.573	S. W.	1	4	Cir. cum.
		5 00	1609	58.0	60.0	.574	S. W.	1	4	Cir. cum.
		6 00	1609	57.0	59.0	.566	S. W.	1	4	Cir. cum.
		7 00	1609	55.0	57.0	.534	S. W.	1	4	Cir. cum.
		8 00	1609	49.0	53.0	.504	S. W.	1	5	Cir. cum.
		9 00	1609	48.0	51.0	.534	S. W.	1	3	Cir. cum.
Yukon River	July 24	P. M. 3 00	An.	......	65.5	29.700	S. S. W.	1	4	Cir. cum.
	July 25	A. M. 9 00	An.	......	62.0	29.780	W.	3	7.5	Cir. cum. strat.
		12 M.	An.	......	71.0	.795	....	0	6	Cir. cum. strat.
Right bank of Yukon.	July 26	A. M. 9 00	An.	......	69.5	29.990	W. S. W.	2	6	Cir. cum. strat.
Yukon River	July 26	P. M. 1 00	An.	......	61.0	.950	W. S. W.	3	4	Cir. cum. strat.
		3 00	An.	......	64.0	.925	W. S. W.	3	5	Cir. cum. strat.
Left bank of Yukon	July 26	9 00	An.	......	55.5	29.950	....	0	6	Cir. cum. strat.
Yukon River	July 27	12 M.	An.	......	66.0	30.020	S. W.	3	4	Cir. strat.
		P. M. 3 00	An.	......	66.0	.000	S. W.	3	4	Cir. nim.; sprinkling.
		6 00	An.	......	68.0	29.980	S.	1	3	Cir. cum.
	July 28	A. M. 9 00	An.	......	64.0	30.060	....	0	2	Cum.
		P. M. 4 00	An.	......	68.0	.090	S. W.	1	4	Cum. strat.
	July 29	A. M. 9 00	An.	......	64.5	29.825	S. W.	1	6	Nim.
		P. M. 6 45	An.	......	65.5	.650	....	0	8	Nim.
	July 30	A. M. 9 00	An.	......	64.0	29.460	N. E.	2	2	Cir. strat.
		P. M. 1 00	An.	......	68.0	.410	N. E.	2	2	Cir. strat.
		3 00	An.	......	73.0	.390	N. E.	3	2	Cum.
	July 31	A. M. 9 00	An.	......	71.0	29.350	....	0	8	Cum. nim.
		P. M. 12 30	An.	......	75.0	.350	....	0	6	Cir. strat.

Meteorological observations en route—Continued.

Station.	Date.	Time.	Barometer.	Thermometers. Attached.	Thermometers. Detached.	Reading of barometer.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
	1869.	A. M. *h. m.*		°	°					
Fort Adams	Sept. 4	8 00	1609	51.5	52.0	29.413	N.E.	1	6	Nim. cir. strat.
		9 00	1609	51.5	52.0	.419	N.E.	1	7	Nim. cir. strat.
		11 00	1609	53.5	54.0	.460	N.E.	1	8	Nim.
		12 M.	1609	53.5	54.5	.470	N.E.	1	8	Nim.; rain.
		P. M.								
		2 00	1609	52.0	54.0	.478	N.E.	1	8	Nim.; rain.
		3 00	1609	51.0	52.5	.482	N.E.	1	8	Nim.; rain.
		4 00	1609	50.5	52.0	.482	N.E.	1	8	Nim.; rain.
Nulato...............	Sept. 8	2 30	1609	51.5	52.5	29.795	S.	2	3	Cir. cum.
		2 45	1609	50.5	53.0	.784	S.	2	3	Cir. cum.

METEOROLOGICAL OBSERVATIONS AT FORT YUKON.

Cistern barometer No. 1609, and thermometer, by James Green, New York—Observers, Mr. J. J. Major and Private Michael Foley, United States Army.

Date.	Time.	Thermometers. Under cover. Att.	Thermometers. Under cover. Det.	Thermometers. Open air. Dry.	Thermometers. Open air. Wet.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
1869.	*h. m.*	°	°								
Aug. 3	9 00 a. m.	62.0	65.0	....	....	29.011	28.910	......	0	8	Nim.; rain.
	3 00 p. m.	65.0	68.5	....	....	28.971	.862	......	0	8	Nim.
	6 00 p. m.	64.0	68.0	....	....	.963	.857	S. E.	1	7	Nim.; rain at intervals.
Aug. 4	10 00 a. m.	60.0	63.0	....	....	29.020	28.924	N. W.	2	8	Nim.
	2 00 p. m.	60.0	63.0	....	....	.024	.928	N. W.	2	8	Nim.
	7 00 p. m.	60.0	63.0	....	....	28.996	.900	N. W.	2	8	Nim.
Aug. 5	10 00 a. m.	60.0	63.0	....	....	29.004	28.908	N. W.	2	8	Nim.
	12 00 m.	59.0	64.0	....	....	.064	.971	W.	1	6	Cum. nim.
	3 00 p. m.	63.0	67.0	....	....	.077	.974	W.	1	4	Cum. nim.
	4 00 p. m.	72.0	67.5	....	....	.089	.962	W.	1	4	Cum.
	6 00 p. m.	62.0	67.0	....	....	.074	.973	......	0	3	Cum. strat.
Aug. 6	9 00 a. m.	59.0	62.0	....	....	29.155	29.062	......	0	7.5	Cum. strat.
	11 00 a. m.	60.0	64.0	....	....	.166	.070	......	0	5	Cum. strat.
	3 30 p. m.	64.0	69.5	....	....	.181	.075	......	0	5	Cum. strat.
Aug. 7	6 45 a. m.	57.5	60.5	....	....	29.332	29.259	N. W.	2	7	Cum. nim. strat.
	7 00 a. m.	57.5	60.5	....	....	.333	.243	N W.	2	7	Cum. nim. strat.
	7 30 a. m.	59.0	62.0	....	....	.340	.246	N. W.	2	7	Cum. nim. strat.
	8 00 a. m.	59.5	62.5	....	....	.341	.245	W.	1	5	Cum. strat.
	8 30 a. m.	59.0	62.0	....	....	.353	.259	W.	1	5	Cum. strat.
	9 00 a. m.	59.0	62.0	....	....	.353	.259	W.	1	5	Cum. strat.
	12 00 m.	60.0	63.0	....	....	.326	.229	E.	1	5	Cir. cum.
	2 00 p. m.	64.5	68.0	....	....	.312	.203	S. W.	1	3	Cir. cum.
	3 00 p m.	64.0	67.5	....	....	.300	.192	......	0	4	Cir. cum.
	4 00 p. m.	65.0	67.0	....	....	.274	.164	......	0	4	Cir. cum.
	5 00 p. m.	68.0	67.0	....	....	.216	.098	......	0	4	Cir. cum.
	6 00 p. m.	66.0	67.0	....	....	.266	.153	......	0	4	Cir. cum.
	7 00 p. m.	64.0	67.0	....	....	.254	.146	......	0	4	Cir. cum.
Aug. 8	9 00 a. m.	58.0	61.0	....	....	29.339	29.247	S.	1	3	Light fleecy clouds.
Aug. 9	10 00 a. m.	61.0	65.0	....	....	29.501	29.401	S. W.	1	5	Cir. strat.
	11 00 a. m.	62.0	66.0	....	....	.501	.399	S. W.	1	4	Cir. strat.
	3 00 p. m.	67.5	73.0	....	....	.495	.378	N. E.	1	4	Cir. strat.
	4 00 p. m.	72.5	73.0	....	....	.494	.364	N. E.	1	3	Cir. strat.
	8 00 p. m.	66.0	71.0	....	....	.488	.375	......	0	2	Cir. strat.
Aug. 10	8 00 a. m.	58.0	62.0	....	....	29.510	29.418	N.	1	1	Cir. strat.; light and fleecy.
	9 30 a. m.	60.5	64.0	....	....	.514	.416	N.	2	1	Cir. strat.; light and fleecy.
Aug. 11	11 00 a. m.	60.0	64.0	....	....	29.550	29.453	N.	2	5	Cir. strat.
Aug. 12	11 00 a. m.	60.0	64.0	....	....	29.575	29.478	......	0	1	Cum.
	12 00 m.	61.0	65.0	....	....	.564	.464	W.	1	0	....
	3 00 p. m.	64.0	70.0	....	....	.563	.455	W.	1	3	Cum.
	6 00 p. m.	65.0	73.0	....	....	.530	.420	W.	1	3	Cum.

Meteorological observations at Fort Yukon—Continued.

Date.	Time.	THERMOMETER. Under cover. Att.	THERMOMETER. Under cover. Det.	THERMOMETER. Open air. Dry.	THERMOMETER. Open air. Wet.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
1869.	*h. m.*	°	°	°	°						
Aug. 13	9 00 a. m.	60.0	63.0	....	....	29.556	29.459	W.	1	3	Cum.
	11 00 a. m.	61.0	65.5	....	....	.552	.452	......	0	1	Cum.
	12 00 m.	62.0	67.0	....	....	.551	.449	S.	1	1	Cum.
	1 00 p. m.	64.0	69.0	....	....	.546	.438	S.	1	1	Cum.
	2 00 p. m.	65.0	71.0	....	....	.536	.426	S.	1	1	Cum.
	3 00 p. m.	65.0	72.0	....	....	.536	.426	S.	1	1	Cum.
	4 00 p. m.	67.0	74.0	....	....	.536	.421	S.	1	1	Cum.
	4 15 p. m.	67.0	75.0	....	....	.532	.417	S.	1	1	Cum.
	5 00 p. m.	67.0	74.0	....	....	.524	.409	S.	1	1	Cum.
	6 00 p. m.	67.0	74.0	....	....	.526	.411	S.	1	1	Cum.
	7 00 p. m.	66.0	72.0	....	....	.536	.423	S.	1	1	Cum.
	8 00 p. m.	65.0	70.0	....	....	.526	.416	S.	1	1	Cum.
	9 30 p. m.	63.0	67.0	....	....	.526	.421	S.	1	1	Cum.
Aug. 14	9 30 a. m.	61.0	65.5	....	....	29.546	29.446	......	0	0	
	10 00 a. m.	62.0	65.5	....	....	.544	.442	......	0	0	
	11 00 a. m.	62.0	65.0	....	....	.534	.432	......	0	0	
	12 00 m.	64.0	68.0	....	....	.534	.426	......	0	0	
	1 00 p. m.	65.0	71.0	....	....	.534	.424	S. W.	1	1	Cum.
	2 00 p. m.	67.0	73.5	....	....	.542	.427	S. W.	1	1	Cum.
	3 00 p. m.	67.0	73.5	....	....	.540	.425	......	0	0	
	4 00 p. m.	67.5	75.0	....	....	.538	.421	......	0	0	
	5 00 p. m.	69.0	75.0	....	....	.536	.415	......	0	0	
	6 00 p. m.	68.0	75.0	....	....	.534	.416	......	0	0	
	7 00 p. m.	66.0	72.0	....	....	.526	.413	......	0	0	
	8 00 p. m.	65.0	70.0	....	....	.536	.426	......	0	0	
	9 00 p. m.	65.0	70.0	....	....	.516	.406	S. W.	1	1	Cum.; light and fleecy.
Aug. 15	9 30 a. m.	62.5	66.0	....	....	29.603	29.499	W.	1	1	Cir. strat.
	10 30 a. m.	64.0	67.0	....	....	.664	.556	W.	1	1	Cir. strat.
	11 00 a. m.	64.0	67.0	70.0	59.7	.662	.554	W.	1	1	Cir. strat.
	12 45 p. m.	65.0	71.0	79.0	63.0	.664	.554	W.	1	1	Cir. strat.
	2 00 p. m.	66.0	73.0	84.0	62.5	.605	.492	W.	1	1	Cir. strat.
	3 00 p. m.	68.0	75.0	82.5	64.0	.586	.468	W.	1	1	Cir. strat.
	4 00 p. m.	68.0	75.0	82.0	62.5	.584	.466	W.	1	1	Cir. strat.
	5 00 p. m.	68.0	75.0	81.5	62.5	.576	.458	W.	1	1	Cir. strat.
	6 00 p. m.	68.0	75.0	81.5	63.5	.576	.458	W.	1	1	Cir. strat.
	7 00 p. m.	67.0	72.5	72.0	59.0	.576	.461	W.	1	1	Cir. strat.
	8 00 p. m.	67.0	71.0	66.5	57.3	.576	.461	W.	1	1	Cir. strat.
Aug. 16	9 00 a. m.	61.0	64.4	59.8	55.0	29.664	29.564	W.	1	5	Cum.
	10 00 a. m.	63.0	66.4	67.8	59.2	.664	.559	S. E.	1	3	Cum. cir. strat.
	11 00 a. m.	64.0	66.4	71.1	61.4	.606	.498	S. E.	1	2	Cir. strat.
	12 00 m.	65.0	70.0	71.6	62.0	.554	.444	E.	1	2	Cir. strat.
	1 00 p. m.	66.0	71.0	78.0	60.7	.546	.433	E.	1	1	Cir. strat.
	2 00 p. m.	66.4	71.0	80.7	62.5	.576	.462	E.	1	2	Cir. strat.
	3 00 p. m.	67.5	73.0	82.5	64.0	.566	.449	E.	1	2	Cir. strat.
	4 00 p. m.	69.0	75.0	85.6	66.2	.556	.435	E.	1	2	Cir. strat.
	5 00 p. m.	69.4	76.0	81.5	64.5	.556	.434	E.	1	2	Cir. strat.
	6 00 p. m.	69.0	76.0	79.5	62.4	.546	.425	E.	1	3	Light fleecy clouds.
	7 00 p. m.	67.3	72.0	65.2	61.7	.554	.438	S. E.	2	5	Cum. cir. strat.
	8 00 p. m.	64.0	69.0	61.4	54.7	.556	.448	S. E.	1	5	Cum.
	9 00 p. m.	64.0	69.0	60.7	55.4	.546	.425	E.	1	5	Cum.
Aug. 17	10 00 a. m.	61.0	64.0	71.8	63.0	29.556	29.456	E.	1	1	Cir. strat.
	11 00 a. m.	63.0	67.0	71.8	60.4	.554	.449	E.	1	1	Cir. strat.
	12 00 m.	65.0	69.0	71.6	62.2	.552	.442	E.	1	1	Cir. strat.
	1 00 p. m.	67.0	73.0	78.0	62.5	.546	.431	E.	1	1	Cir. strat.
	2 00 p. m.	67.0	73.0	82.6	65.4	.544	.429	E.	1	2	Cum. cir. strat.
	3 00 p. m.	68.0	75.0	81.5	63.2	.534	.416	E.	1	2	Cum. cir. strat.
	4 00 p. m.	73.0	76.0	84.7	65.0	.536	.409	E.	1	3	Cum. cir. strat.
	5 00 p. m.	87.0	76.0	88.0	66.2	.544	.376	E.	1	2	Cir. strat.
	6 00 p. m.	84.0	77.0	82.3	65.5	.536	.376	E.	1	2	Cir. strat.
	7 00 p. m.	73.0	77.0	71.5	63.4	.516	.385	S.W.	1	1	Cir. strat.
	8 00 p. m.	66.0	71.0	64.5	61.6	.446	.333	S.W.	1	2	Cir. strat.
	10 00 p. m.	65.0	69.0	56.0	53.4	.446	.336	S.W.	1	1	Cir. strat.
Aug. 18.	9 00 a. m.	61.0	65.0	62.5	54.4	29.556	29.456	E.	1	2	Cir. strat.
	10 30 a. m.	63.0	67.0	73.0	60.5	.566	.461	E.	1	1	Cir. strat.
	11 00 a. m.	64.0	67.0	71.2	62.0	.574	.466	E.	1	1	Cir. strat.
	12 00 m.	65.0	70.0	76.5	61.2	.576	.466	E.	1	2	Cir. strat.
	1 00 p. m.	66.0	72.0	78.0	63.0	.574	.461	E.	1	1	Cir. strat.
	2 00 p. m.	68.0	74.0	82.5	63.0	.576	.458	E.	1	2	Light fleecy clouds.
	3 00 p. m.	70.0	75.0	82.0	62.5	.564	.441	E.	1	3	Cum.
	4 00 p. m.	65.4	66.0	85.0	64.7	.564	.453	E.	1	3	Cum.
	5 00 p. m.	70.0	76.0	87.0	65.0	.554	.431	E.	1	4	Cum.
	6 00 p. m.	69.0	74.0	75.4	62.5	.564	.443	S.W.	1	4	Cum.

Meteorological observations at Fort Yukon—Continued.

Date.	Time.	THERMOMETERS.				Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind.		Clouds.	
		Under cover.		Open air.							
		Att.	Det.	Dry.	Wet.			Direction.	Force.	Amount.	Kind.
1869.	*h. m.*	°	°	°	°						
Aug. 18	7 00 p. m.	68. 0	73. 0	70. 6	61. 0	29. 546	29. 428	S.W.	1	4	Cum.
	8 00 p. m.	67. 0	72. 0	65. 5	59. 5	. 546	. 431	N.	1	4	Cum. cir. strat.
	9 00 p. m.	66. 0	71. 0	61. 7	59. 0	. 544	. 431	N.	1	4	Cum. cir. strat.
Aug. 19	8 00 a. m.	59. 0	62. 0	57. 0	53. 0	29. 414	29. 320	E.	1	2	Cum. cir. strat.
	9 00 a. m.	61. 0	64. 0	64. 0	55. 6	. 346	. 246	N.	1	4	Cum. cir. strat.
	10 30 a. m.	64. 0	67. 0	71. 3	60. 0	. 324	. 216	E.	1	5	Cum. cir. strat.
	11 00 a. m.	64. 0	68. 0	71. 5	58. 5	. 314	. 206	E.	1	5	Cum. cir. strat.
	12 00 m.	65. 0	68. 0	70. 6	62. 7	. 346	. 236	S.W.	1	5	Cum.
	1 00 p. m.	66. 0	69. 0	72 2	60. 5	. 344	. 231	S.	1	5	Cum. cir. strat.
	2 00 p. m.	67. 0	70. 0	71. 5	59. 4	. 326	. 223	S.	1	7	Cum. cir. strat.
	3 00 p. m.	66. 0	69. 0	69. 0	63. 0	. 326	. 211	S.W.	1	7	Cum. cir. strat.
	4 00 p. m.	67. 0	70. 0	67. 5	58. 5	. 324	. 209	S.W.	1	7	Cum.
	5 00 p. m.	67. 0	69. 0	65. 6	55. 5	. 326	. 211	S.W.	2	7	Cum.
	6 00 p. m.	65. 0	68. 0	63. 0	54. 0	. 324	. 214	S.W.	2	7	Cir. strat.; little rain.
	7 00 p. m.	64. 0	67. 0	58. 0	54. 2	. 355	. 247	S.W.	1	7	Cir. strat.; little rain.
	8 00 p. m.	63. 0	65. 0	57. 5	53. 0	. 353	. 248	S.W.	2	7	Cir. strat.; little rain.
Aug. 20	8 00 a. m.	59. 0	61. 0	54. 0	49. 5	29. 415	29. 321	S.W.	2	4	Cum. cir. strat.
	9 00 a. m.	60. 0	62. 0	56. 2	51. 3	. 414	. 317	S.W.	2	4	Cum. cir. strat.
	10 00 a. m.	61. 0	63. 0	57. 0	52. 0	. 425	. 325	S.W.	2	4	Cum. cir. strat.
	11 00 a. m.	65. 0	63. 0	58. 5	51. 2	. 416	. 306	S.W.	2	5	Cum. cir. strat.
	12 00 m.	66. 5	66. 0	62. 0	52. 3	. 425	. 311	S.W.	2	5	Cum. cir. strat.
	1 00 p. m.	67. 0	66. 0	60. 0	52. 0	. 425	. 310	S.W.	3	7	Cum. cir. strat.
	2 00 p. m.	62. 0	65. 0	62. 0	53. 5	. 423	. 321	S.W.	3	7	Cum. cir. strat.
	3 00 p. m.	68. 0	67. 0	61. 0	52. 0	. 425	. 307	S.W.	3	7	Cum. cir. strat.
	4 00 p. m.	63. 0	69. 0	63. 0	53. 5	. 425	. 320	S.W.	3	7	Cum. cir. strat.
	5 00 p. m.	64. 0	67. 0	59. 5	51. 5	. 436	. 328	S.W.	3	7	Cum. cir. strat.
	6 00 p. m.	69. 0	66. 0	63. 5	53. 5	. 425	. 304	S.W.	2	7	Cum. cir. strat.
	7 00 p. m.	62. 0	65. 0	55. 4	50. 2	. 447	. 345	S.W.	2	7	Cum. cir. strat.
	8 00 p. m.	62. 0	65. 0	54. 0	49. 2	. 458	. 356	S.W.	2	7	Cum. cir. strat.
Aug. 21	9 00 a. m.	58. 0	61. 0	56. 5	52. 6	29. 475	29. 383	S.W.	2	7	Cum. cir. strat.
	10 00 a. m.	60. 0	62. 0	58. 7	52. 5	. 476	. 379	S.W.	2	7	Cum. cir. strat.
	11 00 a. m.	61. 0	63. 0	58. 0	51. 7	. 450	. 350	S.W.	3	7	Cum. cir. strat.
	12 00 m.	61. 0	63. 0	59. 7	53. 5	. 495	. 395	S.W.	1	7	Cum. cir. strat.
	1 00 p. m.	61. 0	63. 0	61. 5	54. 5	. 446	. 346	S.W.	1	6	Cum. cir. strat.
	2 00 p. m.	62. 0	65. 0	61. 4	53. 0	. 487	. 385	S.W.	2	7	Cum. cir. strat.
	3 00 p. m.	63. 0	65. 0	67. 0	52. 6	. 486	. 381	S.W.	1	7	Cum. cir. strat.
	3 30 p. m.	66. 0	67. 0	64. 7	54. 5	. 435	. 322	S.W.	2	6	Cum. cir. strat.
	4 00 p. m.	72. 0	67. 0	62. 5	57. 4	. 497	. 368	S.W.	2	5	Cum. cir. strat.
	7 00 p. m.	64. 0	67. 0	59. 5	52. 6	. 485	. 377	S.W.	2	4	Cum. cir. strat.
	8 00 p. m.	66. 0	65. 0	56. 0	51. 1	. 436	. 323	S.W.	1	4	Cum. cir. strat.
	9 00 p. m.	61. 0	64. 0	53. 5	58. 0	. 445	. 345	S.W.	1	3	Cum. cir. strat.
Aug. 22	10 30 a. m.	59. 0	61. 0	58. 2	52. 4	29. 665	29. 571	S.W.	2	7	Cum. cir. strat.
	11 00 a. m.	61. 0	63. 0	58. 0	52. 5	. 665	. 565	S.W.	2	7	Cum. cir. strat.
	12 00 m.	61. 0	63. 0	58. 2	52. 5	. 674	. 574	S.W.	3	7	Cum. cir. strat.
	1 00 p. m.	61. 0	63. 0	59. 0	51. 3	. 625	. 525	S.W.	2	7	Cum. cir. strat.
	2 00 p. m.	61. 0	65. 0	62. 7	53. 7	. 625	. 525	S.W.	2	5	Cum. cir. strat.
	3 00 p. m.	65. 0	69. 0	65. 5	56. 2	. 635	. 525	S.W.	2	5	Cum. cir. strat.
	4 00 p. m.	66. 0	67. 0	63. 0	59. 6	. 645	. 532	S.W.	2	5	Cum. cir. strat.
	5 00 p. m.	71. 0	69. 0	63. 5	56. 0	. 655	. 529	S.W.	2	6	Cum. cir. strat.
	6 00 p. m.	76. 0	69. 0	65. 0	55. 4	. 635	. 496	S.W.	2	4	Cum. cir. strat.
	7 00 p. m.	65. 0	67. 0	58. 2	52. 0	. 615	. 505	S.W.	2	4	Cum. cir. strat.
	8 00 p. m.	61. 0	65. 0	55. 2	51. 1	. 615	. 515	S.W.	2	5	Cum. cir. strat.
Aug. 23	7 00 a. m.	57. 0	59. 0	49. 5	47. 0	29. 764	29. 675	S.W.	2	2	Cum. cir. strat.
	8 00 a. m.	56. 0	59. 0	51. 0	50. 4	. 715	. 628	S.W.	2	2	Cum. cir. strat.
	9 00 a. m.	58. 0	60. 0	55. 2	49. 3	. 765	. 673	S.W.	2	1	Cum. cir. strat.
	10 30 a. m.	59. 0	61. 0	60. 7	53. 2	. 756	. 662	S.W.	2	4	Cum. cir. strat.
	11 00 a. m.	59. 0	62. 0	62. 5	53. 6	. 756	. 662	S.W.	2	4	Cum. cir. strat.
	12 00 m.	60. 0	65. 0	65. 2	55. 3	. 745	. 648	E.	1	3	Cum. cir. strat.
	1 00 p. m.	62. 0	68. 0	63. 7	58. 0	. 736	. 634	S.W.	1	3	Cum. cir. strat.
	2 00 p. m.	63. 0	68. 0	71. 0	58. 5	. 736	. 631	S.W.	1	4	Cum. cir. strat.
	3 00 p. m.	65. 0	69. 0	72. 0	56. 0	. 725	. 615	S.W.	1	4	Cum. cir. strat.
	4 00 p. m.	66. 0	69. 0	66. 2	58. 2	. 715	. 602	S.W.	1	4	Cum. cir. strat.
	5 00 p. m.	66. 0	68. 0	65. 0	56. 7	. 695	. 582	W.	1	5	Cum. cir. strat.
	6 00 p. m.	63. 0	66. 0	63. 4	54. 0	. 675	. 570	W.	1	6	Cum. cir. strat.
Aug. 24	9 00 a. m.	56. 0	59. 0	55. 0	51. 0	29. 437	29. 350	E.	1	2	Cum. cir. strat.
	10 00 a. m.	58. 0	60. 0	61. 0	52. 0	. 426	. 334	E.	1	2	Cum. cir. strat.
	11 00 a. m.	60. 0	63. 0	64. 3	56. 5	. 415	. 318	E.	1	2	Cum. cir. strat.
	12 00 m.	61. 0	65. 0	68. 4	55. 4	. 453	. 353	N.	1	2	Cum. cir. strat.
	1 00 p. m.	62. 0	66. 0	65. 0	55. 0	. 396	. 294	N.	1	3	Cum. cir. strat.
	2 00 p. m.	63. 0	67. 0	68. 2	54. 5	. 376	. 271	E.	1	4	Cum. cir. strat.
	3 30 p. m.	61. 0	65. 0	64. 0	55. 0	. 356	. 256	E.	1	4	Cum. cir. strat.
	4 00 p. m.	62. 0	65. 0	64. 3	55. 4	. 346	. 244	E.	1	6	Cum. cir. strat.
	5 00 p. m.	62. 0	65. 0	63. 4	55. 3	. 345	. 243	E.	1	6	Cum. cir. strat.

Meteorological observations at Fort Yukon—Continued.

Date.	Time.	Thermometers. Under cover. Att.	Thermometers. Under cover. Det.	Thermometers. Open air. Dry.	Thermometers. Open air. Wet.	Barometer uncorrected.	Barometer reduced to standard and 32° F.	Wind. Direction.	Wind. Force.	Clouds. Amount.	Clouds. Kind.
1869.	*h. m.*	°	°	°	°						
Aug. 24	6 00 p. m.	61.0	64.0	61.0	56.5	29.326	29.226	S.	1	6	Cum. cir. strat.
	7 00 p. m.	60.0	63.0	59.0	53.4	.316	.219	N.	1	7	Cum. cir. strat.
	8 00 p. m.	60.0	63.0	54.0	50.0	.265	.168	N.	1	7	Cum. cir. strat.
Aug. 25	10 30 a. m.	59.0	62.0	56.0	54.0	29.348	29.254	......	0	7	Nim. cum.
	12 00 m.	60.0	64.0	62.5	58.0	.346	.249	N. E.	1	5	Cir. nim.
	1 00 p. m.	60.5	64.0	62.3	58.0	.337	.239	......	0	0	
	3 00 p. m.	60.0	64.0	60.7	55.5	.335	.238	S.	1	8	Nim. cum. strat. cir.; light rain.
Aug. 26	9 00 a. m.	59.5	62.0	56.7	56.0	29.349	29.253	......	0	7	Cum. cir. nim.
	10 30 a. m.	59.5	63.0	59.5	56.0	.347	.251	S.	1	4	Cir. cum.
	12 00 m.	60.5	64.5	62.8	58.2	.345	.247	S.W.	1	4	Cir. cum.
	1 00 p. m.	62.0	67.5	67.3	60.0	.343	.231	S.W.	1	4	Cir. cum.
	2 00 p. m.	63.0	67.5	65.0	58.5	.336	.231	S.W.	1	6	Cir. cum.
	4 00 p. m.	63.5	67.5	66.5	60.0	.330	.224	S.W.	1	6	Cir. cum.
	5 00 p. m.	62.5	66.0	64.3	58.0	.328	.224	......	0	7	Cir. cum.
Aug. 27	9 00 a. m.	55.0	58.0	48.5	47.0	29.447	29.363	N.W.	2	7	Nim.
	11 00 a. m.	56.0	59.0	49.0	47.8	.460	.373	N.W.	3	7	Nim.; light rain.
	12 00 m.	56.5	60.5	50.0	47.5	.475	.387	N.W.	2	7	Cum. nim.
	4 00 p. m.	60.0	62.0	50.0	48.0	.476	.379	N.W.	2	7	Cum. nim.
	7 00 p. m.	56.0	60.5	46.5	43.5	.493	.406	N.W.	3	8	Nim.

OBSERVATIONS OF MINIMUM TEMPERATURE DURING THE NIGHT.

Spirit thermometer, having a steel index within the tube.

Date.	Observed minimum temperature.	Thermometer reduced to open-air dry thermometer.	Date.	Observed minimum temperature.	Thermometer reduced to open-air dry thermometer.
	°	°		°	°
August 19, 1869	41.0	39.6	August 24, 1869	36.2	34.9
August 20, 1869	43.5	42.0	August 25, 1869	46.0	44.4
August 22, 1869	42.4	40.9	August 26, 1869	48.0	46.3
August 23, 1869	42.4	40.9	August 27, 1869	44.5	43.0

ALTITUDE OF FORT YUKON.

Computation of $A \log \frac{h}{H}$. Set A.

No.	Date, 1869.	Hour.	$A \log h$	$A \log H$	$A \log \frac{h}{H}$	t
						°
1	August 3	9 a. m.	28414. 3	27840. 1	574. 2	61. 5
2	August 3	3 p. m.	28433. 8	27796. 5	637. 3	57. 0
3	August 5	12 m.	28338. 9	27895. 3	443. 6	55. 0
4	August 5	3 p. m.	28335. 2	27898. 1	437. 1	55. 0
5	August 6	9 a. m.	28429. 4	27977. 6	451. 8	61. 8
6	August 7	9 a. m.	28309. 4	28154. 7	154. 7	57. 8
7	August 7	12 m.	28350. 3	28136. 7	213. 6	58. 5
8	August 7	3 p. m.	28407. 2	28094. 6	312. 6	56. 3
9	August 8	9 a. m.	28500. 2	28233. 5	266. 7	45. 0
10	August 9	3 p. m.	28642. 3	28261. 2	381. 1	70. 0
11	August 12	12 m.	28597. 4	28337. 9	259. 5	63. 0
12	August 12	3 p. m.	28587. 7	28329. 8	257. 9	66. 5
13	August 13	9 a. m.	28571. 8	28333. 4	238. 4	59. 5
14	August 13	12 m.	28582. 0	28324. 5	257. 5	63. 2
15	August 13	3 p. m.	28587. 7	28304. 0	283. 7	65. 0
16	August 14	12 m.	28657. 2	28304. 0	353. 2	72. 0
17	August 14	3 p. m.	28681. 0	28303. 1	377. 9	65. 5
18	August 14	9 p. m.	28677. 5	28286. 1	391. 4	54. 0
19	August 15	3 p. m.	28752. 9	28341. 4	411. 5	73. 0
20	August 16	9 a. m.	28759. 0	28426. 8	332. 2	62. 0
21	August 16	12 m.	28756. 4	28320. 1	436. 3	75. 5
22	August 16	3 p. m.	28742. 4	28324. 5	417. 9	76. 5
	Means.....	....	28550. 6	28192. 0	358. 6	62. 4

Computation of $A \log \frac{h}{H}$. Set B.

No.	Date, 1869.	Hour.	$A \log h$	$A \log H.$	$A \log \frac{h}{H}$	t	t'	$t+t'$	a	a'	$a+a'$
						°	°	°			
1	August 17	12 m.	28640. 5	28318. 3	322. 2	73. 3	71. 6	144. 9	0. 667	0. 563	1. 230
2	August 17	3 p. m.	28644. 9	28295. 3	349. 6	76. 0	81. 5	157. 5	. 627	. 343	0. 970
3	August 18	9 a. m.	28690. 7	28330. 7	360. 0	57. 0	62. 5	119. 5	. 704	. 582	1. 286
4	August 18	12 m.	28695. 1	28339. 6	355. 5	58. 0	76. 5	134. 5	. 658	. 402	1. 060
5	August 18	3 p. m.	28692. 4	28317. 4	375. 0	58. 0	82. 0	140. 0	. 658	. 323	0. 981
6	August 18	9 p. m.	28499. 3	28313. 8	185. 5	57. 0	61. 7	118. 7	. 729	. 837	1. 566
7	August 19	9 a. m.	28282. 7	28143. 0	139. 7	55. 5	64. 0	119. 5	. 672	. 577	1. 249
8	August 19	12 m.	28312. 1	28134. 0	178. 1	54. 3	70. 6	124. 9	. 745	. 617	1. 362
9	August 19	3 p. m.	28371. 7	28122. 5	249. 2	56. 3	69. 0	125. 3	. 686	. 650	1. 336
10	August 20	9 a. m.	28591. 2	28207. 5	383. 7	53. 5	56. 2	109. 7	. 777	. 707	1. 484
11	August 20	12 m.	28639. 6	28201. 3	438. 3	54. 3	62. 0	116. 3	. 763	. 521	1. 284
12	August 20	3 p. m.	28644. 9	28197. 7	447. 2	55. 0	61. 0	116. 0	. 723	. 541	1. 264
13	August 21	9 a. m.	28570. 0	28265. 7	304. 3	53. 0	56. 5	109. 5	. 797	. 776	1. 573
14	August 21	12 m.	28634. 4	28276. 3	358. 1	55. 0	59. 7	114. 7	. 767	. 653	1. 420
15	August 21	3 p. m.	28652. 8	28263. 9	388. 9	56. 3	67. 0	123. 3	. 738	. 735	1. 473
16	August 22	12 m.	28929. 2	28435. 6	493. 6	54. 3	58. 2	112. 5	. 732	. 671	1. 403
17	August 22	3 p. m.	28935. 3	28392. 0	543. 3	58. 5	65. 5	124. 0	. 684	. 544	1. 228
18	August 23	9 a. m.	28872. 7	28523. 3	349. 4	54. 3	55. 2	109. 5	. 694	. 652	1. 346
19	August 23	12 m.	28825. 4	28510. 0	315. 4	57. 5	65. 2	122. 7	. 656	. 520	1. 176
20	August 23	3 p. m.	28769. 6	28471. 9	297. 7	59. 0	72. 0	131. 0	. 661	. 370	1. 031
21	August 24	9 a. m.	28524. 2	28236. 2	288. 0	57. 5	55. 0	112. 5	. 644	. 750	1. 394
22	August 24	12 m.	28524. 2	28238. 9	285. 3	58. 5	68. 4	126. 9	. 559	. 433	0. 992
23	August 25	3 p. m.	28634. 3	28131. 8	502. 5	54. 8	60. 7	115. 5	. 761	. 738	1. 499
	Means...	....	28633. 8	28289. 8	344. 0	57. 7	65. 3	123. 0	0. 700	0. 587	1. 287

	Feet.
Mean by weight of the values of $A \log \frac{h}{H}$, from Sets A and B	350. 4 ±4. 9
For temperature	+ 20. 7
For latitude	— 00. 6
For decrease of gravity on a vertical acting on the mercurial column	+ 00. 12
For decrease of gravity on a vertical acting on the density of the air	00, 0
For atmospheric humidity	+ 1. 4
Height of Fort Yukon above Redoubt St. Michael's	372. 0 ±4. 9
Estimated height of Redoubt St. Michael's above the level of the sea	40. 0
Approximate height of Fort Yukon above the level of the sea	412. 0

APPENDIX D.

TABLE OF DISTANCES ON THE YUKON RIVER.

Locality.	Description of locality.	Position on the Yukon.	Distance from— Preceding locality.	Fort Yukon.	The sea.
			Stat. ms.	*Stat. ms.*	*St. ms.*
Fort Yukon	American trading-station	Right bank			966. 0
Porcupine River	Mouth	do	1. 5	1. 5	964. 5
Achenchik River	do	do	32. 5	34. 0	932. 0
Cletagután River	do	Left bank	10. 0	44. 0	922. 0
Chetletchuk River	do	Right bank	138. 5	182. 5	783. 5
Chetaut River	do	do	13. 0	195. 5	770. 5
Atonisonik River	do	do	5. 5	201. 0	765. 0
Yukuchargut River	do	Left bank	21. 0	222. 0	744. 0
Clanachargut River	do	do	12. 0	234. 0	732. 0
Rampart Rapids			} 20. 5	254. 5	711. 5
Senati's Village	Native summer village	Right bank			
Tananá River	Mouth	Left bank	} 28. 0	282. 5	683. 5
Nuclucayette	Spring trading-ground	do			
Fort Adams	American trading-station	Right bank	} 17. 0	299. 5	666. 5
Tosekargut River	Mouth	do			
Atutsakulakushchargut River	do	Left bank	9. 0	308. 5	657. 5
Nuchuklikargut River	do	Right bank	5. 5	314. 0	652. 0
Klatsutachargut River	do	Left bank	12. 0	326. 0	640. 0
Chokoyik	Island and village	Mid-stream	23. 5	349. 5	616. 5
Newikargut River	Mouth; village	Left bank	20. 5	370. 0	596. 0
Melozekargut River	Mouth	Right bank	38. 0	408. 0	558. 0
Yukokargut River	do	Left bank	21. 5	429. 5	536. 5
Sakadelontin	Native village	Right bank	10. 5	440. 0	526. 0
Kukuyukuk River	Mouth	Left bank	23. 0	463. 0	503. 0
Kuyukuk River	do	Right bank	14. 0	477. 0	489. 0
American Creek	American trading-station	do	21. 5	498. 5	467. 5
Nulato	Old Russian station	do	0. 5	499. 0	467. 0
Upper Kahltog	Native village	do	32. 0	531. 0	435. 0
Kahltog Creek	Mouth	do	1. 0	532. 0	434. 0
Kahltog	Entrance to portage	do	4. 5	536. 5	429. 5
Lower Kahltog	Native village	do	1. 0	537. 5	428. 5
Takaitski River	Mouth	do	} 13. 0	550. 5	415. 5
Hultulkakut	Native village	do			
Tagutakaká	do	do	6. 0	556. 5	409. 5
Yakutskalitnik	Entrance to portage	do	23. 0	579. 5	386. 5
Muskoietaká	Native village	do	14. 0	593. 5	372. 5
Hall's Rapids			42. 5	636. 0	330. 0
Anvic	American station; village	Right bank	22. 5	658. 5	307. 5
Makagamute	Native village	do	13. 5	672. 0	294. 0
Ingekasagmi	do	do	20. 5	692. 0	273. 5
Nunaikagamute	do	do	5. 5	698. 0	268. 0
Cuyikaniukpuk	do	do	20. 5	718. 5	247. 5
Ikaklagmute	do	do	20. 5	739. 0	227. 0
Mission	American (old Russian) station	do	10. 0	749. 0	217. 0
Old Chief's Village	Native village	do	6. 0	755. 0	211. 0
Kochkogamute	do	do	11. 0	766. 0	200. 0
Youkagamute	do	do	9. 0	775. 0	191. 0
Chukchukamute	do	do	8. 5	783. 5	182. 5
Ankachagamuk	do	do	34. 0	817. 5	148. 5
Kaniugamuk	do	do	10. 5	828. 0	138. 0
Konnekova River	Mouth	do	13. 0	841. 0	125. 0
Andreavsky	Old Russian station	do	8. 5	849. 5	116. 5
Aphoon	Native village	do	104. 5	954. 0	12. 0
Coatlik	Old Russian station	do	7. 0	961. 0	5. 0
Norton Sound	Mouth of Aphoon Outlet		5. 0	966. 0	

DISTANCES ON THE COAST.

Mouth of Aphoon Outlet to Pikmiktalik	46 miles.
Pikmiktalik to anchorage off Redoubt St. Michael's	27 miles.
Traveled distance from Redoubt St. Michael's to Fort Yukon	1,039 miles.