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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

RECONNAISSANCES

IN THE

CAPE NOME AND NORTON BAY REGIONS, ALASKA, IN 1900

BY

ALFRED H. BROOKS, GEORGE B. RICHARDSON, ARTHUR J. COLLIER
AND WALTER C. MENDENHALL

WASHINGTON
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A RECONNAISSANCE OF THE CAPE NOME AND ADJACENT GOLD FIELDS OF SEWARD PENINSULA ALASKA, IN 1900

BY

ALFRED HULSE BROOKS

ASSISTED BY

GEORGE BURR RICHARDSON AND ARTHUR JAMES COLLIER

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RECONNAISSANCE OF CAPE NOME AND ADJACENT GOLD FIELDS OF SEWARD PENINSULA, ALASKA.

By Alfred H. Brooks,

Assisted by George B. Richardson and Arthur J. Collier.

INTRODUCTION.

In consequence of the discovery and rapid development of the rich placer gold fields of Nome, Alaska, and the adjacent districts, a topographic survey and a geological investigation were demanded of the Geological Survey.[1] The topographic work was put in charge of Mr. E. C. Barnard, whose map and report are embodied in this volume, while the geological work was intrusted to the writer. The following is extracted from his field orders:

> You are herewith assigned to work in Alaska, to take charge of a party to make a geological survey of the southern portion of the Seward Peninsula, west of Cape Darby. Your attention should be especially directed to the gold-producing districts of the Golofnin Bay region, the Bonanza and Salmon Bay region, and the Cape Nome region, and so far as may be practicable your work should be extended to Cape York and vicinity. * * * It is proposed that the geologic survey, to the execution of which you are assigned, shall be as detailed and thorough as the extent of the region and the physical conditions permit. You will endeavor to ascertain the extent and distribution of the placer deposits, with reference not only to the streams but also the present and former marine beaches, the source of the gold in the original deposits, and the extent, distribution, and geological relations of the gold-bearing rocks. You will also gather all possible information as to the general geology and physiography of the district traversed, including any other economic resources besides the gold, and you will secure data concerning trails, routes of summer and winter travel, and conditions of transportation and subsistence which may be of use in future work.

Messrs. George B. Richardson and Arthur J. Collier were detailed as assistant geologists, and R. C. Applegate, H. B. Baker, A. D. Esty, W. E. Herbert, and George Revine were employed as camp hands. All these members of the expedition rendered faithful service, as the report will show.

[1] In the fall of 1899, Mr. F. C. Schrader and the writer spent a few weeks at Nome and made a hasty examination of the gold placers in the immediate vicinity. Compare preliminary report on the Cape Nome gold region, Alaska, by Frank C. Schrader and Alfred H. Brooks. United States Geological Survey, 1900.

Transportation for the party to and from Alaska on steamers of the Coast and Geodetic Survey was furnished by the courtesy of the Superintendent.

According to instructions, our party was assembled at Seattle early in June. On the 13th we embarked on the U. S. S. *Pathfinder*.[1] A short stop was made at Dutch Harbor for coaling, another at Nome, and on the 28th of June we were landed at Golofnin Bay.

The area mapped by our party lies west of Fish River (see map, Pl. XVIII, in Mr. Mendenhall's paper, following). The eastern part of the peninsula was investigated by Messrs. W. J. Peters and W. C. Mendenhall, whose report will be found herewith.

A part of our provisions was stored at Golofnin Bay. A few days having been spent in examining the shores of the bay, our entire party ascended Fish and Niukluk rivers to Council. Provisions and outfit were transported by means of three Peterboro canoes, which had been brought along for that purpose.

At Council a second cache of provisions was made, and again we devoted a few days to the geology of the vicinity. Then our journey was continued to the mouth of the Koksuktapaga. At this point the party divided, Mr. Richardson, with two men, going up the Koksuktapaga to its head, while the others continued up the Niukluk to the mouth of American Creek.

Mr. Richardson afterwards returned to Council, went to the head of Ophir Creek, and then back to Golofnin Bay. Thence he went by steamer to Bluff, visiting Topkok, and continued his work in the drainage basins of Solomon, Bonanza, Eldorado, and Flambeau rivers. He reached Nome on September 18 and spent the remainder of the season investigating the Nome mining region.

From American Creek the larger division of the party made an excursion toward the head of Niukluk River and then portaged two canoes and a month's supplies across to the Kruzgamepa. This portage for a distance of 12 miles was very arduous, as it required four trips to transport the outfit, and occupied the energies of the entire party for a week.

On July 31 a start was made up Kruzgamepa River, and its head, Salmon Lake, was reached on August 3. From this point the writer, accompanied by Mr. Applegate, made a trip to Nome, 40 miles distant, while Mr. Collier and two men went northward across the Kigluaik Range. On the trip to Nome we followed Nome River down, and made the return via Snake River; thus two geological sections were obtained. The work occupied about ten days. As it was done with packs on our backs and for the greater part in the rain, and we were unable to carry tents, it was both trying and disagreeable. On

[1] The writer wishes hereby to express his thanks to Capt. J. J. Gilbert and the other officers of the *Pathfinder* for the courtesies extended to his party during this voyage.

August 14 the party was reassembled on the Kruzgamepa and two weeks later reached the junction of that river with the Kuzitrin.

It was no part of the original plan to visit the Kugruk region. In fact, when the plans were made this gold district had not been discovered. Rumors of its valuable placer deposits, however, had reached us in the course of the summer. Knowing the importance of getting authentic information in regard to the new district, the writer determined to make a hasty reconnaissance there, and the Kuzitrin was ascended to the mouth of the Kugruk. There we found a small camp, then known as Checkerstown, or Checkers, and from this point the writer, with Mr. Collier and two camp hands, all with packs, continued up the Kugruk.

By making forced marches for four or five days in succession, we were enabled to visit practically all the placer diggings of the district except those on Harris Creek.[1]

Returning to Checkers, we ran down the Kuzitrin in our canoes to Imuruk Basin, taking two days for the trip, and then, crossing the bay, followed the Tuksuk channel to Grantley Harbor, and reached the Teller Reindeer Station at Port Clarence on August 31. Here we were very hospitably received by Mr. and Mrs. T. L. Brevig. Thanks to the kindness of Capt. J. F. Pratt, of the U. S. S. *Patterson*, we could here replenish our supplies from those which he had brought for us.

Mr. Collier, with two men, took the first steamer to Nome, and from there made an excursion to Cripple and Penny rivers. He then returned to Nome and joined Mr. Richardson in his investigation of the geology of the immediate vicinity. On September 28 Mr. Richardson and Mr. Collier, with the members of their respective parties, were picked up by the U. S. S. *Pathfinder* and taken to San Francisco.

The writer and Mr. Applegate remained at Port Clarence and prepared to make a cross-country trip to York. While still at the station the U. S. S. *Bear* arrived, and Captain Tuthill very kindly undertook to transport us to York. We spent ten days at York in reconnaissance of the mining-district surveys.

During this time the writer, in company with an Eskimo, made a trip to Cape Prince of Wales. The trail crosses over a high bench of Cape Mountain. This ascent was made along a steep talus slope during a blinding snowstorm. Just as the western declivity was reached the sky cleared. Fifteen hundred feet below us was the narrow sand spit which marks the westernmost point of the North American continent. Across an expanse of cold, gray water the Diomede Islands were plainly visible, while still more distant the

[1] We are much indebted to A. R. McAdams, who furnished the supplies which enabled us to carry out our plans. Mr. McAdams and Mr. Joe Furlong also gave us valuable information in regard to the region.

Siberian coast could be seen on the horizon. At the outskirts of the Eskimo village which occupies the sand spit is the Congregational Mission, where the writer was very hospitably received by Mr. and Mrs. W. T. Lopp.

We returned from York to Port Clarence with a party of prospectors[1] in a small boat, and from Port Clarence made a hurried excursion into the Bluestone gold district. This trip the writer made alone, with his pack on his back, depending on miners and prospectors for food and shelter. Winter weather had set in, and the snow, which covered the ground to a foot or more, made the trip the hardest of the season. The return to Port Clarence ended the field work, during which the writer's packing trips aggregated over 200 miles.

At Port Clarence we were storm bound for several days, and then went by steamer to Nome, where we embarked on the *Patterson*[2] on October 8, and reached Seattle on October 29, after a stormy and perilous passage.

The result of our work has thrown light on the geology and mineral resources of an area of something over 6,000 square miles. In some cases the investigations were made in considerable detail, while in others the limited time at our disposal permitted only the most hasty reconnaissance. Our work in the Bluestone and Kugruk districts was of the latter character. Of the 6,000 square miles, 4,500 were topographically mapped by Mr. Barnard and party, who made use of the Coast Survey triangulation and shore line. The geological party made reconnaissance topographic maps of about 1,500 square miles by means of hand compasses and traverse plane tables and with barometric determination of elevations. This topography is included in the maps of Kugruk and York districts (Pls. XI and XIII). Mr. Barnard has also made use of a small part of it along the northern margin of his sheet (Pl. XVII).

In planning this report it was thought best to give summaries of the geology and physiography of the region, with some theoretical discussion, and, at the risk of making some repetitions, to throw the chapters on economic geology into more popular form, avoiding technical terms as far as possible. It is hoped that this arrangement will make the results so far obtained of immediate and practical value to the average miner and prospector, as well as generally intelligible to other readers not versed in geological nomenclature.

In presenting this report the writer wishes to disclaim any idea of its being more than a hasty summary of the results of a preliminary reconnaissance of the gold fields. In no localities were the field studies exhaustive, and in many only a few general facts were gleaned.

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[1] Messrs. Barnaby and Herman Anderson; we shared their boat and tent for several days, and we hereby wish to express our hearty thanks. They belong to the class of true pioneers, whom it is always a pleasure to meet.

[2] To Captain Pratt and the officers of the *Patterson* the writer is deeply grateful for many courtesies and hospitality during this very trying voyage.

Popular demand for an early publication of the results made it necessary to curtail the office work to a considerable degree. The winter work has therefore been directed chiefly toward such phases of the subject as have more or less direct bearing on the mineral resources of the region. It has been the writer's desire to give results which would be of direct interest to the general public rather than to enter into a scientific discussion of the many interesting problems which the field presents.

In the itinerary given above some reference has been made to the work of the individual members of the party. In the investigation of Niukluk River and Golofnin Bay all the geologists cooperated. Mr. Richardson alone is responsible for the field work in the upper part of Ophir Creek, in Koksuktapaga, Solomon, Eldorado, and Bonanza river basins, and in the Topkok region. The Kruzgamepa and Kugruk regions were studied jointly by Mr. Collier and the writer. In the Bluestone and York districts the writer worked alone. All of the credit for the work in Penny and Cripple river basins belongs to Mr. Collier. The Nome region proper was investigated by all three of the geologists, but to Mr. Richardson fell most of the detailed work in the immediate vicinity of Nome.

The work of preparing the detailed descriptions of those placer fields with which the writer is not personally familiar has fallen largely on Mr. Richardson and Mr. Collier, while for the summaries of the structural and economic geology the writer is alone responsible. The historical sketch of the previous explorations is the joint work of Mr. Richardson and the writer. Mr. Collier has prepared a chapter on the flora of the peninsula, based largely on his own observations and collections. He deserves great credit for having persistently kept up his botanical notes while his time was fully occupied by regular field work. Mr. Frederick V. Coville, botanist of the Department of Agriculture, has kindly determined the specimens submitted by Mr. Collier. Mr. Collier's report on the climate is based on his own meteorological records and on compiled data, as well as on the observations of the other Geological Survey parties in the peninsula, for which we are indebted to Mr. Barnard and Mr. Mendenhall. At the request of the writer, Mr. Barnard has prepared a brief summary of the methods of work employed by his parties. The writer would express his thanks to his assistants, Messrs. Richardson and Collier, for their earnest efforts to bring the work to a successful conclusion.

GENERAL GEOGRAPHIC FEATURES.[1]

Seward Peninsula, in which lie the gold fields forming the subject of the present investigation, is a land mass stretching out from the northwestern part of the American Continent and extending westward

[1]A detailed description of the topography will be found under the heading "Physiography."

to within 60 miles of the Asiatic coast, from which it is separated by Bering Strait (Pl. I). This peninsula, together with the Chukchi Peninsula of eastern Siberia, separate the Arctic Ocean from Bering Sea. Cape Darby, the southernmost point of the peninsula, lies a little south of 64° 20′, while Cape Espenberg, on the north, is just within the Arctic Circle. The one hundred and sixty-first meridian lies near the eastern margin of the peninsula, while Cape Prince of Wales is just west of the one hundred and sixty-eighth meridian. The area of the peninsula is approximately 20,000 square miles, of which about 6,000 square miles are considered in this report. An examination of the map shows the peninsula to have the general outline of a crudely shaped arrowhead pointed due west toward Cape Nuniamo, on the Siberian coast. Cape Prince of Wales forms the point of the arrow, while Cape Espenberg, on the north, and Cape Darby, on the south, suggest the barbs.

The outline of the north coast of the peninsula is interrupted by deep indentations—Shishmaref Inlet and Goodhope Bay, the former communicating directly with the Arctic Ocean, the latter a portion of Kotzebue Sound. According to the report of Captain Beechey, Shishmaref Inlet is connected with Goodhope Bay by a broad depression, which has apparently within recent times been an arm of the sea, isolating the highland to the north.

Along the southern margin the coast line is broken by three bays—farthest west by Port Clarence and its connecting bodies of salt water, Grantley Harbor and Imuruk Basin, forming a far-inland-reaching tidal channel; next by Golofnin Bay, which, with Port Clarence, separates a minor peninsula from the mainland mass; and most easterly by the deep indentation, Norton Bay, which, with Kotzebue Sound on the north, cuts out the peninsula from the body of Alaska.

Two kinds of shores can be differentiated, one characterized by a low coastal plain with many lagoons and sandspits, the other by bold cliffs that rise abruptly from a very narrow, rocky margin. A glance at the map accompanying Mr. Mendenhall's report, Pl. XVIII, will show that, broadly speaking, the coast topography of the western half of the peninsula is mainly of the first description, while that of the eastern half has more of the bold and rocky character.

The coastal plain is everywhere covered with a dense growth of moss and grass, and, indeed, much of the upland region is mantled in a similar way. This growth tends to give the region smooth, flowing contours, which are here and there broken by rock cliffs. The Russian word "tundra" is generally accepted to designate these plains of the north, which are covered with arctic vegetation (see Pl. II, *A*). The word "tundra" is not limited to an absolute plain, but includes also a rolling country covered with arctic vegetation. The tundras of Seward Peninsula differ in no way from those which are found encircling the polar region at the northern margin of the continents.

JULIUS BIEN & CO. LITH. N.Y.

OUTLINE MAP OF SEWARD PENINSULA AND ADJACENT REGION, ALASKA

Showing area of larger scale maps

Scale

50 0 50 100 150 MILES

An examination of the hachured maps, Pls. XVII and XVIII, will show that the topography of Seward Peninsula is irregular. The interior is occupied by uplands from 800 to 2,600 feet in height, above which rise many isolated peaks or knobs and several mountain masses. The uplands are formed of low, rounded hills, usually increasing in height away from the coast, and their gentle slopes are frequently broken by well-marked benches and terraces. The isolated peaks and knobs rise above the uplands to elevations varying from 1,500 to 2,000 feet. A reference to the map, Pl. XVIII, will show a number of these in the northern part of the peninsula. Beyond their location, little is known of them, as they have been mapped only from a distance. In the southern half of the peninsula, where more of them have been examined, they are usually found to consist of such rocks as have resisted erosion better than those that surround them. In some localities, as along the southern coast of Kotzebue Sound, these peaks have a linear grouping that suggests a mountain range, but usually their distribution is entirely irregular.

In the southern half of the peninsula a fairly well-defined mountain range exists, which is divided into three groups by broad valley lowlands. The westernmost of these groups is known as the Kigluaik Mountains. This mass rises rather abruptly from the upland, 10 miles inland from Cape Woolley, and stretches for about 40 miles in a northeasterly direction, where it falls off precipitously to the flat valley of Kruzgamepa River. The north slope of the mountains is steep to Imuruk Basin and to the flat of the Lower Kruzgamepa. To the south the mountains slope off to a broad depression, which runs parallel to them and includes parts of Feather, Stewart, and Kruzgamepa river valleys. The Kigluaik Mountains are rugged, with sharp peaks and canyon-like valleys. Mount Osborn reaches an elevation of about 4,700 feet and is the highest of the range.

The Bendeleben Mountains extend eastward for about 50 miles from the valley of the Lower Kruzgamepa. They are not so high nor so rugged as those above described. They take their name from the highest peak, which reaches an elevation of about 3,500 feet. To the north they fall off rather abruptly to the valley of Kuzitrin River, while their southern slopes merge more gradually with the upland.

A third mountain mass, called the Darby Mountains, extends for about 40 miles from Cape Darby, and ends abruptly in a low pass, which forms the watershed between Fish River and the Tubutulik. These mountains, a description of which will be found in Mr. Mendenhall's report, have rounded summits and are not over 2,000 feet high.

The map (Pl. XVIII) shows that these three mountain groups, though separated by valley lowlands, are in a certain sense coextensive, and can be considered as belonging to the same range. This range extends eastward from Cape Woolley, sweeps around the drainage basin of

Fish River, and ends in the rocky promontory of Cape Darby. The highest points, as well as the most rugged topography, are in the western part of the range, which gradually decreases in elevation toward the east and south. The axis of the range has a hyperbola-like form.

Northward from Cape York extends a mountain mass, usually called the York Mountains, which has been but little explored. While not so high as the Kigluaik Mountains, its highest peaks being about 2,500 feet, it has a similar rugged character. The streams have been sharply cut, and the mountain slopes rise precipitously. The northern limit of these mountains is not mapped, but probably they fall off rather abruptly, as shown on the accompanying map.

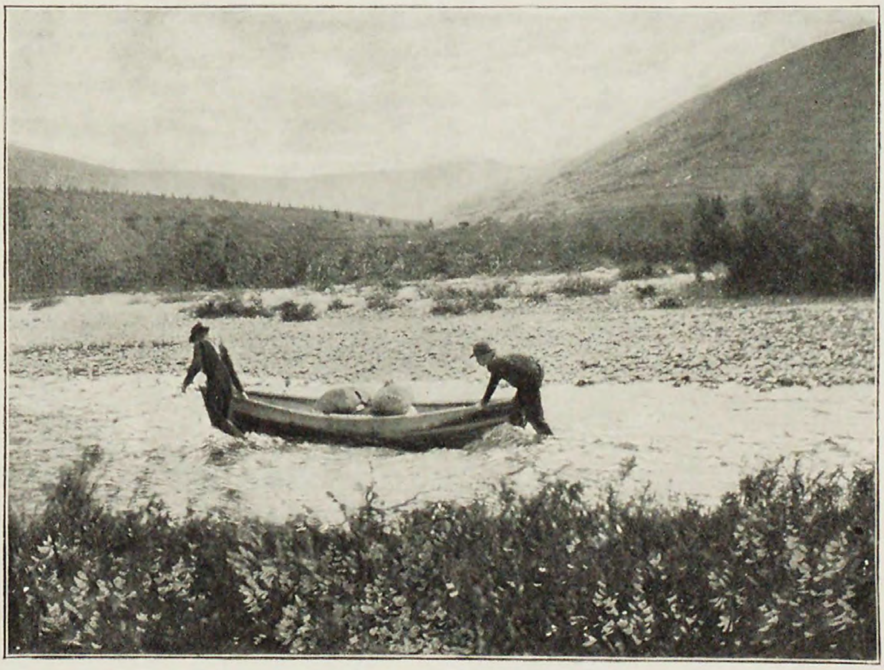
The drainage in the southern half of Seward Peninsula does not fall into well-marked provinces. South of the Bendeleben Range the waters reach Golofnin Bay; south of the Kigluaik Range they flow directly into Norton Sound or Bering Sea; north of the Kigluaik Range they mainly enter Port Clarence or its connecting bodies of salt water, and west of the York Mountains they flow into Bering Sea. In the northern half of the peninsula the rivers have usually a northerly course and empty into the Arctic Ocean or Kotzebue Sound. The river systems east of Golofnin Bay are described by Mr. Mendenhall.

The upland region lying to the south of the Niukluk Valley and the Kigluaik Mountains is drained, for the most part, by southward-flowing rivers which empty into lagoons or directly into Bering Sea. The valleys of these rivers have a rough parallelism. A smaller part of this upland belt is drained northward into the Kruzgamepa, which, sweeping around the western end of the Kigluaik Mountains, empties into Imuruk Basin. Niukluk River, a tributary of the Fish, which flows to the southeast into Golofnin Bay, also receives a part of the drainage of this upland.

Fish River takes the drainage of the southern slope of the Bendeleben Mountains, as well as the western drainage of the Darby Mountains, to Golofnin Bay. The eastern half of the Kigluaik Mountains and the western and northern slopes of the Bendeleben Mountains drain into Imuruk Basin, via the Kruzgamepa, Kuzitrin, and some shallow streams. Imuruk Basin, which is connected with Grantley Harbor by a tidal channel, receives a large tributary from the north called Agiapuk River. The drainage basin of the Agiapuk includes a large area lying northeast of Port Clarence. Between Port Clarence and Cape Prince of Wales the southerly flowing streams are comparatively small. The watershed between the Arctic Ocean and Bering Sea lies considerably north of a line bisecting the plain in an east-west direction. The northward-flowing rivers are, therefore, as a rule, shorter than those emptying into Bering Sea. The largest rivers tributary to

neg. #332 Brooks.

A. TUNDRA.



B. VIEW OF TRIBUTARY OF OPHIR CREEK NEAR WESTERN LIMIT OF SPRUCE TREES.

the Arctic Ocean are in the eastern part of the peninsula and flow into Kotzebue Sound.

The most striking features of the topography are the broad, flat-bottomed valley basins which drain through comparatively narrow outlets. Of this class are the basins of Upper Fish River, of the Upper Kuzitrin, and the valley lowland, which includes the Kruzgamepa and Upper Niukluk waters. The floors of all of these basins are gravel covered.

HISTORY OF EXPLORATION OF SEWARD PENINSULA.

As Seward Peninsula is the most western part of the North American continent and is separated by only 60 miles of water from the Asiatic coast, its first exploration by white men was from the west. It was, in fact, discovered before any other part of Alaska. What had been the intercourse across the straits between the primitive people previous to the coming of the white man can be determined only by close ethnological investigations. It is known, however, that the natives of the extremities of the two continents are of closely allied races, and the presumption is that there has long been intercourse between them.

While the settlements on the Atlantic coast of America were still in their infancy, Russian traders had pushed their way well across the plains of Siberia. It was a Cossack who made Russia an Asiatic power by extending the limits of the Empire across the Ural Mountains and eventually conquering Siberia; and, according to Dr. Dall, it was one of this same race, Simon Deshnef, who in 1648 sailed eastward from the mouth of the Kolyma, on the north coast of Siberia, and, rounding East Cape, discovered Bering Strait and spent the winter at the mouth of Anadyr River.[1] This voyage seems to have been lost sight of until 1736, when the orignal accounts of the Russian navigator were found in the archives of Yakutsk.[2]

In 1711 another Cossack, named Popof, was sent to East Cape, his mission being to induce the natives to pay tribute. He failed in his object, but he brought back an account of the islands which lie beyond East Cape and rumors of a continent reported to lie beyond these islands.[3]

We owe to Peter the Great the first systematic attempts at an exploration of Alaska. When his attention was called to the matter he was quick to see the advantages to Russia of a knowledge of the extremities of the Asiatic and American continents.[4] By his orders

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[1] Alaska and its Resources, by W. H. Dall, p. 295.

[2] Account of the Russian Discoveries between Asia and America, by William Coxe, London, 3d edition, 1787, p. 253.

[3] Alaska and its Resources, by W. H. Dall, p. 297; also Müller, Voyages from Asia to America, London, 1761, pp. iv–v.

[4] History of Alaska, by H. H. Bancroft, 1886, p. 36.

an exploring expedition was organized and Vitus Bering, a Dane, fleet captain in the Russian navy, was placed in command. One of the last acts of Peter the Great's life was to sign the orders for this expedition. It started overland across Siberia a few days before his death. His successor, the Empress Catherine, was earnest in carrying out his will in regard to this work. Bering built two small vessels at Okhotsk, on the northern coast of Okhotsk Sea, and in July, 1728, started to the northeast. He kept near the Asiatic coast, but discovered and named St. Lawrence Island, and proceeding northward passed through the strait which bears his name. He continued his journey up to the point where the Asiatic coast line bends to the westward, and then, having proved to his own satisfaction that there was no land connection between the two continents, he turned southward and followed the same route back to Kamchatka. Strangely enough, he did not see the American continent, though it is sometimes plainly visible from the Siberian coast.

At this time Athanasie Shestakof,[1] a man of great energy, commanding the Cossacks of the Siberian province of Yakutsk, became interested in these explorations, and obtained, in 1729, authority from St. Petersburg to explore the Chukchi region and subdue the natives. The war which was thus waged against the Chukchis did not result in conquest, but in consequence of it some knowledge of the western coast of Bering Sea and Strait was obtained. In 1731 a vessel belonging to this same military expedition, on board of which was Gvozdef, the surveyor of the party, was carried by a storm to the American coast. Gvozdef's report is not very definite, but it seems probable that he cruised along Norton Sound.

In the meanwhile the interest excited by Bering's voyage led to elaborate preparations at St. Petersburg for a thoroughly organized and equipped expedition to explore the northwest coast of America.[2] This expedition was placed in charge of Bering, who spent six years in transporting the outfit across Siberia. At Okhotsk vessels were built, and in 1741 Bering sailed eastward from Avatcha Bay, Kamchatka, with two vessels. They became separated early in the voyage, but Bering continued eastward, and discovered and named Mount St. Elias, returning along the line of the Catherina Archipelago. Bering's party was attacked by scurvy, and late in the year his vessel was wrecked and the party was forced to winter on an island off Avatcha Bay, since called Bering Island. Here Bering died, together with many of his companions. The survivors built a boat, and in the following spring made their escape from the island.

Russian voyages of discovery were frequent after this. In 1767

[1] History of Alaska, by H. H. Bancroft, 1886, p. 40; Voyages from Asia to America, by S. Muller; translated by T. Jefferys; London, 1761.
[2] History of Alaska, by H. H. Bancroft, 1886, p. 36.

Lieutenant Synd, on a voyage of discovery, sailed past the Diomedes and discovered a mountainous coast east of East Cape. This was mapped on his chart as "coast supposed to be the continent of America."[1]

Very gradually the coast became better known. It appears that the early Russian voyagers contributed but little accurate information, for up to the time of Captain Cook's voyage no trustworthy charts had been drawn.

In August and September, 1778, Captain Cook, in the *Resolution*, coasted along Seward Peninsula, mapped its outline, and named Point Rodney, Sledge Island, King Island, Cape Prince of Wales, Cape Darby, and Norton Sound. Although he passed near their entrances, Cook failed to notice Golofnin Sound, Port Clarence, and Kotzebue Sound. He brought back the first definite information in regard to this coast and its inhabitants.[2]

Kotzebue was the next to make and record discoveries in these parts.[3] His voyage was undertaken for the general advancement of scientific knowledge; its expenses were met by Count Rumiantzof. He visited St. Lawrence Island and, rounding Cape Prince of Wales in 1816, explored the coast lying eastward, along the north side of the peninsula. Shishmaref Bay, Cape Espenberg, Kotzebue Sound, Eschscholtz Bay, Chamisso Island, Cape Deceit, and Goodhope Bay were discovered and named by Kotzebue, and he also noted the position of some mountains in the interior. He reported the north coast to be thickly inhabited.

In 1822 the Russian American company fitted out an expedition for the exploration of northwestern America.[4] A vessel of this expedition, the *Golofnin*, in command of Captain Kromchenko, visited the south coast of Seward Peninsula in 1822,[5] and explored Norton Bay and Golofnin Bay. While in the latter a communication from the natives led Kromchenko to believe that there existed a water passage between Port Clarence and Golofnin Bay.[6] This error did not appear on the maps for about forty-five years, but was then introduced and has since been persistently copied by the cartographers.

The last of the noteworthy discoveries along the coast of Seward Peninsula was made by Capt. F. W. Beechey, R. N., in H. M. S. *Blossom*, in 1827.[7] Beechey charted the coast northwest of Point Rodney to Cape Prince of Wales. He discovered Port Clarence and Grantley

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[1] Coxe, op. cit., p. 225.

[2] A Voyage to the Pacific Ocean, by Capt. James Cook, London, 1785.

[3] A Voyage of Discovery into the South Sea and Bering Straits, 1815-1818, in the *Rurik*, by Otto von Kotzebue; translated by H. E. Lloyd; London, 1821. Also Weimar, 1821.

[4] Voyage autour du monde, partie nautique, by F. Lütké; translated from the Russian by J. Boyé; St. Petersburg, 1836, p. 246.

[5] Petrof, in Bancroft's history, p. 546. Lütké's date, 1821, is probably an error.

[6] Op. cit., p. 247.

[7] Narrative of a Voyage to the Pacific and Beering's Strait, performed in H. M. S. *Blossom* in the Years 1825-1828; London, Colburn and Bentley, 1831; 4°, pp. 742, 3 maps, 23 plates.

Harbor, and named them, as well as Point Spencer and Cape York. Beechey's work, considering its extent and the inadequacy of his means, is remarkably accurate, and up to the present time his chart has been the basis of all maps of the region.

Among other far less important explorations, mention may be made of the famous but unfruitful expedition of Billings,[1] who visited the Diomedes and touched along the coast near Cape Prince of Wales in 1791, and of the voyages of Etolin, Vasilief, and others, who in 1830 explored more thoroughly Norton Sound and Golofnin Bay.[2]

Between 1848 and 1854 the North Pacific was much frequented in consequence of the numerous relief expeditions sent out in search of Sir John Franklin. An added stimulus was the hope of finding the long-sought northwest passage. Port Clarence, Grantley Harbor, and Kotzebue Sound were convenient harbors, and several vessels wintered in them during the years of the search. Among these vessels were the *Herald*, commanded by Captain Kellett; the *Plover*, by Commander Moore; the *Enterprise*, by Captain Collison; the *Investigator*, by Captain M'Clure; and the *Rattlesnake*, by Commander Trollope. While comparatively little was added to the knowledge of the general geography of Seward Peninsula by these expeditions, they brought about many additions and corrections to the already existing charts. During the winters excursions of greater or less length were undertaken to neighboring localities. A noteworthy overland trip was made in the spring of 1850 by Mr. Bedford Pim, of the *Plover*, then lying in winter quarters at Kotzebue Sound. Pim left the ship March 10 with two men and a dog sledge, and after many privations reached St. Michael April 6 and returned to the *Plover* April 29. Another expedition, under Captain Kellett, ascended Buckland River from Kotzebue Sound.

After the Franklin relief expeditions were discontinued there was little activity in this northern country until the attempt was made by the Western Union Telegraph Company to construct an overland line through British Columbia and Alaska in order to reach the eastern hemisphere across Bering Strait. The route chosen in Seward Peninsula was from the head of Norton Bay to Fish River, thence up the Niukluk and across to Imuruk Basin, Grantley Harbor, and Port Clarence; thence west to Cape Prince of Wales.

The explorers of the telegraph expeditions added much to the knowledge of the region. In the winter of 1865–66 a party in charge of Baron Otto von Bendeleben explored the route between Golofnin Bay and Port Clarence.[3] In 1866 men and telegraph material were sent to

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[1] Account of an Expedition to the Northern parts of Russia by Commodore Joseph Billings, 1785–1794, by M. Sauer, London, 1802. Dall, op. cit., p. 336.

[2] Bancroft, op. cit., pp. 547–548.

[3] Dall, op. cit., p. 357.

Port Clarence by sea.[1] They established a camp at Grantley Harbor, where the members of the party spent the winter of 1866–67. Some miles of telegraph line were built. The success of the Atlantic cable suddenly ended all this work.

After the discontinuance of the telegraph surveys this part of Alaska was seldom visited by white men, except at points touched by whalers. In 1848 the American whaler *Superior* passed through Bering Strait, and every year since this example has been followed by many others. Port Clarence has long been used as a rendezvous for the whaling fleet, as well as a whaling station. Traders also annually visited the peninsula, but for many years no trading post nearer than Unalaklik was established.

There had long been rumors of valuable silver deposits on Seward Peninsula, when in 1881 a party, under the leadership of John C. Green, ascended Fish River and located a galena claim on its headwaters. Subsequent development of this property was one of the first attempts at mining in Alaska.

During the Russian occupation of the territory no white settlement existed in the peninsula, not even a mission. St. Michael, the nearest trading post except Unalaklik, was established in 1835, and here a Russian-Greek church was founded, which has been maintained to the present time. In 1890 the American Missionary Association of the Congregational Church established a mission at Cape Prince of Wales. This has continued to be very successful. It was at this mission that Rev. Harrison R. Thornton, who had charge of the station, was murdered by some renegade Eskimos in 1894. The murderers were promptly captured and executed by the natives of their own village. This murder, together with an attempt to capture a schooner by a party of armed natives some years before, are among the few occasions when the Eskimo of this part of Alaska have shown any lawlessness in their relations with the whites. The few other cases where white men have been killed by natives seem, from the best evidence obtained, to come under the head of justifiable homicide.

Since the purchase of the territory many Government vessels have visited Bering Sea on various missions. The vessels of the Revenue-Cutter Service have for many years kept up a patrol of the Alaskan coast as far north as Point Barrow. The excellent service rendered by the officers of the revenue cutters embraces the punishment of lawlessness, among both whites and natives, the aiding of vessels in distress, the prevention of illicit traffic, and the transportation of destitute miners out of the country. In fact, up to the time of the recent Nome excitement, the execution of Territorial law in the peninsula

[1] Mr. W. H. Libby, a member of this party, claims to have at that time found colors of gold on Niukluk River, and hence must be regarded as the first discoverer of gold on Seward Peninsula.

was almost entirely in the hands of the officers of the Revenue-Cutter Service.

Within recent years missions have been established both at Port Clarence and at Golofnin Bay. At different times schools receiving more or less Government support have been connected with these missions.

Since 1890 energetic efforts have been made to introduce domesticated reindeer into this part of Alaska,[1] with the view of providing a sufficient and unfailing supply of food and clothing for the natives. Largely through the efforts of Dr. Sheldon Jackson, of the United States Bureau of Education, and with the support of the Revenue-Cutter Service, about 3,000 reindeer have been imported from Siberia and distributed along the coast. It is hoped that gradually the natives may be brought to learn the value and the need of caring for these animals.

In the winter of 1897–98 Lieut. D. H. Jarvis,[2] accompanied by Dr. Call, of the Revenue-Cuttter Service, and Mr. Lopp, of the Cape Prince of Wales Mission, made a trip from Port Clarence along the coast to relieve ice-bound whalers at Point Barrow. This first attempt at driving reindeer a long distance, thanks to the abilities of the leaders, was very successful. Lieutenant Bertholf, of the same expedition, crossed with dog teams from Norton Bay to Eschscholtz Bay by way of Buckland and Koyuk rivers.

The maps of the coast of Seward Peninsula that have been in use down to the present are based upon the explorations noted above. Beechey made a map of the coast from Point Rodney to Point Barrow that was published by the British admiralty as Chart No. 2172.[3] This map contained the corrections made by the vessels of the Franklin relief expeditions, and was published in 1853. The Russian Government published an elaborate series of charts of its American possessions under Tebenkof in 1852. In 1880 the United States Coast Survey cutter *Yukon* made hydrographic, magnetic, and astronomical explorations in Bering Strait and Kotzebue Sound. In more recent years the work of the United States Revenue Marine Service has resulted in many corrections being made to the charts. In 1898 the accurate mapping of the coast of the northern Bering Sea was begun by the

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[1] Education in Alaska; report of the Commissioner of Education for 1894-95, by Sheldon Jackson, Chapter XXXIII, p. 1455.

[2] Report of the cruise of the United States revenue cutter *Bear* and the overland expeditions, 1897–98, Washington, 1899.

[3] The origin of the name Nome has not been discovered. Perhaps it is from the Eskimo *Kinome* meaning *I don't know*. Relative to this word the following is an extract from a manuscript dictionary of Alaskan geographical names by Marcus Baker: "Nome: cape, on the northern shore of Norton Sound. Named *Tolstoi* (broad) by Tebenkof in 1833. Russian hydrographic chart 1455, published in 1852, calls it *Sredni* (middle), adding Tolstoi as a synonym. The name *Nome* first appears on British admiralty charts after the Franklin search expeditions, and was given by Kellett in 1849. Sir William Wharton, hydrographer to the British admiralty, writing in April, 1901, says: 'The name Cape Nome, which is off the entrance to Norton Bay, first appears on our charts from an original of Kellett's in 1849. I suppose the town gets its name from the same source, but what that is we have nothing to show.'"

United States Coast and Geodetic Survey, and the work was placed in charge of Capt. J. F. Pratt. Since then this survey has steadily progressed.

The finding, in 1866, of colors of gold on the Niukluk by Libby, of the Western Union Telegraph expedition, was the earliest recorded gold discovery on the peninsula. Gold was first found in commercial quantities in the spring of 1898 on Ophir Creek, a tributary of the Niukluk River. As this gold was rather fine the claims were not promising enough to create any great excitement. Nevertheless, in the fall of 1898 there were several hundred people in the Golofnin Bay and Fish River country, a part of the overflow of the great stream of gold seekers that started for the Klondike in 1897 and 1898.

The following account of the discovery on Anvil Creek is extracted from a previous report:[1]

Up to the time of the "Klondike rush" of 1897 and 1898 but little attention was paid to prospecting in Seward Peninsula, in spite of the fact that both gold and silver had been found in the Golofnin Bay region. According to Father F. Barnum, for many years missionary on the Lower Yukon, and one of the best informed men of the country, the presence of gold in the Nome region was reported by natives to Yukon prospectors some six or eight years ago. These seem to have placed but little confidence in the report, and did not consider it worthy of further investigation. In the fall of 1898 a considerable influx of disappointed "Klondikers" into the Golofnin Bay district took place, and the prospecting of Seward Peninsula may be said to have been inaugurated.

In July, 1898, a rumor is said to have reached the Swedish Mission at Golofnin Bay that gold had been found by a reindeer herder on the coast at Sinuk (Sinrock), about 30 miles northwest of Cape Nome. Soon after a party consisting of the missionary, N. C. Hultberg, J. J. Brinterston, and others set out for Sinrock in a small boat along the coast. Becoming storm bound on the way, they landed near the mouth of Snake River, at the present site of Nome. Here they are reported to have prospected some and found fine gold on the bars in the lower reaches of the river, which led them next day to cross over the tundra to the now famous Anvil Creek, a tributary of the Snake. Here, on July 26 or 27, they found some colors of coarse gold, but the majority of the party insisted on proceeding to Sinrock, their original destination. At Sinrock, however, they were not successful, and returned to Golofnin Bay. The colors of coarse gold which had been found on Anvil Creek during their storm-bound period were not forgotten, for they were considered a favorable prospect by Hultberg. Accordingly a small party of Swedes or Norwegians, consisting of Erik O. Lindblom, John Brinterson, and Jafet Linderberg, one of whom was in the employ of the Government reindeer service as herder, and another a whaler from the bark *Alaska*, returned to Anvil Creek about the middle of September (1898). Here they spent a couple of weeks, and on the 20th are reported to have discovered some coarse gold of unquestionable economic value. They made extensive locations on Anvil Creek, and also crossed over the low divide and staked claims on Glacier Creek and one of its tributaries, Snow Gulch, which during last season proved the richest gulch in the Nome region. Ground was also located on Rock and Dry creeks. After collecting some samples the party returned to Golofnin Bay with ground enough staked to make all of them millionaires, as the development of the property last season (1899) demonstrated.

[1] Preliminary report on the Cape Nome gold region, by F. C. Schrader and Alfred H. Brooks, U. S. Geological Survey, 1900, pp. 31 and 32.

Upon their return to Golofnin Bay another and larger party was soon formed, which hurried back to the Nome region, and as the news spread, notwithstanding the lateness of the season, a general stampede for the new El Dorado to secure locations set in from Golofnin Bay, the Fish River country, and St. Michael. A meeting was held on October 18 (1898), when the Cape Nome mining district was organized, which was to comprise an area 25 miles square, with Cape Nome at its southeastern corner. Dr. Kittleson is reported to have been elected recorder. The meeting also determined that the size of all locations should be 320 by 560 feet. Nearly every individual located, not only for himself, but also for his many friends, by power of attorney. These locations comprised not only mining claims on the different gulches, but also town lots near the present site of Nome. The lowest number of locations said to have been made by any one person was 4, and the highest 30. To such an extent was the power of attorney here abused that more than 7,000 acres of ground were located, so that the several thousand Americans who arrived later, finding no unstaked ground anywhere in the vicinity, justly raised a somewhat bitter complaint. * * *

Up to the middle of the summer of 1899 the attention of the prospectors was entirely confined to the creeks and gulches, but late in July the first discoveries of gold beach were reported almost simultaneously by a soldier from the United States army barracks, who is said to have found gold while digging a well, and by some prospectors of Nome.

One of the first reported to engage in beach diggings was an old prospector from Idaho, by the name of John Hummel, who, it is said, was afflicted with scurvy, and therefore could not reach the gulches. Hummel prospected the beach, and finding that it yielded a fair return, went to work with a rocker and took out $1,200 in twenty days of work.

As soon as the news of these rich finds became disseminated, a perfect frenzy for digging in the beach seized the people of Nome. The commandant of the United States army post enforced a regulation[1] that no claims could be staked within a strip of ground running along the beach 60 feet in width, measured from high-tide limit. Within this reserved area all had an equal right to dig and wash the gravels. The good feeling and good fellowship which generally prevailed in this isolated community is attested by the fact that, in spite of the crowded condition of this public strip, few, if any, serious disputes occurred between the miners. This is rather remarkable, considering the fact that men are often within a few feet of one another on the same pay streak. This may have been in part because of the popular fallacy that the beach furnished an inexhaustible supply of gold, and that the deposits were being constantly renewed by the action of the surf.

During the height of the excitement upward of 1,000 men were at work on the beach; by some the estimate is even put as high as 2,000. Every man at Nome, be he physician or carpenter, lawyer or barkeeper, dropped his usual vocation and went to work with a shovel and rocker. Men who had been employed in the gulches at good wages flocked to the beach and went to work for themselves. This undoubtedly retarded the development of the gulch diggings very much, for it was difficult to get miners, even when the wages went up to $11 a day. The beach placers proved a veritable "poor man's proposition." No capital for development was required, anyone owning a shovel and a rocker having an equal chance with the rest.

The larger part of this crowd of men were at work near the town, but the beach diggings extend for 12 or 15 miles to the west of Nome. In the fall, when this army of miners had stopped work because of the frost, an almost continuous rampart extended along the beach near Nome, which had been formed by the newly dug gravel, and gave the shore the appearance of having been fortified to repel an invasion.

[1] See circular from the General Land Office, issued June 8, 1898, p. 18, section 41, on "A roadway 60 feet in width parallel to shore line."

GENERAL GEOLOGY.[1]

INTRODUCTION.

Description of geological map.—The distribution of the various formations and of the different types of igneous rocks is shown on the geological reconnaissance map, Pl. III. For the sake of emphasizing the general structural features, some parts of the map colored include areas concerning which we have but very meager information. Thus the formation which makes up the Kigluaik and Bendeleben mountains has been extended, on topographic evidence alone, both to the east and to the west of the area actually visited by members of the party. The belt of Pleistocene deposits which extends along the coast between Point Rodney and Port Clarence, as well as those of Sinuk River Valley, are mapped purely on the evidence offered by Mr. Barnard's topographic map. The distribution of the Nome series north of Kuzitrin River and Imuruk Basin is represented largely by such facts as could be gleaned from prospectors' reports and from the evidence offered by stream gravels. The correlation of the rocks of the York region with those to the east is based on lithological similarity and similarity of stratigraphical succession.

Stratigraphical succession of sedimentary formation.—The hard rocks of the region which have a sedimentary origin have been grouped into three formations, named, in ascending order, the Kigluaik series, Kuzitrin series, and Nome series.

Igneous rocks.—Two groups of igneous rocks have been differentiated. The basic, which are here termed greenstones, are usually schistose and have a wide distribution, both in stock and as sills and dikes. The acid igneous rocks, which are classed as granitic, are chiefly massive, and occur for the most part intruded in the Kigluaik series. The area mapped as "chloritic schists" is occupied by green schistose rocks whose affinities could not be determined in the brief time which was given to their field study.

BED-ROCK GEOLOGY.

SEDIMENTARIES.

Kigluaik series.—The oldest rocks of the peninsula are some highly crystalline limestones and schists which were first found in the heart of the Kigluaik Mountains and later identified at other localities. The limestone of this series is usually massive, quite pure, and always highly crystalline, generally white in color, but sometimes bluish. Interbedded with it are found layers of gray mica-schist, consisting chiefly of mica and quartz, which are probably also of clastic origin.

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[1] A more detailed account of the local geology will be found in the descriptions of the placer deposits.

Granites, both massive and gneissoid, occur abundantly in this series. So intimate is the association that it has been found impossible to differentiate the igneous and the sedimentary rocks on the small-scale map, and the presence of the intrusives is indicated in diagrammatic manner. At the head of Ophir Creek and near the western flank of the Kigluaik Mountains some amphibole-schists, whose origin is obscure, occur with the rocks of the Kigluaik series.

Mr. Collier found these rocks exposed as an anticlinal fold in a section which he studied from the Upper Kruzgamepa across the Kigluaik Range. We have reason to believe that the same series extends toward the west and with the associated igneous rocks forms the mass of the Kigluaik Mountains. Our studies would also lead us to believe that the rocks of the Bendeleben Mountains belong to the same series.

Between Cape Mountain and Baituk Creek, in the York region, there is a belt of crystalline and semicrystalline limestone which is often beautifully banded and occasionally contains intercalated beds of mica-schist. This limestone is the oldest rock in the York region and its relation to the granite is similar to that of the limestone found in the Kigluaik Mountains. It is therefore tentatively correlated with the Kigluaik series.

Kuzitrin series.—Succeeding the Kigluaik series is a mass of schistose rocks, characterized by a large percentage of graphite and being, as a rule, very arenaceous. These rocks form a well-defined stratigraphic unit, and have been named the Kuzitrin series. While the relation of these rocks to the underlying Kigluaik series was not definitely established, the evidence indicates that it is one of conformity.

The type rock of this series is a well-jointed graphitic quartz-schist, but there are many variations from this type. Intercalated strata of graphitic slates are not uncommon, and the schists are sometimes very calcareous, approaching an impure limestone in composition. The calcareous phases are more particularly characteristic of the top of the series. Locally the Kuzitrin rocks contain beds of mica and chloritic schist whose sedimentary origin it is not always possible to prove. In many localities amphibole-schists and chloritic schists are abundant in the Kuzitrin series. These are usually intruded parallel to the bedding plane and are often difficult to differentiate from the sediment; they will be discussed below in more detail. On Kuzitrin River some pegmatite dikes were found cutting the graphitic schists.

Though these rocks are usually well bedded, in some localities the bedding planes are nearly obliterated by a secondary development of schistosity and jointing. In attempting to obtain a measure of their thickness several difficulties were encountered. The intercalated beds of graphitic argillites are often intensely crumpled and

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folded, and the inclusion of such crumpled beds in a section must necessarily introduce a large element of error. In other localities, again, the large intrusion of greenstones gives rise to another source of error. Moreover, the base of this series is not well defined, as it was not found in contact with the underlying limestone except in the York region. In view of the above facts it is clear that an estimate of thickness can be regarded only as a very rough approximation. The several sections studied would go to show that the Kuzitrin beds are between 2,000 and 3,000 feet thick.

The Kuzitrin series is typically exposed in the Kigluaik Mountains, near their northern limit, where it occurs in a belt which runs parallel to the axis of the range and is cut by the northerly tributaries of Kruzgamepa River. The rocks strike about east and west, and dip with great regularity to the south. These rocks are again found on the upper portion of Ophir Creek, where they strike a little north of east and dip to the south, and their topographic relation to the Bendeleben Mountains is similar to that which the western belt bears to the Kigluaik Mountains. The series takes its name from Kuzitrin River, along whose lower course it is well exposed. Here the rocks in the fresh cuttings of the river channel show well-marked bedding planes. The series as mapped in this part of the area includes some calcareous schists which may possibly belong to the overlying Nome series.

In the York region some graphitic arenaceous schists are provisionally classed with the Kuzitrin series. These York rocks are somewhat more argillaceous than those farther east, but in general are lithologically similar. With them occur some beds of impure limestones. The bedding planes of rocks classed as Kuzitrin in the York region are very obscure, as they are much jointed and fractured.

Nome series.—Much the greater part of the area represented on the accompanying map is occupied by the Nome series, made up of limestones, graphitic mica, and calcareous schists, with many greenstone intrusives and some chloritic schists, whose origin has not been determined. Mr. Richardson's investigations in the Koksuktapaga and Solomon River basins show that with more detailed work this series can be subdivided into a number of different formations, but with the limited observations made it was not found possible to extend these subdivisions into adjacent areas. This series can hardly be considered a stratigraphical unit, as the lithological constitution of its beds is rather heterogeneous. Broadly speaking, however, the rocks of the Nome series are calcareous.

The stratigraphical relation of the Nome and Kuzitrin series was not definitely established. In the Upper Kruzgamepa Valley the evidence indicates that the relation is one of unconformity, but elsewhere no such evidence was found.

In the Upper Kruzgamepa region and in the Ophir Creek Basin the basal member of the Nome series is a flaggy limestone or calcareous schist, probably less than a thousand feet in thickness. In the Solomon River Valley Mr. Richardson found graphitic quartz-schist as the lowest exposed member of the schistose series. This may be a local phase of the calcareous schists, or an upper member of the Kuzitrin series. As Mr. Richardson is inclined to the former view, these graphitic quartz-schists have been mapped as a part of the Nome series.

The flaggy limestones and calcareous schists are succeeded by some beds of graphitic limestones and phyllites, probably but a few hundred feet in thickness. Above these graphitic beds are found some heavily bedded limestones, aggregating 1,000 or 2,000 feet in thickness. Above these limestones the series retains its calcareous character, but is more schistose and includes mica-schist and often graphitic slates. As has been stated, our work was not done in sufficient detail to map these various formations, so they have been grouped together in one series; nor have we always been able to determine to what part of the series any given beds belong.

Green schists are common in the rocks of the Nome series. In most of these the color is due to the presence of chlorite. In many cases these are plainly altered igneous intrusives, while in other localities they are of sedimentary origin. The major part is believed to belong to the former class, as will be shown in the discussion below.

The Nome series is most typically developed in the region lying to the south of Kigluaik Mountain and of the Bendeleben Mountains. In the Port Clarence region rocks of similar lithologic character, and probably identical in age, were studied and have been mapped as part of the same series. These rocks are probably coextensive with those of the Kugruk region to the northeast. In the Kugruk Basin the area underlain by these rocks afforded very few outcrops, and our determinations are based almost entirely on the stream gravels.

In the York region a limestone and a greenstone series occur above the Kuzitrin rocks, and a provisional correlation would place them with the Nome series, though they are much less metamorphosed. North of Port Clarence is a series of thin-bedded, earthy limestones, which have yielded some fossils. The general stratigraphical position of these beds would make it seem probable that they belong with the Nome series; they are, however, much less altered. It will be shown that the metamorphism of this series is local rather than regional and that it furnishes no clue to the relative ages of different horizons.

A few fossils were obtained from beach gravels in the vicinity of the Teller Mission at Port Clarence. While no fossils were found in the bed rock itself, there can be no doubt that the pebbles from which they were obtained had their source in the limestone hills just north of the mission. The fossils were submitted to Dr. George H. Girty, and the following is quoted from his letter referring to them:

The material is very fragmentary, rendering exact determinations impracticable. I find fragments of trilobites in considerable abundance, besides which, several imperfect brachiopods occur. The trilobites are of a primitive type and it is thought that the genera *Asaphus* and *Barrandia* have representatives among them. The brachiopod species appears to be one of the early Orthoid types related to *Orthis hamburgensis*.

After a consultation with Mr. Walcott the conclusion has been reached that the geological age indicated by the fauna is Lower Ordovician, and that it suggests an affinity with that of the Pogonip group of Nevada.

This evidence shows that there are some older Paleozoic rocks included in the Nome series. At White Mountain, on Fish River, Mr. Mendenhall found some obscure fossils in the white limestones, which Dr. T. W. Stanton regards as Mesozoic or Tertiary, certainly not Paleozoic. Mr. Mendenhall, in his report, advances arguments, which will not be repeated here, that make it exceedingly improbable that this limestone is of Tertiary age. We can, therefore, tentatively regard it as Mesozoic. The limestone in which Mr. Mendenhall found these fossils is identical, in its degree of metamorphism and lithological character, with some of the beds of the Nome series. If this correlation be correct, the Nome series includes both Ordovician and Mesozoic beds. It is very unfortunate that there is not sufficient evidence available to enable us to differentiate this series, which embraces beds so far apart in the geological column.

Very few facts were obtainable bearing on the thickness of the Nome series. At one locality a rough estimate made by the writer showed a minimum thickness of 5,000 to 6,000 feet. Mr. Richardson's determinations would more than double this estimate.

Chloritic schists.—This is a series of green schistose rocks, which occur in the drainage basins of Flambeau and Bonanza rivers. They are essentially quartz-muscovite chloritic rocks which are characterized by a light-green color and by being finely laminated. Some thin sections which were examined by Mr. Richardson showed secondary feldspar and calcite. Mr. Richardson, who studied the field occurrence, was not able to satisfy himself as to whether they were of igneous or sedimentary origin. Nor did the microscopical study furnish definite proof. If these rocks are sedimentary, they overlie the Nome series. It has been thought advisable, therefore, to give these schists a separate color. Some other areas of this rock were found in the region, but they are too small to be represented on the geological map (Pl. III).

IGNEOUS ROCKS.

Greenstones and greenstone-schists.—The most widely distributed rocks of the region form a group having the common characteristic of being green in color and of igneous origin; they are, as a rule, schistose, though in some localities massive phases are found. They are usually composed very largely of secondary minerals which seem to be the product of dynamic as well as metasomatic metamorphism. Being generally deeply weathered, they present many difficulties for petrographical study. With the comparatively small amount of material at hand, and the limited time for microscopic work, it has not been found feasible to differentiate these various basic rock types.

The greenstones are commonly so much altered that their original characteristics are entirely destroyed. At several localities, however, rocks which were plainly diabases were found. This diabase is of a dark-green color and has an aphanitic texture in the hand specimen. In thin sections the ophitic structure was discernible, though often nearly destroyed by subsequent deformation. The feldspar, as far as determined, is a labradorite which occurs in tabular crystals. The pyroxene has been largely replaced by actinolite and chlorite; magnetite and ilmenite are common accessories, the latter frequently altered to leucoxene. As alteration phases of the diabase we have innumerable varieties of green schistose rock. The commonest secondary mineral is chlorite; quartz is often abundantly developed; calcite, zoisite, and epidote are very common. In some localities garnet has been abundantly developed, sometimes associated with biotite and muscovite. In the extreme phases of metamorphism these rocks are difficult to distinguish from the altered sediments. It is only by tracing the gradual transitions from the massive to the very schistose rocks in the field that the igneous and sedimentary schists can be differentiated. As it is not always possible to make this determination, errors are liable to be introduced in the mapping.

While by far the predominating rock type of the greenstone belongs to the diabase group or to rocks closely affiliated, yet in some localities the greenstone-schists seem to have been derived from more coarsely crystalline rocks which probably belonged to the dioritic group. These rocks are characterized by somewhat greater acidity; in their metamorphic phases quartz is far more abundant than in the series derived from the diabases. The metamorphic minerals are, however, about the same, with a greater predominance of quartz. In these types ilmenite and magnetite are not so common, nor are zoisite and epidote the characteristic minerals. The schists more commonly consist largely of quartz and chlorite.

In course of examination of the thin sections, a few were found which seemed to have been derived from more basic rocks. While the microscopic study did not reveal any positive evidence of the presence of effusive rocks among the greenstones, it is not improbable that a more careful study will do so. In a few instances the thin sections showed what seemed to be detrital material and are probably of tuffaceous origin. The field relations also suggest that some of the greenstones are of pyroclastic origin. They are frequently found interbedded in thin layers with calcareous schists and limestones, with contact relations which could have been brought about only by sedimentation.

These greenstones are widely distributed throughout the region under discussion. They are especially abundant in the Nome series, but are found cutting both the Kuzitrin and the Kigluaik rocks. Those that are regarded as effusive were found only in the Nome series. In all three of the sedimentary series they occur as sills and occasionally as dikes. On the accompanying map some large areas of greenstones of irregular outline are represented, which the field relations to the surrounding sediments show to be intrusive. These stocks are in some cases schistose throughout, and in others have a massive central core which seems to grade off into a schist peripherally.

A third phase of basic intrusives are dikes which cut the granitic rocks. As will be shown below, the granites are younger than most of the greenstones. Exceptions to this are found in some diabase which is found cutting the granite. These later intrusives may represent the same epoch of igneous activity which manifests itself by the basaltic lavas which Mr. Mendenhall[1] found in the eastern part of the region and which have been reported from the north arctic coast of Seward Peninsula.

Granitic rocks.—A reference to the map will show that granitic rocks occur at a number of localities. In the Kigluaik Mountains occurs a large granite mass which in places has gneissoid phases. The massive rock is normally a biotite-muscovite-granite of coarsely crystalline texture. In its gneissoid phase it has a similar mineralogical composition, but the minerals have a marked parallel structure. This structure is evidently original, as the microscopic examinations show little if any evidence of dynamic movement. The quartz and feldspar individuals are elongated without being crushed, and the biotite plates are not deformed. Another type is a white muscovite-granite with pegmatite phases, which was found in the Kigluaik Mountains and also on Kuzitrin River, cutting the Kuzitrin series. This is found cutting the other granite and is probably the latest intrusive in the region. These granites form a network of intricate intrusions in the Kigluaik series. On the accompanying map their intricate relation is shown diagrammatically, as the intrusions were not mapped in detail. In the Bendeleben group, as far as our limited observations would permit us to determine, a similar relation of the sediments and granites exists. Mr. Mendenhall determined that in the Darby Mountains there is also a large intrusion of granite. All of these intrusive masses often show porphyritic phases near their peripheries. On the north

[1] Compare Mr. Mendenhall's paper in this report.

shore of Golofnin Bay we found large masses of a coarse[1] porphyritic diorite which seems to belong with the granitic intrusions, together with some pegmatite.

Cape Mountain, at Cape Prince of Wales, is formed by a stock of granite intruded into the white crystalline limestone which has been described. This rock is coarsely crystalline, usually porphyritic, and consists essentially of quartz, microcline, and biotite. As in the Kigluaik Mountains, it seems to have had considerable metamorphic effect on the adjacent limestones. Mr. W. T. Lopp informed the writer that Fairway Rock is composed of granite, and a similar rock has been reported from the Diomede Islands and from the adjacent portions of the Siberian coast.[2] Large granite masses are also said to occur on St. Lawrence Island,[3] associated with slates and effusive rock.

In the bold bluff which faces the sea at Cape Nome Mr. Richardson found rocks of a granitic character. The dominant type is a coarse augen-gneiss, in which lenticular pink feldspar individuals are contained in a greenish matrix consisting largely of quartz, chlorite, and biotite. Under the microscope the feldspar shows the double twinning of microcline. The rock itself in thin sections shows evidence of having suffered intense dynamic metamorphism. As far as our studies go, this occurrence is unique in the region.

STRUCTURAL GEOLOGY.

Relation of topography to geological structure.—It will be shown below that the range formed by the Kigluaik, Bendeleben, and Darby mountains is a topographic expression of the dominant structure of the region. The significance of the York Mountains, relative to the geology, is not known, as their structure has not been studied. The isolated mountains and hills which rise above the general upland are in many instances found to be due to differential erosion, being formed of harder masses surrounded by softer rock material, which erodes more rapidly. The broad valley lowlands are probably also due, in part at least, to differential erosion. In the northern and southern highland belts the structure is not pronounced enough to find expression in the topography to any marked degree, and the low, rounded hills and ridges—usually moss covered, with only an occasional outcrop—afford but little insight into the dynamic history of the region.

Metamorphism of sediments.—It has been shown that the oldest sediments, called the Kigluaik series, are limestones which are inter-

[1] See Mr. Mendenhall's report.

[2] Coal and lignite of Alaska, by Wm. H. Dall: Seventeenth Ann. Rept. U. S. Geol. Survey, Pt. I, p. 835.

[3] Op. cit., p. 849; also Coasts of Bering Sea and vicinity, by G. M. Dawson: Bull. Geol. Soc. America, Vol. V, 1893, p. 138.

bedded with crystalline schists and in which large masses of granite have been intruded. The beds of this series are closely folded and much metamorphosed. What evidence we have points toward the conclusion that their metamorphism was largely caused by the intrusion of these igneous bodies and is largely of a contact character. These granites often have gneissoid facies, and the microscopic study shows that these are original structures.

The succeeding series, named the Kuzitrin, consists largely of quartz-graphite-schist, with some graphitic argillites and some greenstone-schists. The rocks are metamorphosed, but relatively less so than the Kigluaik series. The quartz-schists have become indurated, and the carbonaceous matter is usually, though not always, changed to graphite.

Above the Kuzitrin are the rocks of the Nome series. These are prevailingly limestones and other calcareous rocks, with some phyllites and mica-schists, and include a great deal of igneous material. They show one striking difference from the two underlying series, and that is in the character of the metamorphism. The metamorphism of the Kigluaik and Kuzitrin beds is rather uniform. In the two older series beds having a similar physical character show about the same amount of alteration. The factors which brought about this metamorphism acted with some degree of uniformity over considerable areas, including all the exposures of the two series found in the region. The disturbances that produced the alterations of the beds of the Nome series are of a more local character. While the rocks of this series, as a whole, are considerably altered and would nearly all be classed as metamorphic, yet there is great variation in their degree of metamorphism. In the Nome series are to be found limestones which show little or no recrystallization, while others again are entirely recrystallized. In the argillites of this series are found, in some localities, phyllites which are only slightly altered slates, while in other localities the argillites have been altered to highly crystalline mica-schists. The carbonaceous matter in these rocks is unaltered in some places, while in others it is changed to graphite. These examples might be multiplied, but sufficient has been said to show that while the rocks of the Nome series must be classed as metamorphic, the relative amount of metamorphism varies greatly in different localities.

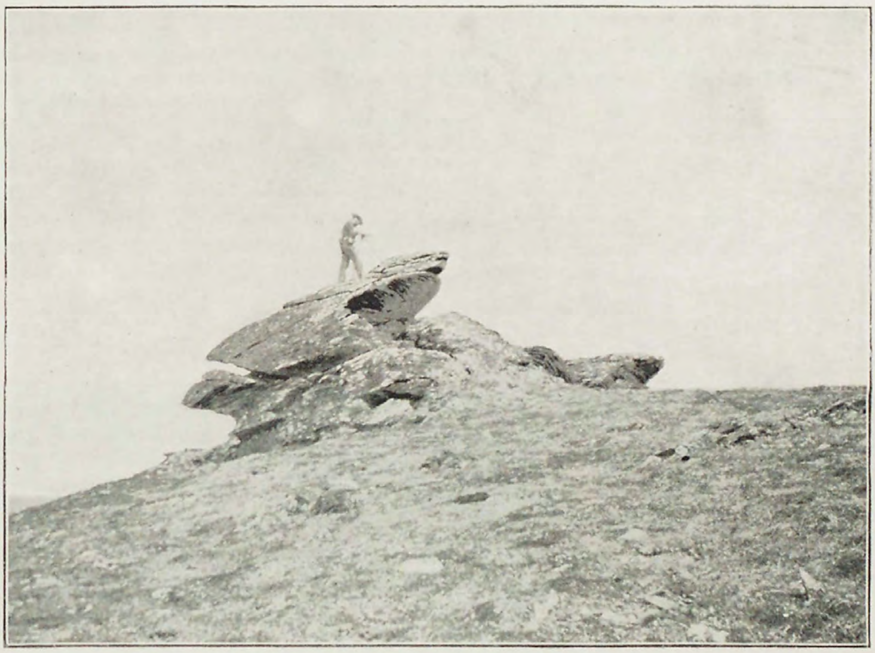
Metamorphism of igneous rocks.—The wide distribution of the basic intrusives has been described. They are typically highly schistose and often entirely recrystallized. But in some localities, where they occur in considerable masses, they are much less altered and are comparatively massive. These massive phases are, however, always jointed. The parallel structure of the granitic intrusives found in the Kigluaik is probably an original structure of crystallization. The granites, as a whole, show very little schistose structure, but are cleaved by well-marked systems of jointing. An exception to this is the granite at Cape Nome, which has suffered considerable deformation.

Foliation and bedding.—The foliation of the schistose rocks of the region is usually found to be parallel to the bedding planes wherever the latter are determinable. In the following discussion of the structural features no distinction will be made between the planes of bedding and the planes of foliation, as they are usually parallel, and their present attitudes seem to be the result of the same deformation. Except in the vicinity of the mountain range which has been described, the strikes are extremely variable. The dips are usually low, the rocks often being horizontal (see Pl. IV, *B*). Locally, steep dips are found.

Structural types.—An examination of the geological map and section (Pl. III) will show that our interpretation of the structure of the Kigluaik and Bendeleben mountains is that they consist of two elongated domes, the extension of whose axes would not coincide, but would be parallel. At the eastern end of the Kigluaik dome the rocks bend to the north and thus bring out the character of the structure. The strata which form the main mass of the mountains, and also those which flank them, dip away from the central core.

In the regions lying north and south of these mountains there are no strongly marked structural features. The strikes and dips, when platted on a map, at first sight offer only a bewildering mass of incongruities, and the first impression gained is that the structure is very complex. A more careful examination of parts of this region where more detailed work was done showed that in many instances the strikes and dips roughly grouped themselves into a series of low domes. These domes are of very irregular outline, and vary in diameter from one-fourth of a mile to 8 or 10 miles. They are sometimes almost circular in outline, but more often quite irregular. Occasionally two domes merge with each other, giving a confusion of structural lines. The strikes mark the outline of the domes, and the dips are in general away from the center. The dips are usually low—from 5° to 30°—but occasionally steep, and in at least one locality a reversal of the dip toward the center of the dome was observed, which was interpreted as an overturn. At other localities evidence was obtained which showed that faulting had taken place along the peripheries of these structural lines.

Relation of foliation to dome structure.—The foliation of the schistose rocks has usually a relation to the dome structure similar to that which the true bedding bears. On the top of the dome the plane of foliation is usually horizontal or nearly so, and at the sides it dips away from the center. Where schistose layers occur between two massive beds along the periphery of the dome the foliation planes are often very irregular.



A. OUTCROP OF MICA-SCHIST NEAR GOLOFNIN BAY.

B. HORIZONTALLY FOLIATED MICA-SCHIST NEAR GOLOFNIN BAY.

Relation of intrusive rocks to dome structure.—At a number of localities certain facts which were observed suggested a causal relation between the intrusive stocks and the dome structure. At three localities there was observed a mass of greenstone surrounded by lines of foliation which dipped away from the central core. In two instances this central stock of greenstone was massive, except for jointing, and was surrounded by a zone of schistose greenstone, and this in turn by sedimentary beds, all, as far as determined, striking parallel to the periphery of the dome and dipping away from the center. In other localities a similar relation obtained, but the entire mass of greenstone was schistose, the massive core being absent. These facts suggest that there is a causal relation between the greenstone stocks and the dome structure and that the latter may have been caused by the intrusion of igneous rocks. In some cases these intrusive cores have been laid bare by erosion; in others they are manifested only by the structure of the overlying sediments. The foliation of the sediments could have been brought about by the upward pressure produced by the intrusions. This foliation, being parallel to the surface of the stocks, would be horizontal above it and tilted at the sides, thus giving the phases which have been described in the region. The difficulty of this theory is that the intrusive rocks themselves are often foliated. This can be explained only by believing that these intrusive stocks were loci of subsequent movement which produced an upward pressure and so rendered the stocks themselves schistose parallel to the periphery of the dome. This interpretation necessitates the belief that the rocks were deeply buried at the time of the intrusion of the stocks, for if the schistosity was brought about by an upward pressure, there must have been a resisting force against which this pressure acted.

Such an interpretation of the structure might also account for the fact that in the Nome series, where the massive dome structure is dominant, the metamorphism is local rather than regional. Little or no evidence of contact metamorphism was observed, yet, as has been shown, the rocks of the Nome series have not everywhere been subjected to the same degree of metamorphism. The variation in amount of alteration is vertical rather than horizontal, for some of the lowest beds in any locality are locally less metamorphosed than some of the upper beds in other localities. This shows that the factors which produced the metamorphism have not acted with equal intensity over the whole region, and we are forced to look for some local cause. The evidence does not show that the metamorphism was caused by metasomatic changes produced by the intrusion of igneous masses, and we are therefore forced to the conclusion that it was due to dynamic metamorphism of a local character. Hence, the theory of dome structure, which, because of the limited time spent in the field, was substantiated only by evidence in certain localities, receives further support from these facts relating to the metamorphism of the rocks of the Nome series.

Relation of quartz veins and mineralized zones to structure.—Mention has been made elsewhere of the occurrence of quartz veins and stringers in the rocks of the region. As far as our observations go, they are not found to any great extent in the Kigluaik series or in the granites associated with this series. In the Nome and in the Kuzitrin series they are often abundant, as will be shown in the detailed descriptions of the various placer fields. They occur chiefly in the rocks which have suffered the greatest deformation and have thereby been rendered schistose. As the deformation has a dome character, it would be expected that the greatest shearing would take place along the margins of these domes, and that there would be loci of a maximum development of quartz veining. The facts known are not sufficient to determine definitely that such is the case, but they point strongly to such a conclusion. A number of the gold districts are, in fact, situated along the margins of these uplifts, and it seems quite probable that more detailed study will show similar structures of the bed rock of other gold districts.

At a number of widely separated localities it was found that when beds composed of less resistant material—for example, layers of phyllite—had a position between more massive beds, the former would be much sheared and would contain many quartz veins. When deformation took place the planes of movement followed these less resistant beds and in consequence they were much fractured and sheared.

As the facts that were obtained by the last season's work are not sufficient definitely to prove this theory of the relation of the structure and the quartz veins, it is here advanced only tentatively. The occurrence of the quartz veins and mineralized zones is of the greatest importance in its bearing on the occurrence of the placer gold. As will be shown elsewhere, the gold has its source in mineralized quartz veins, stringers, and zones. If it were definitely established that this mineralizing took place along the margins of the domes, it would be a great aid to the prospector and miner. It is therefore with some hesitancy that the writer advances this theory before actual proof can be established. Should it prove to be correct, we might expect new gold districts to be discovered, as a recurrence of these conditions might be looked for at any point within the gold-bearing series. This mode of occurrence is at variance with the popular conception that the gold belts of Seward Peninsula run in continuous zones which extend in a northeast-southwest direction. As will be shown elsewhere, the distribution of the gold districts of Seward Peninsula suggests localized conditions for the origin of the gold rather than zonal belts.

Summary of dynamic history.—The oldest period of deformation in the region which has thus far been established left its record in the low dome structures which have been described as occurring in the Nome series. It has been shown that there is some evidence of an unconformity between the Nome and Kuzitrin series, and therefore the older rocks may have been subjected to disturbances before the Nome series was deposited. Of this, however, we have no definite proof, and must regard the intrusion of the greenstones and the consequent deformation as the earliest manifestation of the activity of the dynamic forces. Later, as has been shown, deformation took place, which it is believed was brought about by forces acting in a vertical direction. These rendered the greenstones schistose.

At a still later period the uplifts occurred, also of a dome-like character, which find topographic expression in the Kigluaik, Bendeleben, and probably the Darby Mountains. These later disturbances were accompanied by large intrusions of granite, which now form a great part of the core of the mountain masses. The granite masses are not, however, so far as exposed, batholithic in character; or, if they are, erosion has not yet reached the batholithic mass, but has exposed only its upper surface where it occurs as a complex series of intrusions with the sediments. The granitic intrusions took place along a cross section measuring 10 to 15 miles, and a very large mass of igneous rock was injected in the sediments. Such an increase of bulk was compensated for by an upward movement of the strata, and the sediments on all sides of the mass dip away from it. It is probable, also, that the strata some distance from the mountains were affected by this uplift. In point of fact, some lines of jointing were observed throughout the region which are later than the foliation associated with the first period of deformation.

There is some evidence of still later dynamic action, for the granites themselves often show lines of jointing (see Pl. V, *B*). This later period of disturbance was followed in some parts of the region by the injection of pegmatitic dikes. In the adjacent regions there was a still later epoch of dynamic activity evidenced by outpourings of lava.[1]

AGE AND CORRELATION OF SERIES.

During the progress of the field work a careful search was made for paleontological evidence, but this met with little success. North of Port Clarence some Ordovician fossils were found, as has been shown, in some earthy limestones, which are believed to be part of the Nome series.

While the precise identity of these fossil-bearing beds with the Nome series is not established, yet it seems the most rational conclu-

[1] See Mr. Mendenhall's report.

sion from the facts in hand. Such being the case, a part of the Nome series would be grouped with the Lower Ordovician, for this bed of earthy limestone is believed to be very near the base of the Nome series. The Kigluaik and Kuzitrin series, the upper one of which may be separated from the Nome rocks by an unconformity, may be Cambrian or pre-Cambrian.

Reference has been made to Mr. Mendenhall's discoveries of what are probably Mesozoic fossils on Fish River, in beds which probably belong to the Nome series. The Nome series, therefore, probably embraces both Ordovician and Mesozoic rocks.

By this fragmentary evidence we are led to the conclusion that we have adhered to, that the series of rocks range in age probably from Cambrian, if not pre-Cambrian, up to Mesozoic. As the Mesozoic rocks are also crystalline, we must conclude that a part of the metamorphism took place in Mesozoic time. Mr. Mendenhall, in his very hasty reconnaissance of the eastern part of the peninsula, was not able to differentiate his metamorphosed sediments into different series. What he has mapped as metamorphosed sediments probably embrace all the rocks of the metamorphic series which have here been given distinctive names.

We have neither stratigraphical continuity nor paleontological evidence to correlate these metamorphic horizons with the rocks of the Yukon Basin. There is, however, certain lithological similarity between this series and some rocks on Koyukuk River, described by Schrader,[1] which, to say the least, is suggestive. These he was inclined, also on lithological evidence, to correlate with the rocks described by Spurr[2] in the Fortymile region. Spurr found, in the Upper Yukon Basin, some evidence that these older semimetamorphic rocks were of pre-Silurian age, and established the fact that they were separated from the overlying Carboniferous by a well-marked unconformity.

Both[3] Upper Paleozoic and Mesozoic rocks are reported to occur near Cape Lisburne, about 200 miles north of Seward Peninsula, but these, as far as known, are entirely unmetamorphosed. On the Upper Kuskokwim, Spurr has also reported Carboniferous and Devonian strata. Kowak and Noatak rivers have never been geologically examined, but from the reports of prospectors and explorers it seems possible that the same series is found in these river basins. In this connection it is of interest to note that coarse gold was discovered on the headwaters of the Noatak in the summer of 1889, but on account of the inaccessibility of the region it was not in paying quantities.

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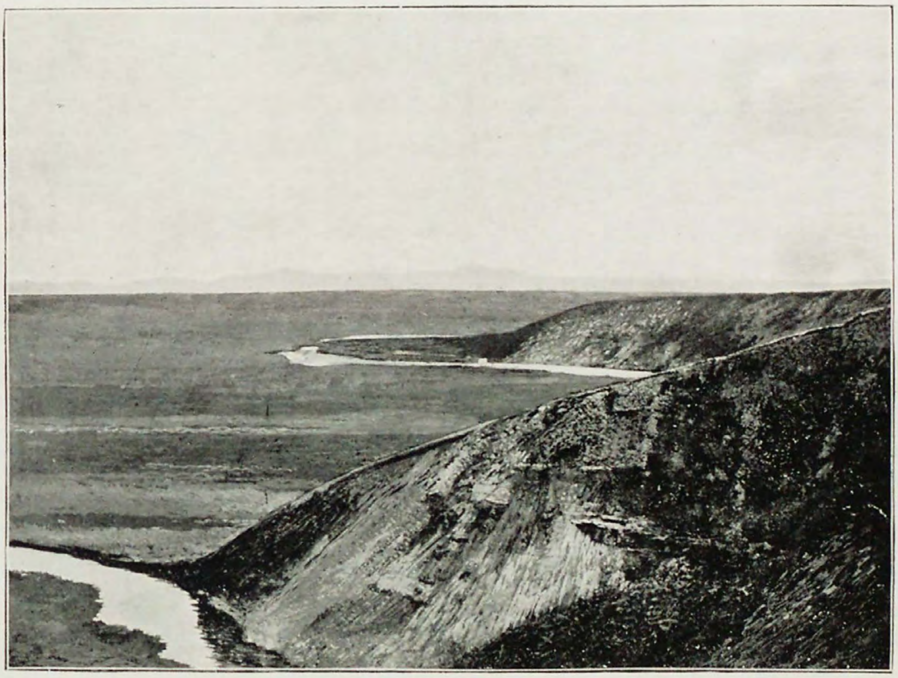
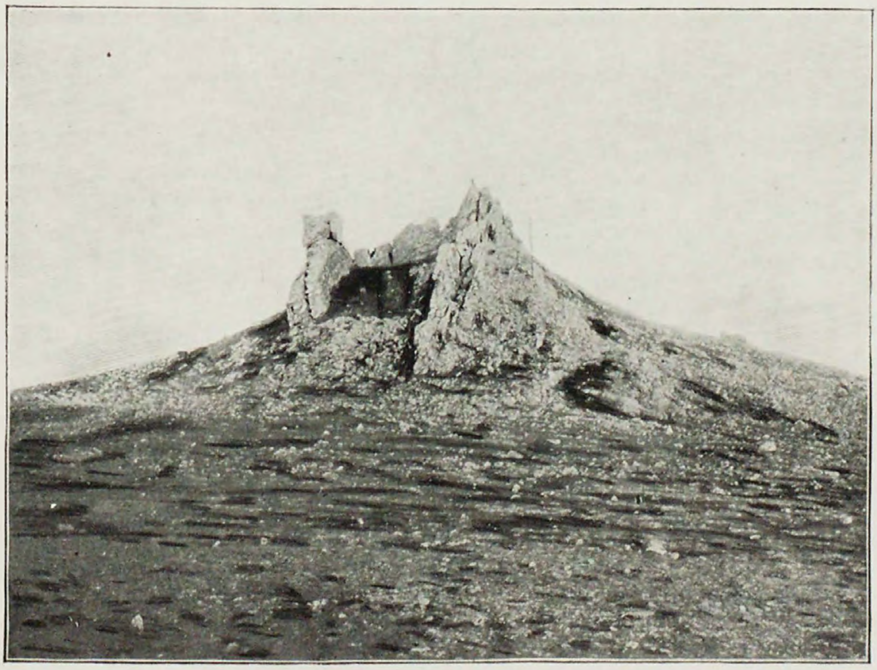
[1] A reconnaissance of the Chandlar and Koyukuk rivers, by F. C. Schrader: Twenty-first Ann. Rept. U. S. Geol. Survey, Pt. II.

[2] The Yukon gold fields, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol Survey, Pt. III.

[3] Coal and lignite of Alaska, by W. H. Dall: Seventeenth Ann. Rept. U. S. Geol. Survey, Pt. I, p. 819.



A. GRAVEL TERRACES AT MOUTH OF QUARTZ CREEK, KUGRUK RIVER.



B. FISSURED GRANITE NEAR MOUTH OF KRUZGAMEPA RIVER.

DIAGRAMMATIC SUMMARY OF BED-ROCK GEOLOGY.

1. Deposition of Kigluaik series.
2. Deposition of Kuzitrin series.
3. Dynamic disturbances (?).
4. Deposition of Nome series, extending from Ordovician to Mesozoic time.
5. Intrusions of greenstones.
6. Deformation by vertical thrust and intrusion of quartz veins.
7. Intrusion of granites. Slight deformation; development of jointing.
8. Intrusions of pegmatite dikes.
9. Extrusion of lavas.

SURFICIAL GEOLOGY.

GENERAL DESCRIPTION.

The most widely distributed strata in this province are the gravels, sands, and clays which make up the unconsolidated beds of the region. These embrace the present stream gravels and also the older beds which occur on high terrace deposits. On the map they are all grouped together as Pleistocene deposits. The proof of the Pleistocene age of the older surficial deposits is not definite, but such evidence as we have points toward that conclusion.

The nearest known Tertiary deposits lie along the eastern shore of Norton Sound, over 100 miles distant, where Dr. Dall[1] found late Tertiary beds. These are more or less indurated and somewhat deformed. In the eastern part of the peninsula Mr. Mendenhall found some beds which he regards as being probably Tertiary; they are cemented and somewhat deformed. The beds of the Tertiary era of this part of Alaska seem, therefore, to have suffered some changes since their deposition. The surficial deposits under consideration, however, have not been disturbed, and are as a rule entirely uncemented,[2] except by ice. The fact that these are practically entirely unaltered makes it extremely probable that they are of Pleistocene age. Furthermore, if these beds were older than the Pleistocene, it would be expected that they would have been more dissected, if not entirely removed by erosion. Fossil vertebrates have been found at a number of localities in the Nome region, but as they have not been found in place in the gravels their evidence is of little help in determining the age of the surficial deposits.

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[1] Compare map of known distribution of Neocene formations, in Bull. U. S. Geol. Survey No. 84.

[2] Some of the lowest beds of the high terrace deposits which have been reached by mining operations are an exception to this rule and show some cementing. There is a possibility that these cemented beds may be pre-Pleistocene, but of this there is no evidence. Compare description of the high bench placers, p. 148.

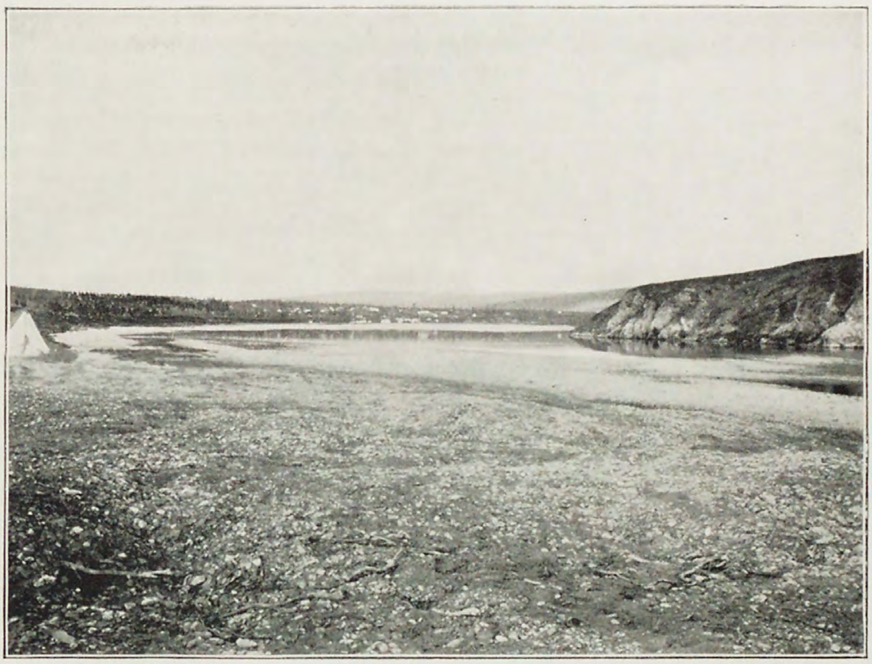
SUBDIVISIONS OF SURFICIAL DEPOSITS.

The Pleistocene may be divided into four groups. The first group includes the deposits of the present rivers, streams, and sea beaches. The second group includes marine and river terraces and the coastal plain sediments. The third group is made up of the glacial deposits, which are limited to a few of the higher mountain ranges. As a fourth group we have the ground ice and the residual soil.

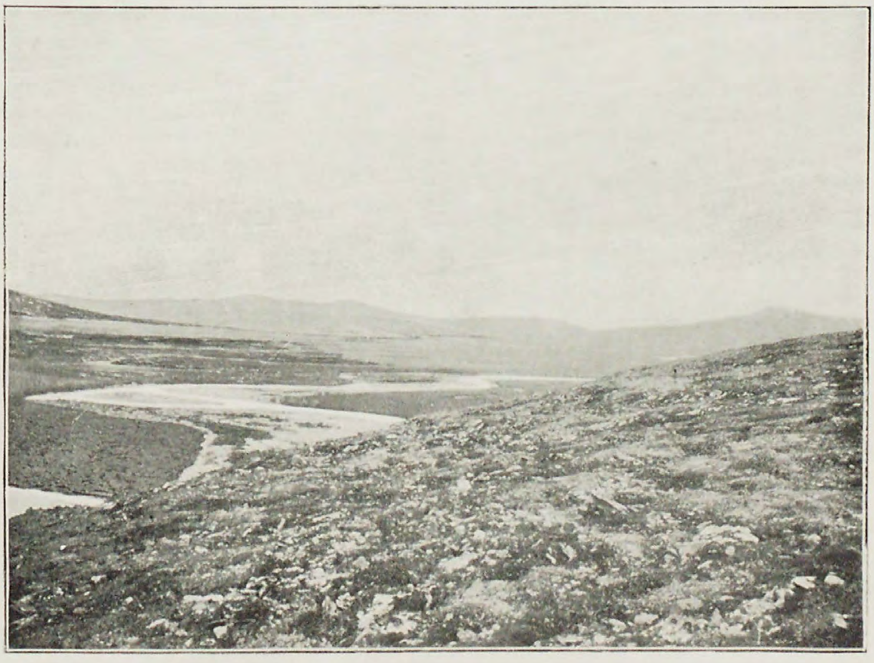
River and stream gravels.—These deposits will be described in detail in connection with the placers with which they occur. They include many varieties of gravels, sands, and silts, from the heavy bowlder beds of some of the mountain streams to the fine silts found in the channels of the larger rivers, where they meander sluggishly across the coastal plain. (See Pls. II, *B;* VI, *A;* X.)

Beach deposits.—In these are included the sands and gravels which are within reach of wave action. The beach is usually a hundred feet or less wide, and bounded on the land side by a low escarpment from which the coastal plain extends inland. In the eastern part of the peninsula, where abrupt cliffs frequently rise almost from the water, the beach is often but a few yards wide, and in places entirely absent, and then the waves beat at the base of the cliffs. The beach sediments include every variety of coarse and fine material (Pl. IX, *B*). They have been studied more carefully in the Nome region than elsewhere because of their associated placers. Where the cliffs are exposed to the erosion of the sea the beach sands include many bowlders and shingle. Where the waves are acting on coastal plain deposits the sediments are usually finer (Pl. IX, *A*). In nearly every case a local source for material of the beach can be found. Occasional erratic bowlders suggest shore-ice transportation, but as a rule nothing but the finer material has been carried parallel to the shore.

Terrace deposits.—This group of the Pleistocene sediments includes the stream terraces of the present dainage system, stream deposits of former drainage channels, marine benches (Pl. VIII, *A* and *B*), and, as a subgroup of the latter, the coastal plain deposits (Pl. IX, *A*). In the western half of Seward Peninsula high terraces and rock benches are common. The highest of these were found near the head of the Kruzgamepa, at elevations of 1,400 feet, and many at lower elevations down the coastal plain at Nome, which is only a few feet above sea level. The high terraces are the oldest Pleistocene deposits of the region. The material of the terraces is of every variety and need not be discussed in detail. In some cases very coarse gravels are found in these terraces, and, again, especially in the lower one, very fine silts. The material from the higher terraces often mantles the hill slope below, so that the bed rock is entirely covered. This mantle of gravel, together with the thick growth of moss, makes bed-



A. NIUKLUK RIVER AT COUNCIL.



B. UPPER BASIN OF NIUKLUK RIVER.

Looking downstream from mouth of American Creek.

rock prospecting very difficult. Attention should here be called to granitic bowlders which are found associated with these high terrace deposits. These may belong to an extra-morainic drift derived from an older system of glaciation, of which they furnish us the only evidence, or they may have reached their present position by ice floes.

Glacial deposits.—Dr. Dall,[1] in his early exploration, fully recognized that there was no evidence of regional glaciation in northern Alaska. Many years later Mr. John Muir, who spent a summer cruising along the coast of northern Alaska, found what he believed conclusive evidence that all this region had been subjected to regional glaciation,[2] and that the same ice sheet excavated Bering Strait and scoured the coasts of both continents, and discharged its moraine into Bering Sea and the northern Pacific Ocean. Dr. George M. Dawson,[3] who visited some of Muir's localities, could find no evidence of ice action, and Mr. Stanley-Brown[4] also reported the nonglaciated character of the Pribilof Islands.

It is a favorite theory among prospectors and miners of this region that the placer gold owes its origin to glacial action, and it is a matter of some economic importance to know whether ice action had any bearing on the origin of the auriferous gravel. Our exploration of last season shows conclusively that there is no evidence of regional glaciation in the peninsula. The glacial moraine which Mr. Muir referred to at Golofnin Bay is a mass of water-laid gravels and sand. Rocky pinnacles and needles are common, outcropping through a residual soil (see Pl. IV, *A*). Among the most common topographic forms are the turrets of granite, deeply fissured and jointed, which often mark the tops of mountains (see Pl. V, *B*). The greenstone and mica-schists of the region also give characteristic forms, bearing evidence of conditions which permitted of deep decay (see Pl. IV, *A*).

We found in the region two centers of glacial action which cover considerable area and two more of very limited extent. The more important of these lies in the Kigluaik Mountains, whose southern margin we had opportunity to study in some detail. Here the valleys were found to have been glaciated up to an elevation of 500 or 600 feet. The valleys have the typical U-shaped cross sections (Pl. VII, *B*) and head in glacial cirques, and at the margin of these valley glaciers typical morainic topography was found (Pl. VII, *A*). On studying some of the higher mountain valleys, they were found to contain remnants of these former glaciers, and the presence of small but true glaciers was definitely established.

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[1] Alaska and its Resources, 1870, p. 462.

[2] Report of the cruise of the U. S. revenue steamer *Corwin* in the Arctic, 1881, pp. 133-145.

[3] Geological notes on some of the coasts and islands of Bering Sea and vicinity: Bull. Geol. Soc. Am., Vol. V, 1894, pp. 117-146.

[4] The Pribilof Islands: Bull. Geol. Soc. Am., Vol. III, pp. 496 and 500.

The typical topography of the Kigluaik Range is marked by deep valleys, terminating in glacial cirques, with perpendicular walls often over 1,000 feet high (see map, Pl. XVII). The valley of Grand Central River is a good example of glacial topography, and was studied in some detail by Mr. Collier. This river, whose drainage is on the south side of the mountains, discharges into Salmon Lake, a beautiful sheet of water, about 5 miles long, in the foothills of the range. At the lower end of Salmon Lake is a large terminal moraine full of characteristic kettle holes and strewn with granite bowlders. Through this moraine, to which the lake owes its origin, Kruzgamepa River, which drains the lake, has cut a gorge about 50 feet deep. Along the southern margin of this lake are a number of moraines; and also in the low pass to the head of Eldorado River, a distance of 2 miles to the south, a number of kettle-hole lakes suggest a southern extension of the ice sheet.

Following up the valley of the Grand Central, it is found to be broad and U-shaped, with its floor strewn with granite bowlders. About 7 miles above the lake the river forks, and both branches of the stream have cut through an extensive moraine (Pl. VII, *A*). This moraine is full of potholes and carries many erratics. It is an interesting fact that above this moraine there is practically no vegetation in the valley. The willows, which below it are abundant along the creek bed, cease, as if they had not had time to gain a foothold since the glacier had disappeared. Here the morainic material is found 500 feet above the valley floor. On the north fork of the river the canyon becomes narrower, and 2 miles above ends in a great amphitheater with a level floor and perpendicular walls reaching up into the clouds, which hung over the mountains during the time of Mr. Collier's visit. This cirque, which is at the foot of Mount Osborn, the highest peak of the range, has a vertical cliff of about 3,000 feet. At the base of this cliff there are a number of small bodies of ice, which in all probability are perpetual, and one of these distinctly showed crevasses. From this cirque a strong river flows, such as would in other parts of Seward Peninsula suggest a drainage area of more than a hundred square miles. About one-half mile below the center of this cirque a low U-shaped gap in the northern rim marks a pass to the northward. Climbing up over a series of benches, we reached this gap at about 400 feet above the floor of the cirque and found it to be the upper end of a glacial valley extending northward through the range. About one-fourth mile north of this pass another small field of ice was encountered, possibly 400 feet long, which showed one well-developed crevasse. This small glacier occupies the floor of a cirque on the east side of the valley. Above it the cliffs rise vertically for about 1,000 feet. The valley which extends north has the characteristic U-shape, is 3 miles long, and opens out on the plain east of Imuruk Basin. A low

A. GLACIAL MORAINE AT FORKS OF GRAND CENTRAL RIVER.

B. UPPER VALLEY OF SINUK RIVER, SHOWING U SHAPE.

hill rising above the tundra one-fourth mile beyond the foot of the mountains marks the terminal moraine.

The South Fork of the Grand Central also heads in a glacial cirque about 3 miles above the forks, one tributary rising in a small circular lake in the center of a very characteristic cirque. From the head of the Grand Central a low pass leads into the cirque at the head of Sinuk River. Upper Sinuk Valley was also found to be U shaped and filled with glacial material (Pl. VII, *B*).

The seaward limit of the glacier which occupied Sinuk Valley was not determined, as Mr. Collier was able to visit only the headwaters of this river. There is some evidence that it may have extended nearly to the coast, for Mr. Collier found a deposit of glacial bowlders in a low divide west of Cripple River. These bowlders, which are of granite, had their source in the Kigluaik Mountains and could have reached their place of deposition only by ice transportation. This may have been accomplished by floating bergs which were discharged from the ice near the head of the valley. The terraces, as shown elsewhere, indicate that the region stood at a lower level at the time of the deposition of the bowlders, and that estuaries extended inland. Attention will be called below to the granite bowlders which are found associated with some of the high terrace deposits of the region.

Crater Creek, east of Salmon Lake, also has a characteristic U-shaped valley where it emerges from the mountains, and other valleys have a similar form. Toward the western limit of the Kigluaik Mountains Mr. Barnard noted a number of tributaries having glacial cirques at their heads and also morainic topography along the valleys. According to Mr. Barnard, a northern tributary of Sinuk River has been dammed by a glacial moraine, and forms a lake about 5 miles long, which he named Glacier Lake (see map, Pl. XVII). On the north side of the range the typical cirques and U-shaped valleys were also observed, but our opportunities for studying the region were more limited. The topography, as represented on Mr. Barnard's map (Pl. XVII), is, however, so typical that there can be no doubt that the ice sheet radiated to the north as well as to the south of the mountains. The limits of glaciation to the south, as far as determined, seem to correspond very closely with the depressions already described, which follow the base of the range, while to the north the valley glaciers at their maximum extension probably discharged in Imuruk Lake and crossed the divide between Canyon Creek and Tisuk River.

The Bendeleben group of mountains formed another important center of glaciation. Here valley glaciers seem to have been limited to the mountains themselves. The low, broad divide which separates the Niukluk and the Kruzgamepa contains a good many glacial bowlders which probably were derived from the Bendeleben Mountains. These bowlders have been interpreted as extra-morainic drift. Similar erratics occur on Ophir Creek. While our opportunities for studying the Bendeleben Mountains were very limited, the presence of this extra-morainic drift and of unmistakable glacial cirques showed conclusively that their valleys were at one time occupied by glaciers. As the Bendeleben Mountains are lower, the development of the valley glaciers was probably of less extent than in the Kigluaik Mountains.

Along the western margin of the York Mountains a little morainic material was found. The interior of this mountain range has not been explored, but it seems to have also been a local center of glaciation. At Cape Mountain, which forms Cape Prince of Wales, a high mountain valley, about a thousand feet above the sea, contains traces of the previous existence of a small glacier.

The glacial phenomena which have been described belong to an epoch of glaciation which was very recent—in fact, whose ice remnants are still preserved in some of the higher mountain valleys. During the maximum development of these glaciers the region of the immediate vicinity stood nearly at its present altitude relative to the sea. This is proved by the fact that on the north side of the Kigluaik Mountains the moraines which were deposited at the ice front are now nearly at sea level, and the evidence goes to show that they must have been deposited at about this same altitude. Along the southern coast there is some evidence that the land was slightly submerged during this glacial epoch. The erratic bowlders found on some of the lower terraces in this part of the region are tentatively assigned to this period of glaciation.

Older extra-morainic drift.—Mention has been made of some granite bowlders which have been found on the higher benches and terraces of the region. On the south side of the valley, near Salmon Lake, a granite bowlder was found on the hill slope at an altitude of 800 feet. Near Nome granite bowlders occur in the gravel at about the same altitude. These bowlders unquestionably had their sources in the Kigluaik Mountains, and reached their present position by ice transportation. Their altitude precludes the possibility that they were in any way connected with the glacial phenomena that have been described. While they undoubtedly reached their present position by ice transportation, when the region was submerged to a depth equal to their present altitudes, this does not necessarily imply a glacial source for the ice. It is known that the ice floes of the Arctic Ocean frequently bear bowlders to distant points.

In this connection it is interesting to speculate as to the climatic effect of a submergence of 800 feet in this region. Bering Strait would be considerably widened, and there would probably be other straits through Seward Peninsula, which would be cut up into a number of islands. The cold waters of the Arctic Ocean would have better opportunity to reach Bering Sea. The increase in precipitation, which is probably the factor that determines an accumulation of glacial ice in this latitude, would probably be dependent on the extent of the submergence. A depression of the floor of Bering Sea to the extent of a thousand feet might effect changes in ocean currents which would bring a warm, moisture-bearing current to the northern coast.

Ground ice.—In Seward Peninsula, as elsewhere in Alaska, the ground is usually found to be frozen a foot or two below the surface, the larger part of the region being covered by a thick growth of moss, which, being a nonconductor of heat, protects the frozen subsoil. To what depth the ground is frozen is not known, as mining operations have in no instance extended below it. Beds of coarse gravel, and sometimes sand, which are well drained are often not frozen. Such is the case with the beach sands at Nome. The frozen soil, with its spongy mantle, produces stagnant drainage and retards the process of erosion.

At some localities comparatively pure ice is found under the soil, sometimes interstratified with muds and silts. The writer is familiar with many localities in Yukon Basin where such ice masses have been laid bare by the undercutting of stream and river banks, but nowhere has he observed such masses covering any considerable area. These ice beds seem to him to differ in no way genetically from the frozen deposits with which they are connected and into which they grade. They are in no way comparable to an ice sheet of a glaciated region. They were probably originally standing bodies of water, such as flood-plain lakes, which have become congealed, and were preserved by a covering of vegetable growth or were buried by sediments that accumulated after depression. This explanation would account for the presence of the animal remains that have been found in them at many localities. Dr. Dall[1] has given a summary of the existing knowledge of the ground ice of northern Alaska. The localities he has described are chiefly in northern Alaska, and the best-known one is Elephant Point, on Eschscholtz Bay, in the northeastern part of Seward Peninsula. The ice cliffs at this point were discovered by Kotzebue in 1816, and have since then been visited by numerous observers. Dr. Dall[2] enumerates some eight species of vertebrates from this locality. In the southern half of the peninsula vertebrate remains in the frozen gravels are not uncommon, but no collections have been made.

Soil.—The soil of the peninsula affords many varieties, but it is not within the scope of this report to treat of them. The greater part of the region being nonglaciated, the soil, which lies directly on bed rock,

[1] Compare Coal and lignite of Alaska, by W. H. Dall: Seventeenth Ann. Rept. U. S. Geol. Surve , Pt. I, 1896, pp. 850-860.

[2] Op. cit., p. 854. Cf. Am. Jour. Sci., 3d series, Vol. XXI, 1881, pp. 104-111.

is of a residual character. The surficial deposits yield sandy and clayey soils. The coating of moss, which covers nearly the entire region, is usually underlain by a soil containing much humus.

PHYSIOGRAPHY.

INTRODUCTION.

Seward Peninsula offers a great variety of topographic features and many interesting problems in the development of land forms and drainage systems. It is, however, an isolated province, and there is very little accurate information available in regard to the adjacent areas of Alaska and Siberia. The contour maps which accompany this report embrace only about a third of the peninsula, and there are only very meager cartographic data of the other two-thirds. Even those areas of which there are contour maps are but imperfectly known from a physiographic standpoint, for the maps are on a small scale and were made during a hasty reconnaissance, which did not permit of refinement in the delineation of the topography. Owing to these facts, no complete exposition of the physiographic development of the region will be attempted. The writer will confine himself to a description of the more important topographic features and to suggesting an explanation of their origin.

DESCRIPTION OF LAND FORMS.

The general geographic features of the peninsula have already been described, and it will here only be necessary to describe those parts which we have studied in some detail. (See maps, Pls. XVII and XVIII.)

Mountain ranges.—Three mountain groups (compare map, Pl. XVIII), separated by valley lowlands, define a range which extends eastward from near Cape Woolley, around the head of the Fish River drainage basin, to Cape Darby. Of these only the two westernmost groups, the Kigluaik and Bendeleben mountains, fall in the province under discussion, the third being included in the area described by Mr. Mendenhall. The highest peak in the Kigluaik Mountains is Mount Osborn, which reaches an elevation of about 4,700 feet, while a number of other points fall between 2,500 and 3,000 feet. The peaks are cragged and the valleys are sharply cut, giving the mountains a generally rugged character, which is emphasized by the presence of many glacial cirques (see map, Pl. XVII). Some of the peaks bear a striking similarity to volcanic cones, but, as far as known, they are purely erosional forms, and there is no volcanic material of any kind in the range. The mountains have been deeply dissected by drainage channels, and the valley slopes rise precipitously from narrow valley floors. Within the mountains proper the valleys have steep gradients and the streams are torrential. One of the striking features of the drainage system is the remarkably straight character of many of the valleys. The larger ones divide the mountains into a number of irregular masses, some of which form subordinate ranges.

The Bendeleben Mountains, whose highest peak reaches about 3,500 feet and gives the name to the group, are similar in general character to the Kigluaik Mountains, but their relief is less and they are not so rugged. Their highest peaks are pointed and the valleys are sharply cut, and within them are a number of glacial cirques. The detailed topography of only a part of this range has been mapped.[1]

Southern highland belt.—To the south of these two mountain groups is a highland mass whose summits vary from 1,200 to 2,000 feet in elevation. At a number of localities benches are found on the slopes of the higher summits, the highest of which are at elevations of about 1,700 feet. These will be discussed in greater detail below. The area occupied by the highlands is essentially an area of irregular topography, with no well-defined system of ridges. The valleys of the rivers and streams are deeply cut, are broad, and their slopes rise gradually to the divides. The summits are rounded, with frequent rocky knobs, often having fantastic shapes (Pl. IV, *A*). These minor peaks are very characteristic features of the topography. Their contours are dependent on the lithologic character of the rock from which they are carved (Pl. V, *B*). Many of the larger valleys have northerly and southerly directions, and thus block out the highland mass into a number of north-south ridges, whose margins are scalloped by the minor tributaries, which normally join the main valleys at right angles. The numerous drainage modifications, which will be referred to later, have produced many variations in this general system. The highlands usually fall off to the coastal plain to the south by a series of well-defined terraces.

Niukluk-Kruzgamepa lowland.—The highland mass is separated from the Kigluaik Mountains to the north by a broad depression, which contains the drainage of the Upper Sinuk and Kruzgamepa and Niukluk valleys. The broad flat at the head of the Niukluk separates the Bendeleben Mountains in part from the highland mass (Pl. VI, *B*), but to the east, where the Niukluk Valley narrows, there is a gradual mergence between the mountains and the highlands.

Coast topography.—Two kinds of shore-line topography can be differentiated—one characterized by a low coastal plain, with many lagoons and sandspits; the other by bold cliffs that rise abruptly from the sea or from a narrow, rocky beach. A glance at the maps (Pls. XVII and XVIII) will show that, broadly speaking, the coast topography of the western half of the peninsula is mainly of the first

[1] The lack of detail in the hachured map (Pl. XVIII) conveys the erroneous impression that the Bendeleben Mountains are higher and more rugged than the Kigluaik Mountains.

description, while that of the eastern half is more bold and rocky. The coast line east of Golofnin Bay is described by Mr. Mendenhall.

The lower part of Golofnin Bay is bounded on both sides by rocky cliffs, with narrow, shelving beaches. The precipitous character of the coast extends westward for about 30 miles, until near Topkok Head the escarpment recedes inland and a coastal plain intervenes between the uplands and the water line. This coastal plain broadens rapidly westward, until at Port Safety it attains a width of about 12 miles. Thence, sweeping around behind the highland that forms the blunt, rocky headland known as Cape Nome, it continues westward with gradually decreasing width to Rodney Creek, where the escarpment that marks the beginning of the highlands is not more than half a mile from the sea (Pl. XI, *A*). Between Cape Nome and Topkok the continuity of the shore line is broken by large lagoons and other similar bodies of water. West of Cape Nome the shore line, as far as Cape Rodney, is almost straight and uninterrupted save for the tidal inlets at the mouths of the larger rivers. This coastal plain is nearly level, sloping gently toward the sea, here and there interrupted by an escarpment and carried to a higher level by a well-marked bench.

From Cape Rodney the coastal plain is of varying width, including numerous salt-water lagoons and lakes. At Port Clarence it runs out into a long, narrow sandspit embracing the harbor. Inside of this sandspit the eastern shore of Port Clarence presents a bold wall of cliffs, with only here and there a crescent-shaped beach.

As both Grantley Harbor and Imuruk Basin are subject to the ebb and flow of tides, their shore lines must be considered part of the coast line. Two narrow sandspits, between which a deep channel is kept open by the tide, separate Grantley Harbor from Port Clarence, and a narrow, winding canal with steep rock walls connects it with Imuruk Basin (see map, Pl. XVII). From the southern shore of Imuruk Basin the Kigluaik Mountains rise abruptly, almost from the water's edge. At the upper end of the basin and encircling it on the north is a flat, swampy plain, pitted with water bodies, large and small, the partially filled portion of the greater depression which the basin once occupied.

Along the open coast on the north side of Port Clarence is a low plain which includes a lagoon about 20 miles long. To the west, near Cape York, cliffs rise abruptly from the water, with only an occasional small beach. These cliffs are unbroken except by stream valleys and at York, where there is a small crescent-shaped plain half a mile in width between the upland and the beach.

From Cape Prince of Wales to Shishmaref Inlet the coast line is not marked by any escarpment, and a gently sloping plain extends for some distance inland. In this plain are narrow salt lagoons and lakes, one near Cape Prince of Wales being about 20 miles in length. An abrupt escarpment is said to bound the water from Shishmaref Inlet nearly to Cape Espenberg, but the cape itself is a low sandspit. The southern shore of Goodhope Bay and Kotzebue Sound, as far as our information goes, is abrupt and rocky, except for the deltas at the mouths of the larger rivers.

Valley lowlands of Lower Fish River.—From the upper end of Golofnin Sound a broad depression extends inland, which includes the lower parts of the valleys of Fish, Klokerblok, and Niukluk rivers. Except for a 50-foot gravel terrace on the western side of Golofnin, there are few, if any, terraces or benches in this part of the region.

Northern highlands.—The northern slope of the western end of the Kigluaik Mountains descends to a highland mass somewhat similar to that lying south of the range, already described. This upland, however, has many flat-topped summits which stand at the same altitude, which is about 1,000 feet. These seem to mark a plain which falls off to the northwest. Near the mountains this plain has not only been studied from a distance, but at its northern margin washed gravels were found at an altitude of about 900 feet. This upland is much dissected by streams which normally have rather broad valleys, in the bottoms of which sharp canyons have been incised. Tisuk Channel, which connects Imuruk Basin with Grantley Harbor, has a rather tortuous course and steep rock walls. At the northern declivity of this upland several terraces were found at different elevations. A mile south of Teller a gravel terrace about 25 feet in altitude was found.

North of the Bendeleben Mountains is the broad valley lowland of the Upper Kuzitrin. To the north of this valley is a highland mass similar to that which has been described to the northwest of the Kigluaik Mountains. An altitude of about 1,200 feet (determined by barometer) is marked by a series of flat-topped mountains, above which rise some higher, isolated points (see map, Pl. XI). This plain seems to increase in elevation north of the Kugruk Basin.

Imuruk Basin lowland.—This is a striking topographic feature lying to the north of the Kigluaik Mountains. The lowland is bounded on the south by the steep slopes of the Kigluaik Mountains, to the west by the highland mass lying south of Port Clarence. The northern slope rises gradually to the upland surface, while to the east are the Bendeleben Mountains. Near tide water the lowland floor is covered with finer alluvium, while closer to the mountains the mantle consists of coarser gravels. The lowland drains into Imuruk Basin, which is connected with Grantley Harbor by a tidal channel. This feature is connected with the Niukluk-Kruzgamepa lowland, already described, by the broad, flat valley of the Lower Kruzgamepa.

Upper Kuzitrin Valley lowland.—The headwaters of Kuzitrin River lie in a broad lowland, which is about 20 miles wide, and probably at least 30 or 40 miles in length. Its northeastern extension has not been explored. On its western side it has a broad gravel terrace, which stands at an elevation of a hundred feet above the valley. At the north the lowland wall slopes up rather gently to the highlands. To the south the slope is steeper to the flanks of the Bendeleben Mountains. The western part of this lowland drains to Imuruk Basin via Kuzitrin River.

York Mountains.—These mountains extend inland from the coast to the rocky cape of the same name. Only the front which they present to the coast has been mapped, and we know little of their topographic features farther inland. On the hachured map (Pl. XVIII) these mountains have been given far more prominence than their altitude and mass would warrant, and this is especially emphasized because but little drainage has been shown, as there are no detailed maps of this region. Their highest peaks probably reach altitudes of 2,500 feet, and on the seaward sides the streams have incised canyon-like valleys. Eastward the York Mountains are extended by the highlands lying north of Port Clarence, which have not been mapped. Their western flanks fall off rather abruptly to the York Plateau. The general aspect of these mountains is rugged.

York Plateau.—Beyond the western front of the York Mountains is a dissected plateau which stands at an elevation of about 600 feet (see map, Pl. XIII). This plateau is a striking feature and has been noted by a number of the early explorers. The top of the plateau is smooth and perfectly hard, affording excellent footing for man and beast. The larger streams within the plateau have rather broad valleys, which are cut down nearly to sea level, while the smaller tributaries flow in canyons. These facts are well brought out on the topographic map (Pl. XIII). To the south the plateau ends in a steep escarpment which is separated from Bering Sea by a narrow coastal plain or beach. Near the town of York the coastal plain has an elevation of about 50 feet, and above this is a higher bench at about 400 feet, which is similar to the plateau in character, but not so extensive. Our knowledge of the topography to the north was obtained by distant views only, but the plateau seems to slope more gradually to the Arctic Ocean, from which it is separated by a coastal plain which extends inland for several miles. A wide lagoon separates this coastal plain from the Arctic Ocean. The surface of the plateau is covered with a thin layer of semiangular gravels that are lithologically similar to the rocks in the immediate neighborhood.

Reference should here be made to a prominent rock bench which faces the sea on the southern slope of the York Mountains. The altitude of this bench has not been determined, but it seems to be about the same as that of the York Plateau. The bench can be traced almost continuously from Cape York to Port Clarence. The streams which intersect it have canyon-like valleys.

Residuary mountains in York region.—The relation of the York Mountains to the plateau has been described, and they have been shown to rise abruptly from its surface. A similar relation exists between the plateau and some isolated mountains. The largest is Cape Mountain, which forms the westernmost point of the peninsula. This rises to an elevation of about 2,500 feet and has a sharp crest line. It presents a bold southwestern front to the sea. To the west it falls off rather abruptly to the sandspit which forms Cape Prince of Wales. Its eastern slope to the plateau surface is also steep. A well-marked bench occurs at an altitude of about 1,100 feet on the northwestern slope of the mountain.

Within the plateau there are a number of other mountains of similar character, but these are of less prominence. One is located just west of Baituk Creek, another within the angle of the bend of Upper Kigezruk River, and a third near the head of Anakovik River. All of these have flat tops, which stand at the same altitude as the bench on the slope of Cape Mountain.

DESCRIPTION OF DRAINAGE.

Fish River Basin.—The lower course of Fish River lies in the broad valley lowland which extends inland from Golofnin Bay for about 25 miles, and which has been described. Near White Mountain the valley narrows down, and the constricted portion divides this lowland into two basins. The headwaters of Fish River lie in a broad, flat, gravel-covered basin which is drained by a constricted portion of the valley about 10 miles long.

Niukluk River, the largest confluent stream, joins Fish River about 20 miles from the bay. Its lower valley is an extension of the broad flat of the Fish. The Niukluk Valley, near the mouth, is about 6 miles wide, and gradually narrows down, and at the mouth of Richter Creek is less than a mile in width. About 8 miles above its mouth the Niukluk has incised its valley floor and flows in a canyon about 50 feet deep (Pl. VI, *A*). From the mouth of Richter Creek to the mouth of the Koksuktapaga the Niukluk Valley is constricted. Its headwaters lie in a broad basin which is separated by a very low divide from the Kruzgamepa, which flows into Port Clarence (Pl. VI, *B*). The striking features of the Niukluk Valley are the two basins which are connected by the more canyon-like valley.

Koksuktapaga River is the chief tributary of the Niukluk. Its valley is broad, with gentle slopes, and gravel terraces are found in it up to an altitude of 600 feet. Its headwaters are connected by a low, gravel-filled divide with Solomon River, which flows southward. Ophir Creek rises near Chauik Mountain and flows southward to the Niukluk. Near its headwaters is a gravel-filled plain whose upper surface stands at about 600 feet. This gravel terrace extends through to the Parantulik, a fork of Fish River.

Southerly drainage into Bering Sea.—The first river of importance west of Golofnin Bay is the Solomon, whose valley is rather broad and contains gravel terraces. The next river is the Bonanza, which is smaller, but similar in the character of its valley to Solomon River. Still farther west is Eldorado River, which in its lower course has a broad, flat valley. Above this flat its valley is constricted for about 10 miles, and then broadens out again. This upper basin is separated by a very low divide from Salmon Lake, from which it is only a few miles distant. Flambeau River has a broad, basin-shaped valley. The Nome River Valley has the same character as the Eldorado—that is, a broad upper basin, connected by a broad pass with Kruzgamepa waters, and below this basin a constricted valley, and nearer the sea a broad valley whose floor merges into the coastal plain.

The Snake, Penny, and Cripple river valleys merit no special description here. Near the coast these valleys are broad, and the floors are extensions of the coastal plain. Higher up the valleys become constricted.

Sinuk River, which empties into the sea about 30 miles west of Nome, is one of the largest rivers of the southern watershed of the peninsula. It receives the drainage of the southern slope of the western half of the Kigluaik Mountains. Emerging from the mountains in a narrow valley, it flows parallel to the range for about 15 miles in the depression already described, then, turning southward, reaches the sea through a broad, flat valley. Its waters, as well as the headwaters of its chief tributary, Stewart River, are connected by a broad, gravel-filled pass with the Kruzgamepa.

Westerly flowing streams.—Fairview and Feather rivers are streams of minor importance which flow westward from the southern flanks of the Kigluaik Mountains. The Tisuk, a somewhat larger river, belonging to the northern watershed, has its source well within the mountains. It leaves the mountains through a narrow valley, which broadens out. In its lower course the river meanders sluggishly over a flat valley bottom, and finally empties into a lagoon which connects with Bering Sea. A gravel-filled divide about 200 feet high separates the Tisuk from the drainage of Canyon Creek, which flows eastward into Imuruk Basin.

Port Clarence drainage.—A number of small streams flow into Port Clarence and Grantley Harbor, both from the north and from the south. The Bluestone River drainage includes the larger part of the area lying between the Kigluaik Mountains and Port Clarence. Its headwaters are in a basin-shaped valley. At the mouth of the Alder the Bluestone enters a rock-cut canyon from which it emerges in a broad valley that joins the Tuksuk channel.

At the head of Imuruk Basin is a flat, swampy area, through which flows a broad river, sometimes called the Kaviruk, which forks about

20 miles from the bay. The southern fork, called the Kruzgamepa, rises well within the Kigluaik Mountains, flowing southward till it leaves them; then takes a northeasterly course and encircles the east end of the range. This part of the valley lies in the same lowland which includes the upper basin of the Niukluk. Its upper valley and the valleys of its upper tributaries are glaciated. When it leaves the mountains it flows through a broad valley which widens toward its mouth and finally merges into the great flat at the head of Imuruk Basin.

The northern fork of the Kaviruk is called the Kuzitrin. It has its source in a broad, flat basin which seems to be separated from the Arctic drainage by a very low divide. Near the southern margin of this basin it is joined by its chief tributary, the Kugruk, whose source has not been explored. Below this junction the Kuzitrin flows in a rather narrow valley for about 20 miles, after which it debouches on the plain at the head of Imuruk Basin.

A third large area is drained into Imuruk Basin by the river called Agiapuk. It enters the bay near its northeastern end. Its upper course has not been explored, but it is said to have a large westerly fork about 20 miles from the bay, which, it is reported, reaches far to the northwest and takes the drainage of the region lying north of Port Clarence. The lower valley is broad; according to the descriptions of prospectors, it narrows about 30 miles inland from the coast.

Tributaries to Bering Sea west of Port Clarence.—Between Port Clarence and York there are several streams all having in general a southerly course. They are insignificant in size. West of Cape York the first important river is the Kanauguk, which lies well within the York Mountains. Its lower course only has been mapped, and it here has a wide valley and a broad flood plain. The Anakovik, at the mouth of which the mining camp of York is located, rises in the York Mountains about 15 miles from the coast (see map, Pl. XIII). After leaving the mountains it has a rather broad valley and flood plain. Between York and Cape Prince of Wales there are several other streams which head within the plateau and whose valleys are sharply cut.

Arctic drainage.—Of the Arctic drainage of the peninsula we have but little definite information. The mouths of the large streams have been located on Beechey's charts, and more or less information has been gathered from prospectors and natives, but no investigation has been made and therefore no accurate mapping has been done. Mint River, which rises in the York Mountains, north of the source of the Anakovik, reaches the ocean through a large lagoon (named Lopp Lagoon in honor of W. T. Lopp, missionary at Cape Prince of Wales) that extends about 20 miles to the east from Cape Prince of Wales. In its upper course it has a narrow valley. Near the sea it winds for about 10 miles across the tundra. On most maps a large river is represented as entering Shishmaref Inlet, which on some is called the Arctic River. A river of considerable size is known to enter the ocean halfway between Shishmaref Inlet and Cape Espenberg. In their lower courses these two streams have broad valleys. Another river enters Goodhope Bay, which probably takes the drainage from the broad, flat basin near the headwaters of the Kuzitrin. This part of the coast has a steep shore line, and there are small estuaries at the mouths of these rivers. Several other rivers enter Kotzebue Sound from the peninsula, each having an embayment at its mouth. The most important of these are the Kugruk,[1] the Keewalik, and the Buckland. The headwaters of the latter stream lie far inland on the main continent, near the divide of the Koyukuk, which is a tributary of the Yukon.

DEVELOPMENT OF LAND FORMS AND DRAINAGE SYSTEM.

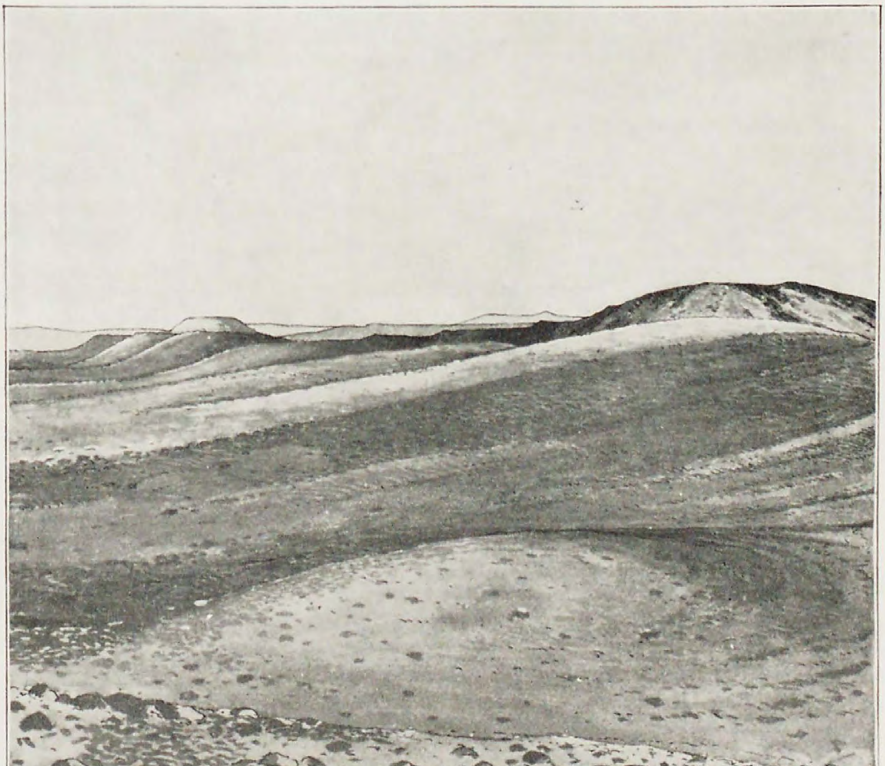
Introduction.—The study of the topography of the southern part of Seward Peninsula and the interpretation of such information concerning the northern half as is available point to the conclusion that the region may be divided into two provinces which have had essentially different physiographic histories. The boundary between these two provinces probably coincides approximately with a line drawn northward from Rocky Point to Cape Espenberg. West of this line the evidence nearly all points toward a series of uplifts. In the eastern province Mr. Mendenhall finds that there is little, if any, evidence of uplift, and that the coast line is rather one which suggests a marine invasion during comparatively recent times. The shore line of Golofnin Bay is one of drowned topography, and Mr. Mendenhall is inclined to give the same interpretation to the shore of Norton Sound. This submergence would seem to have been of comparatively local character, as in the vicinity of St. Michael the evidence points toward an uplift.[2] Mr. Mendenhall presents in his report a description of the topography of the eastern part of Seward Peninsula, and the writer would here only draw attention to the fact that no benches or terraces have been found in this province.

The present studies have not been carried sufficiently far to permit of correlations between the different terraces of the western province, except locally. For convenience of discussion, therefore, it is proposed to make three groups of these topographic forms. Those of the first, which will be called the "upper group of terraces and benches," are, as will be shown, probably all marine, and include those falling between the altitudes of 1,000 and 1,700 feet. Terraces of the second group, termed the "intermediate group of marine and river terraces and benches," are both marine and fluvial, and their altitudes

[1] This river is not to be confounded with a river of similar name which is tributary to the Kuzitrin.

[2] Geology of the Yukon gold district, Alaska, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, 1898, p. 272.

A. MOUNT KING, NEAR NOME, SHOWING BENCHES FROM ELEVATIONS OF 800 FEET.



B. ELEVATED MARINE BENCH, 1,500 FEET, DIVIDE BETWEEN KRUZGAMEPA RIVER AND IRON CREEK.

range from 200 to 900 feet. The third group consists of the so-called "coastal plain terraces," which are of marine origin, and do not exceed 200 feet in altitude. This grouping is, of course, largely artificial, but its use will probably make the discussion clearer.

Upper groups of terraces and benches.—High terraces and benches of this group have been found at a number of different localities. Those of greatest altitude occur in the southern highland belt, near the Kigluaik Mountains. On Mount Distin, near the head of Snake River, a well-marked bench was observed at an altitude of about 1,700 feet.

Similar topographic features were found at approximately the same altitude on several high points along the valley south of Salmon Lake. (Pl. VIII, *B*.) North of the mouth of Golden Gate Creek a gravel-covered bench was found at an altitude of 1,200 feet. In the upper basin of the Bluestone, southeast of Port Clarence, a number of flat summits were observed at an altitude of 1,500 to 1,600 feet. In the York region, as has been stated, an erosion level was found approximately 1,100 feet in altitude. In the Kugruk region the highlands have many flat summits which stand at about 1,200 feet. Near Nome the highest bench has an altitude of about 1,000 feet (Pl. VIII, *A*). In the region lying between the western end of the Kigluaik Mountains and Bering Sea a number of flat summits which stand about 1,000 feet are shown on the topographic map. This region was not visited by any of the geologists, but interpretation of the map leads to the conclusion that these mark plains of erosion.

The evidence that has been presented is of a fragamentary character, and can lead only to tentative conclusions. There can be no doubt that many of the features to which attention has been drawn, especially the benches near the head of the Kruzgamepa, mark a level of erosion which was formed when the region stood at a much lower altitude. That this depression was of rather wide extent is shown by the definite proof of the similar erosional features standing at a high altitude near Cape Prince of Wales. In some cases these high benches were found encircling mountain tops in a way that left no doubt in the mind of the writer as to their being old marine benches rather than river terraces. In a number of localities old sea cliffs were found. In other localities such evidence is lacking, but the writer is inclined to consider all these benches of marine origin.

In the present state of knowledge it is unwise to attempt any correlation among these benches which stand at altitudes varying between 1,000 and 1,700 feet. They may in part represent the same level of erosion and owe their present position to a differential uplift, for, as will be shown below, there is reason to believe that a certain amount of warping has taken place in Pleistocene time.

At the eastern end of the Kigluaik Mountains, where they fall off abruptly to the valley, a high bench was found at an altitude of about

1,600 feet, and below it, at about 1,200 feet, a second bench, apparently also of marine origin. This goes to show that the elevation was intermittent and that there were at least two periods of stability of sufficient length for shore lines to be cut.

We are led to the conclusion that in comparatively recent times the western province was submerged to a depth of 1,000 feet or more. What the topography was previous to this submergence can not be definitely stated. It seems probable, however, that the relief in its general features was not very different from what it is now.

These terraces encircle the Kigluaik Mountains, are found on the western slopes of the Bendeleben Mountains, and probably on both the eastern and western slopes of the York Mountains. These land masses, together with some other high points, such as Mount Distin, must have been islands in the submerged area. Their relief at the time of the depression, relative to the adjacent region, must have been comparable to what it is now. If the period of erosion, which has extended from the time of the emergence of these terraces from the sea to the present time, had been long enough to carve such deep valley lowlands, all the terraces and benches would probably have been destroyed. We must believe, therefore, that these valley lowlands antedate this period of depression. The York, Kigluaik, and Bendeleben Mountains, as well as the larger drainage channels, are probably an inheritance from the topography of the geologic cycle that preceded the depression.

The evidence goes to show that this period of depression was relatively short. Had it extended through a long period of time, there would be much greater contrast in the relative amount of relief and in the character of the topography between the eastern and the western provinces, for the former stood above water, as has been shown, during the submergence of the latter. The Darby Mountains have the topographic character of an older land form than the Kigluaik Mountains. Their summits are more rounded and their slopes more gentle. There is not, however, the amount of contrast one should expect in the character of the topography if the western area had been submerged for a long period of time. Unless the submergence was relatively short, there should also have been an accumulation of the sediments in the depressed area, derived from the land which stood above water to the east. Aside from the terrace deposits which have been described there are no surficial beds that can be traced to the same epoch of depression. If such a gravel mantle had existed and had been removed by erosion, we should expect to find more striking examples of superimposed streams than our investigations have revealed.

The above facts point toward the following conclusions: First, previous to the time when the high terraces were formed, the general features of the present topography had already been developed; second, the amount of submergence may be measured by the altitude of the highest system of terraces; third, the period of depression was relatively short. It seems probable also that these terraces and benches are of marine origin and that their present differences in altitude may in part be explained by deformations. The occurrence of some lower terraces in the region, which are probably also of marine origin, make it probable that the uplift was intermittent and that there were periods of stability during which marine benching could take place.

Intermediate group of marine and river terraces.—Under this heading are classified a number of terraces and benches which occur at lower altitudes than those which have already been described and which are above those belonging to the coastal plain. The elevations vary from 200 to 800 feet. They are in part clearly of fluvial origin, while some are distinctly marine. Of the latter class the most striking example is the York Plateau, which has already been described. This stands at an elevation of about 600 feet, and can be traced eastward along the southern escarpment of the York Mountains. The appearance of the Diomede Islands and the brief descriptions of them that are available suggest that they also have been subjected to marine benching. Mr. W. T. Lopp, of Cape Prince of Wales, informed the writer that the top of Fairway Rock, in Bering Strait, includes several acres, and that it is absolutely flat. As its altitude is about 600 feet and the same level as the York Plateau, it was probably formed during the same period of erosion. South of Grantley Harbor a well-marked bench was observed at an altitude of about 700 feet, on which there was washed gravel and which can probably be correlated with the York Plateau. The isolated knobs which lie between Kruzgamepa and Kuzitrin rivers are benched at about the same altitude, and rounded bowlders are found on the benches. At this latter locality the evidence also points toward marine benching rather than to fluvial terraces. East of this point the only evidences of an erosion level which would correspond to these altitudes are some well-defined stream terraces lying near the head of Warm Creek, a tributary of Goldbottom, which flows into the Niukluk. These terraces are gravel covered and have an altitude of about a thousand feet. Mr. Richardson reports washed gravels on the low divides near the head of Ophir Creek at an altitude of about 800 feet.

In the southern highland belt there is abundant evidence of stream and marine benches of this erosion epoch. Near the coast between Sinuk River and Cape Nome is a well-marked bench at an altitude of about 700 feet. In the vicinity of Nome this is found to be composed of gravels of irregular thickness. These surficial deposits have been described in some detail elsewhere. Sledge Island is flat topped and its summit probably marks the same erosion level, as does also the flat-topped promontory of Cape Nome. Inland from Nome, benches were observed which stood at about this altitude. Near the coast the gravels which form these terraces were unquestionably laid down as littoral deposits. Farther inland, on the other hand, this erosion level is represented by fluvial deposits. It is impossible to draw the shore line of this period of submergence, but it seems probable that it was not far inland, as the material found in the Dexter Creek bench near Nome is very coarse and could not have been carried far.

These facts show that there was a period of stability which interrupted the elevation of the province. During this period the shore line to the north of the Kigluaik Mountains apparently extended inland to the eastern end of the Bendeleben Mountains. The upper end of the Kruzgamepa Valley was probably an estuary. The evidence of benching in this region is not so striking, but the fact that this portion of the sea was partly inclosed would account for the absence of wave-cut terraces. This estuary must also have extended to the Niukluk and the Koksuktapaga, though here few records of former high benches have been preserved. The southern coast line during this submergence was probably not far distant from the present shore line.

During this epoch the drainage lines were similar to the present ones, except that certain modifications have since taken place. A study of the map shows that a number of rivers, of which the Nome and the Eldorado are striking examples, have basins at their upper ends and constricted portions in their valleys below. The Upper Niukluk and its tributary, the Koksuktapaga, doubtless have a similar history—that is, they probably once drained northward to the estuary which has been described. These upper basins unquestionably formerly drained northward, and the change in the direction of drainage took place, it may be supposed, during the submergence under discussion. The reversal of the drainage, as will be explained below, was perhaps brought about in part by the damming action of valley glaciers, but was largely the result of the elevation of the headwaters.

The region lying between Port Clarence and Imuruk Basin contains many drainage features which are of interest, and some old drainage channels can be traced which probably were formed during this epoch. During this depression this highland mass formed a peninsula which had an inland sea of considerable size to the northeast of it.

Coastal plain terraces.—The coastal plain topography has already been described in detail. Mention has been made of the inclusion within the limits of the coastal plain of a number of terraces. These terraces (Pl. IX, *A*) are not sharply differentiated from those of the previous epoch, but for sake of discussion their upper limit will be considered to be about 200 feet. In this group are also included some low river terraces at altitudes of 200 feet and less. These upper terraces merge into the broad flood plains of the larger rivers. Evidence of this period of marine benching is found from Golofnin Bay westward to Cape Prince of Wales. At Golofnin Bay the terrace is but 50 feet high. In the Nome region the highest terrace of the coastal plain is about 100 feet. At Port Clarence a gravel terrace was observed about 25 feet high, and at York the lowest topographic feature of this type is about 50 feet. All of these are made up of sands, gravels, and clays, and are probably littoral deposits. As has been shown elsewhere,[1] the clays often contain some vegetable matter. The interpretation of this fact is that there were periods of emergence during the deposition of these surficial deposits and that these clays and vegetable remains are comparable to the present soil and muck which form the upper layer of the surficial deposits. In other words, the elevation was interrupted by depressions. These were probably of minor importance and the algebraic sum of the movement is an uplift.

During the earlier part of this cycle we must consider that the lower parts of many of the larger valleys of the Nome region were occupied by the sea; that by a succession of uplifts the land reached its present altitude and the valley floors were laid bare.

In the region to the north of the Kigluaik Mountains the history of this cycle is more intricate. It seems probable that the large valley lowlands which lie to the north of the mountains were occupied by water. Unfortunately, we were unable to study the northern flank of the Kigluaik Mountains to look for evidence of terraces. The two small outlying hills north of the lower end of Kruzgamepa River have 50-foot gravel terraces at their bases, and these were presumably deposited in this body of water. Mention has been made of a 100-foot terrace in the broad valley lowland of the Upper Kuzitrin, and this may provisionally be correlated with the same period of depression (Pl. V, *A*). Until the physiography of this lowland has been determined we can not establish a definite correlation. Our present knowledge of the topography does not enable us to determine definitely whether this lowland is a basin or whether it is connected with the Arctic Ocean by a very low divide. In this connection it is worthy of mention that reports of prospectors and travelers go to show that the northern part of the western half of the peninsula is deeply buried in gravels.

The glacial phenomena of the peninsula have been described in some detail and need little further mention here. It has been shown that the valleys of the Kigluaik Mountains, as well as some of those of Bendeleben Mountains, were occupied by ice. This period of glaciation was of comparatively recent date, when the land had probably reached its present attitude. It has brought about, or helped to bring about, certain changes of drainage. As an example of this we have Eldorado River, which, as has been shown, formerly drained northward into the Kruzgamepa Valley. The ice front of the glacier which

[1] See description of gravel plain placers.

occupied Fox Creek at one time blocked the low valley which connects the head of Eldorado River with Salmon Lake. This was probably instrumental in bringing about the great change of drainage which threw the greater part of these waters southward. It should be borne in mind, however, that the southward-flowing streams, after the land reached its present altitude, had decidedly the advantage, as their course to the sea was much shorter and straighter. When the shore line to the north extended inland to the Upper Kruzgamepa Valley the northward-flowing streams had the advantage, as the distance to their base-level was comparatively short; but the elevation which followed lengthened the distance to the sea considerably and gave the southern rivers the advantage.

Origin of the valley lowlands.—Reference has been made to a number of broad, basin-shaped valley lowlands which are drained through comparatively narrow river valleys. Mr. Mendenhall describes a typical example of this form of topography in the upper basins of the Fish. As has been stated, the upper basin of the Kuzitrin may belong to this type of topography or may be a gravel-filled estuary. The best example of these basin-shaped lowlands in the province under discussion is the one which includes the lower course of Kruzgamepa, Kuzitrin, and Agiapuk rivers, as well as the Imuruk Basin. This basin is connected with the sea by a narrow tidal channel. There can be no question that in this particular locality there has been a slight depression which has resulted in changing this channel, which must formerly have been a river, to a tidal waterway. Previous to this depression the basin must have been drained through a narrow river valley similar to that of the Fish, which has been described. How this basin was formed can not now be determined, but the only explanation which seems to be in accordance with the facts is that there was a slight deformation here which dammed up the river and caused it to cut at its headwaters.

It should be noted here that the broad depression which extends along the southern margin of the Kigluaik Mountains and sweeps around the end of the mountains is probably a feature which is dependent on certain lithologic differences in the rocks. This depression is believed to have been caused by differential erosion, as the rocks in this belt are limestones and are eroded much more easily than the quartzites which lie at the base of the mountains or the more impure varieties of limestones and schists that form the northern limit of the southern highlands.

Summary.—An attempt has been made to trace the physiographic history of the region by the aid of the marine and fluvial terraces. On the basis of this evidence the southern half of the peninsula has been divided into two provinces, the western one of which has been submerged to depths of 1,600 feet, while the eastern half is above water.

It has been shown that the highest of these benches stand at elevations of 1,600 or 1,700 feet, and that these were probably formed during a comparatively short epoch of submergence. Facts have been given which tend to show that previous to this submergence the more prominent features of the topography were already blocked out. After this submergence the province was elevated by a series of uplifts until it reached its present position relative to the sea. These periods of uplift were probably interrupted by minor periods of depression. It is believed that the present drainage system is in part an inheritance from the topography of the cycle preceding the submergence. Within comparatively recent times the Kruzgamepa and Imuruk basin lowland was an arm of the sea. There are many changes of drainage in the region which are partly due to the lengthening of the courses of the master streams, and also partly to the presence of the valley glaciers and to uplift in the vicinity of the Kigluaik Mountains. The origin of the valley lowland is tentatively assigned to warping, and attention has been called to the slight depression that took place in the region of Imuruk Basin, causing the Tisuk channel to become a tidal inlet.

As to the age of the various topographic features we have no definite evidence. Elsewhere it has been shown that the terrace gravels are probably all of Pleistocene age, with the possibility that some of the older ones belong to the Tertiary. There is little evidence to establish the correlations between the features that have been described and similar features in adjacent areas. Such descriptions of the Arctic coast belt of Alaska as are available show that it is probably a region of uplift. In the profiles drawn by navigators terraces and benches are not infrequent. In the St. Michael region Spurr[1] has shown that the evidence points toward uplift, and he has similar evidence for the Kuskokwim region. The Siberian side of Bering Strait has a drowned topography, and as far as there is any evidence this region is one of depression. If the writer's correlation of the Diomede Islands with the York Plateau be correct, the line between the depressed area of the Siberian coast and the elevated area of the Alaskan coast should be drawn in the western channel of Bering Strait. One point is clearly brought out—that the orographic movements which produced these changes are of rather local character. On the Siberian coast region we have, as far as known, an area of depression. At St. Lawrence Island Dr. Dawson has pointed out that there is evidence of uplift.[2] East of that, as far as Port Clarence, the evidence is of uplift; at Port Clarence a slight depression has taken place in recent times; and again to the east as far as Golofnin Bay the evidence is in favor of uplift. The Golofnin Bay and Norton Sound regions are depressed areas, and at St. Michael the evidence points

[1] Geology of the Yukon gold district, Alaska, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, 1898, p. 272.

[2] Coasts of Bering Sea and vicinity, by G. M. Dawson: Bull. Geol. Soc., Vol. IV, 1894, p. 140.

toward an uplift. The orographic movements must therefore be regarded as rather local phenomena. This question is of interest in relation to the discussion of the former existence of land connection across Bering Strait between the Siberian and the Alaskan coasts.

ECONOMIC GEOLOGY.

DEVELOPMENT OF THE REGION.

In the fall of 1898, when the discovery of the Anvil Creek placers was made, a few Eskimo tents were scattered along the beach between Snake and Nome rivers. On Anvil Creek itself there was a small log house, which had been built for the herders of the Government reindeer, and this might be said to be the only permanent habitation for many miles along the coast. A few prospectors built driftwood houses near the mouth of Snake River, on the present site of Nome, and spent there the winter following the discovery, thus establishing the first settlement of whites between Golofnin Bay and Port Clarence. During the winter a few more miners who came from the Yukon camps established themselves near these first habitations, and the place received the name of Anvil City. The gold seekers who had their first view of what has since become a famous mining camp, from steamers which arrived from Pacific ports in the early summer of 1899, saw a few driftwood houses on the beach, with a score or two of tents. The return of these first steamers to Puget Sound led to a stampede, for the news of rich placers was confirmed and the outside world was convinced that rich finds actually had been made. On their second trip to the gold fields the steamers brought many more passengers, and also a supply of building material, with fuel and supplies of all kinds. A post-office was established, and "Nome" became the official name of the new camp. In September of that year, when the writer first visited Nome, it already had a population of 3,000 or 4,000 and contained many substantial buildings. The rich beach diggings, which were free for all, had made times prosperous, and Nome had all the characteristics of a typical mushroom mining town. Prices were high, as nearly everything except gold was scarce. Money was easily earned and quickly spent. A city government had been established by the miners, and fairly good order was preserved by the local officials elected by the miners, with the cooperation of the officers of the Army and of the Revenue-Cutter Service. An epidemic of typhoid, often complicated with pneumonia, was raging, which, because of lack of facilities for taking care of the sick, proved widely fatal. In June, 1900, the writer reached Nome a second time, and found a city with a population of 15,000 clustered in buildings of all kinds and in tents stretching out for miles along the beach. Nome had become a city with many of the luxuries and all of the vices of civilization.

During the summer of 1900 the development was very rapid. Thanks to the regulations of the municipal authorities and to some enterprising citizens, who established a pipe line at Nome by which pure water was supplied, the sanitary conditions were fairly good, and typhoid fever was almost a thing of the past. The spread of smallpox, which was introduced by some of the incoming vessels, was prevented by prompt action of the authorities, especially Captain Jarvis, of the Revenue-Cutter Service. Though Nome was overrun by a large body of the worst class of criminals, yet, by the cooperation of the civil and military authorities, order was fairly well preserved. The Federal Government was represented by a district judge, marshals, commissioners, customs and post-office officials, and a company of United States troops. The army post, called Fort Davis, is situated at the mouth of Snake River, and a small detachment of soldiers is quartered at the barracks in Nome itself.

Nome can now boast of good hotels, large stores, newspapers, banks, and many other adjuncts of civilization. During the open season, which lasts from the middle of June to about the end of October, it receives weekly mails, and can be reached from Puget Sound ports in ten or twelve days. In winter communication is kept up with the outside world by dog and reindeer sleds by way of Yukon River. It is proposed to establish a shorter mail route from some port on Cook Inlet, which remains open during the entire year. Nome is connected with St. Michael by cable, and a military telegraph line is now in process of construction from St. Michael to the Upper Yukon, which will give telegraphic connection with Skagway, in southeastern Alaska. A narrow-gage railway has been built from Nome to Anvil Creek, and many wagon roads have been established between the placer mines. Telephone lines connect Nome with many of the mine workings and extend along the coast as far as Port Safety.

The greatest drawback at Nome is the fact that there are no harbor facilities, and all passengers and supplies have to be landed through the surf. During the months of June and July this is accomplished without much difficulty. Later in the season, however, stormy weather prevails in the northern Bering Sea, and the landings through the surf are attended with much danger. Vessels are forced, on account of the shallowness of the sea, to anchor a half mile to a mile from shore, and all goods are taken ashore in lighters or in small boats. During the two seasons in which development has been going on in Nome most of the lighters that were used have been wrecked on the beach, many of them while they were loaded with valuable cargoes. When stormy weather comes the ocean-going vessels stand out to sea or seek shelter behind Sledge Island, but the small steamers and lighters are usually hauled ashore and are quite frequently destroyed by the surf. An attempt was made last year to use a wire rope and bucket tramway for landing supplies, but before it could be put to a fair test a storm arose and the expensive equipment was entirely destroyed.

Supplies are carried into the interior by dog and reindeer sleds in winter, and by pack animals in summer. Mr. Collier's report on the vegetation shows that there are a number of good forage plants indigenous to the region, and pack trains can be used to advantage to about the middle of September. After that date the early frost is liable to injure the grass, and the pasture is not to be relied on. The plentiful supply of reindeer moss makes the use of the reindeer feasible. They have been employed to a considerable extent in hauling sleds in winter, but as yet have not proved very successful pack animals for summer use.

During the summer small steamers ply between the different settlements lying along the coast between St. Michael and York. Some of these during the last season made regular trips, carrying mail, passengers, and freight. Much traveling is also done along the coast in small sailing craft. The experience of the last season shows that only seaworthy boats should be used, and these with caution. During the stormy weather last August and September many lives were lost along the coast by the wrecks of small craft. The Eskimo boats, called umiak, with a native crew, are probably the safest.

Except ptarmigan, fish, and some edible berries, the region yields no food supply for white men. The driftwood along the coast is rapidly being consumed and the miners will soon be dependent on coal brought from a distance. During the summer of 1900 coal sold at from $25 to $50 a ton, delivered on the beach. With cheap water transportation these prices are not likely to hold. In the interior the thick growth of willow along the streams affords a sufficient fuel supply for cooking purposes. All lumber for sluice boxes and building has to be brought from a distance.

Between Nome and Golofnin Bay three mining camps were established during the summer of 1900. Port Safety is located on a sand spit which separates the lagoon of the same name from Bering Sea. Solomon City is on the same lagoon, at the mouth of Solomon River. Both places have stores and the former has a post-office. The tidal channel, which enters the lagoon at Port Safety, affords entrance only for small vessels, as its depth is but 6 feet. Both these settlements lack good water, which has to be brought some distance in boats. They both lie close to the sea and suffered severely during the storms of last season. The Solomon and Bonanza River regions can be conveniently reached from these points by the use of small boats.

Another settlement, called Bluff, is at the mouth of Daniels Creek, a few miles from Topkok. It is about 47 miles east of Nome, from which it may be reached by a route along the beach. Two tidal channels have to be crossed, but as ferries exist at both points they offer no serious difficulties. Bluff owes its existence to the rich beach placers which have been developed at the mouth of Daniels Creek.

Since the discovery of the galena deposits on Fish River in 1881, Golofnin Bay has been more or less visited by white men, and a trading port has been maintained for a number of years on the spit between the upper and lower bay. In 1898 several hundred men found their way to Golofnin Bay in the course of the summer. At the time of the Nome excitement most of them left, but many returned to spend the winter in the timbered region of the Fish River Basin.

The present town of Cheenik is clustered around Dexter's old trading post and in sight of the Eskimo village. Here a number of substantial buildings and numerous tents house a population of several hundred. The town, which has a post-office, includes several stores and a small church of the Swedish mission, which was established many years ago. Ocean vessels anchor about half a mile from the shore, and freight is taken ashore in lighters and small boats. This is accomplished with less danger than at Nome, for the landing has some protection from all but southerly storms. The greatest drawback at Cheenik is the lack of fresh water, which must be brought a mile or more from a creek or taken from holes in the tundra.

Cheenik is the landing place for the supplies, etc., which are bound for Ophir Creek and other placer diggings in the Niukluk Basin. From Cheenik they are taken by river steamer to White Mountain, on Fish River, a distance of 25 miles. White Mountain is usually considered the head of steamboat navigation, though at high water small steamers have ascended the Niukluk as far as the mouth of Melsing Creek. From White Mountain transportation is usually by small boats, which are towed up the river. During low water even rowboats find difficulty in crossing the river bars.

Council, which is distant about 50 miles by river from Cheenik, is the general distributing point of the Upper Niukluk Basin. It has a picturesque site on a bluff overlooking Niukluk River, and in July, 1900, contained about a dozen log and frame buildings and a score of tents. Lying as it does near the western margin of the timber belt of Seward Peninsula, it offers an advantageous location for a winter camp. It can be reached with pack train from Nome in about three days. Above Council there have been no permanent camps established in the Niukluk Basin.

To the west of Nome small camps are scattered along the beach all the way to Port Clarence. They usually consist of a few driftwood huts and tents. The largest settlements are near the mouths of Cripple and Sinuk rivers. Road houses have been established along the route to the Bluestone and Port Clarence, so that it is not necessary for travelers to carry either blankets or supplies.

At Port Clarence a mission and Government reindeer station have long been maintained. Its native population has always been large,[1] and since 1848, when whaling ships first entered the Arctic Ocean, it has been the regular rendezvous for the whaling fleet. Port Clarence is far from being an ideal harbor, but nevertheless it is much better than the open roadstead at Nome, and it affords better protection than Golofnin Bay. A vessel can always find shelter in some part of the harbor, no matter what the direction of the storm. During the excitement incidental to the discovery of rich placers on the Bluestone and at Nome, several so-called "cities" were established near and on Port Clarence. Two of these promise to become the centers of distribution for the adjacent region. The larger place, called Teller, is located on the spit between Grantley Harbor and Port Clarence. In the fall of 1900 it possessed a post-office, numerous substantial buildings, and a population of about 1,000. Ocean-going vessels can approach within about a mile, and vessels drawing 12 feet can be carried over the bar into Grantley Harbor. This inner harbor affords a refuge for small vessels, which can lie close to the shore, and is favorable for landing lighters and small boats during westerly winds, when the outer beach is surf covered. Bering City, which lies some 5 miles to the south of Teller, is also on Port Clarence. In the fall of 1900 it included a population of about 200. It has some advantages over Teller, inasmuch as vessels can approach much nearer the shore and have more protection from easterly and northeasterly winds.

The placer mines of the Bluestone are about 18 miles distant from Teller and about 12 miles from Bering City by overland route. The trail lies across an upland, moss-covered surface, which affords only very poor walking for both man and beast. Supplies are mostly taken in by pack animals. Lumber is taken to the mouth of the Bluestone by steamer, and thence up the river by small boats to the head of boat navigation at the canyon.

The Kugruk region is best reached from Teller by steamer via Imuruk Basin. The head of steamboat navigation is about 75 miles from Port Clarence, and is called Mary's Igloo by the prospectors. From this point small boats are used up Kuzitrin River to the mouth of the Kugruk, where there is a small mining camp called Checkers. From Checkers the transportation to the various creeks is by means of pack train. Checkers can also be reached direct from Nome with pack train via the Nome and Upper Kruzgamepa valleys. The distance is about 85 miles, and, the traveling being fairly easy, can be made in about five days. The Agiapuk can be reached from Teller by boat, or by an overland route with pack horses.

[1] One native village, consisting of about 100 souls, lost 50 per cent of its population by the epidemic of measles, complicated with pneumonia, which during the summer of 1900 was so destructive among the Eskimo of this part of Alaska.

At the mouth of Anakovik River there is a small settlement known as York, which is the distributing point for the region lying to the north. In the spring of 1900 York promised to be a place of importance, but in the early fall its population had been reduced to about twenty or thirty. The settlement includes a number of log cabins and half a dozen substantial frame buildings. During the stormy months of the fall landing at York is difficult, and the place is liable to be shut off from communication with Nome for several weeks at a time. It can be reached overland with horses from Port Clarence, but this route has been but little used. Fifteen miles to the west of York, at Cape Prince of Wales, is the native village of Kengegan, having a population of several hundred, which is the westernmost settlement on the North American continent. The natives are thrifty, and their houses have a neat, well-built appearance. They support themselves by fishing and hunting seals and walrus, but more especially by barter. They make yearly trips in their skin boats to the Siberian coast and import large quantities of reindeer skins, which they dispose of to the other natives, and in recent years to the whites. A Congregational mission has been maintained there for a number of years.

ESTIMATE OF PLACER-GOLD OUTPUT FROM SEWARD PENINSULA IN 1900.

The figures given below are based chiefly on information furnished by Dr. Cabell Whitehead, of the United States Mint, whose residence at Nome during the open season enabled him to get more accurate data than anyone else in regard to the production of the different placer fields.

Anvil Creek	$1,750,000
Glacier Creek, including Snow Gulch	750,000
Dexter Creek	300,000
Extra Dry Creek	15,000
Dry Creek	25,000
Newton Gulch	10,000
Bourbon Creek	5,000
Saturday Creek	10,000
High bench placers near Nome	145,000
Nome Beach	350,000
Oregon, Hungry, and Mountain creeks	50,000
Solomon River	10,000
Topkok Beach	600,000
Daniels Creek	200,000
Ophir and Sweetcake creeks	100,000
Crooked Creek	25,000
Elkhorn Creek	30,000
Goldbottom Creek	10,000
Koksuktapaga	15,000
Kugruk	50,000
Bluestone	75,000
York	1,500
Miscellaneous and undetermined, about	200,000
Total	4,726,500

REGIONAL DESCRIPTIONS.

Nome region.[1]

INTRODUCTION.

In this division it is proposed to describe the drainage basin of Snake and Nome rivers, which include the best placer mines thus far developed in the peninsula. Snake River had its source in the upland region and to the south of the Kigluaik Mountains. It reaches the sea with a southwesterly course through a rather broad, gravel-floored valley. Its headwaters are separated from the mountains to the north by an eastern fork of Sinuk River. After emerging from its valley on the coastal plain, it makes a nearly right-angle bend eastward before emptying into the sea. The total length of the valley is about 20 miles.

The mouth of Nome River is about 3 miles east of Nome. It has its source in a narrow valley in the southern margin of the Kigluaik Mountains. It leaves this narrow valley as a mountain torrent and debouches in a broad, gravel-filled valley, part of the depression already described, which extends along the southern margin of the Kigluaik Mountains. The headwaters of Snake River are separated by very low, flat divides from the upper Kruzgamepa River and the drainage of Sinuk River. After leaving this depression Snake River Valley is narrow for a distance of about 8 miles. Here the valley is almost straight and the river has considerable fall, while below the valley broadens out and the river winds across a gravel-covered flood plain which finally merges with the coastal plain.

The entire region up to the 1,000-foot level is more or less covered with waterworn gravel, though here and there, on prominent elevations of less altitude, the underlying rocks are exposed. Remnants of a series of terraces are well marked on the hillsides as high as the upper limit of the gravel.

Elsewhere it has been shown that in recent geological time the region stood at a considerably lower level, that the shore line extended farther inland than at present, and that estuaries occupied the lower valleys of Snake and Nome rivers. Streams flowing from the hills that were not submerged brought down sand and gravel, which were deposited over the submerged areas. When the uplift occurred and the land assumed its present position, these streams extended their courses to the sea, making their way across the uplifted gravels. Thus it may have come about that most of the streams, in their lower courses at least, and some for their entire length, flow in broad, gravel-filled valleys.

[1] This region is included in the Cape Nome recording district. (See maps, Pls. XIV and XVII.) The Nome mining district, as first organized, included portions of this region, but was limited inland to a distance of 5 miles from the coast. (Compare Appendix A.)

The rocks in the vicinity of Nome belong to the Nome series and are mica-, chlorite-, quartz-, and graphite-schists, crystalline limestone, and massive greenstone (see map, Pl. III). The basal beds are thinly foliated quartz-mica-schists. These are succeeded in ascending order by thin-bedded blue limestone; mica-schists with lenses of quartz containing iron pyrite parallel to the schistosity, of undetermined thickness; and a bed of greenstone, a few feet thick, composed of chlorite, epidote, calcite, and garnet, and so altered that its original composition, possibly diabase, is uncertain. The stratigraphic relations of the greenstone, which occasionally cuts across and sends stringers into the associated rocks, show its igneous origin. Above is a series of chlorite-quartz-muscovite-schists containing some secondary feldspar (albite) and disseminated pyrite; occasionally interbedded with these schists are thin layers of blue crystalline limestone. Black graphitic quartz-schist outcrops on the southern end of the hill west of Anvil Creek. The structure of the rocks is gently undulating; dips are often low, and strikes are variable, giving low dome structures.

This region is distinctly mineralized. The schists in general contain veins and lenses of quartz parallel to the schistose structure and the limestone is commonly traversed by veinlets of calcite. Pyrite-impregnated schists in the hills north of Nome have already been mentioned. The schists on the south side of Glacier Creek and east of Snow Gulch contain mineralized quartz stringers which are reported to contain gold. At the mouth of Grace Creek, a tributary of Buster, the limestone contains disseminated pyrite, and in this vicinity are several veins of iron-stained quartz in mica-schist. The schists in the divide between Anvil and Glacier creeks are traversed by quartz veins containing arsenopyrite, chalcopyrite, pyrite, galena, a little stibnite, and visible gold. As yet no well-defined fissure veins have been discovered. The occurrences are stringers and gash veins. A little development work, consisting of several test pits and one shaft, 5 by 6 feet by 30 feet deep, has been done along these veins. One sample collected by us showed upon assay 9.24 ounces of silver and 1.46 ounces of gold to a ton,[1] and another gave 2.78 ounces of silver and 0.32 ounce of gold. Scheelite[2] is a common accompaniment of the gold in the sluice boxes, but it has not been found in place.

Several pieces, weighing a pound or more, of a massive steel-gray ore, superficially coated pale yellow, have been found as weathered bowlders in Quartz Gulch, a tributary of Anvil Creek from the Anvil-Glacier Creek divide. The ore is a sulphide of antimony and lead containing also a little iron.[3] A sample assayed 14.25 ounces of silver

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[1] Assay by R. H. Officer & Co., Salt Lake City.

[2] Scheelite is a heavy, soft, brownish-white mineral with glassy luster. Its composition is calcium tungstate.

[3] This ore was qualitatively examined by Dr. E. T. Allen, of the U. S. Geological Survey, and he reported as follows: "A compound of lead, sulphur, and antimony, containing some iron. G.=5.44 H.=about 3.5, soluble in HCl. Color, steel gray. Fuses with decrepitation."

and 0.05 ounce of gold to a ton. These veins in the vicinity of Nome are the most promising that as yet have been found in Seward Peninsula. They are not well defined nor of proved extent, yet further exploitation and development are warranted.

It can not be doubted that the source of the gold is in veins of quartz in the rocks adjacent to the placer deposits. Nuggets of a size that precludes distant transportation by flowing water are common. Frequently the gold is jagged and rough and is still attached to bits of quartz, and occasionally nuggets are found with both quartz and schist attached, which union proves the origin and points to slight migration from the source.

The origin and distribution of the unconsolidated beds of the province have already been discussed, but it will be necessary here briefly to recapitulate as much of their history as refers to the Nome region. On the geological map the distribution of the sands and gravels, which are grouped as Pleistocene, is indicated as far as the scale will permit. On this reduced scale it is, however, impossible to represent the gravels of the high terraces. In the vicinity of Anvil Creek these high gravels at one time mantled the entire hill slopes up to an elevation of 1,000 feet. On the steeper hill slopes and in the newly cut valleys these gravels have been removed by erosion and bed rock is exposed. Sufficient remnants of these beds, however, are still preserved to prove that at one time the divide between Anvil and Dexter creeks stood near or below sea level, and that arms of the sea ran far inland as tidal channels and probably cut off some of the higher mountains, such as Mount King. It was during this epoch that these high gravels were deposited in the channels and along the margin of what was then the coast line. Subsequently the region was elevated and these gravel deposits were dissected and to a great extent removed. The uplift was probably intermittent, being interrupted by periods of stability during which the lower terraces were formed. The present coastal plain, with its terraces, is in its genesis, comparable with the higher terraces. The terraces, including the coastal plain, are composed essentially of beds of sand and gravel. In general, it may be said that there is a progressive increase in the size of the material away from the sea and toward what may be considered the parent rock. In the sands and gravels clay beds sometimes containing vegetable remains are not infrequent. These probably were formed above water and are comparable to the present moss and muck which is found forming the upper layer of the terraces. As these clay beds are overlain by sands and gravels they must have been submerged after having been formed. There were, therefore, minor epochs of depression during the general elevation of the region.

The placers of the Nome region can be divided into a number of different groups according to their mode of occurrence. The creek and gulch claims have thus far produced the most gold, have been most extensively worked, and will be among the first to be exhausted. With them are classed the bench placers, which have so far received very little attention and will probably afford rich diggings after the present stream beds are exhausted. The high bench placers, a second group, have thus far been found in only one locality. They promise to be important gold producers. The gravel-plain placers, a third group, include the disseminated gold of the coastal plain deposits and also the concentrations from these deposits found in the numerous smaller creeks which cut into the gravels of the coastal plain in the vicinity of Nome. Deposits of this kind have been important gold producers during the past season. Another group, the river-bar placers, have received but little attention and are relatively unimportant. The beach placers have already become famous the world over. The Nome beach probably reached its maximum production during the first year, but it yielded well in 1900, and will continue to produce some gold. In the following description the placers will be considered from their geographic grouping, the discussion of their genetic relation being left to the section devoted to the summary of the economic geology.

ANVIL, GLACIER, AND DEXTER CREEK REGIONS.

Anvil Creek.—Anvil Creek has proved the richest thus far developed in Seward Peninsula. This creek was the seat of the discovery in the Nome district and was staked by the pioneers, Lindblom, Brinterson, and Linderberg, in September, 1898. It is estimated that the creek has yielded $3,000,000, of which about $1,750,000 was the output for 1900.

Anvil Creek is about 7 miles long. The lower 4 miles are on the coastal plain, while the upper course is in a low, broad valley, a mile and a quarter wide from divide to divide. A well-marked terrace, 20 to 30 feet above the creek bed and about 200 feet wide, extends along the creek and slopes gradually upward. During very dry weather the water is hardly sufficient for mining purposes, but usually there is ample. Bed rock in Anvil Creek bottom is a fissile, graphitic mica-schist. The rocks of the divides are mica-schist, graphitic quartz-schist, and crystalline blue limestone. These rocks are more or less mineralized, as has been shown.

The bed of Anvil Creek near its mouth is very wide and merges with the valley floor of Snake River, to which it is tributary. Near the Discovery claim the valley narrows, and above this point the creek bottom is about 500 feet wide. It maintains about this same width for about 6 miles, up to where the creek begins to narrow, near its source.

The gravels of the creek floor have all been derived from within the basin and include the various types of bed rock which have been described. They have a thickness varying from 3 to 5 feet, and are usually covered by 2 to 3 feet of muck and clay. The gravels generally carry pay throughout their thickness and are all put through the sluice boxes. In the mining operations from 1 to 2 feet of the underlying weathered bed rock is usually found to carry values and is sluiced with the gravels. The richest deposits are found at and in the bed rock. Where the creek valley broadens out, about a mile above its mouth, bed rock has not been reached in the prospect holes. Some gold has been found on a layer of blue clay about 8 feet below the surface. This gold, however, is finer than that found on the bed rock on the stream above and the deposit is not nearly so rich.

Anvil Creek has produced gold throughout its length and all of the claims have paid profits. They are, however, not all of equal richness, and this is probably due to the fact that some of the gold has been contributed by the old terraces, which, being dissected by smaller tributaries, have contributed their gold to the main stream.

The bed of Anvil Creek for nearly 3 miles has been practically all worked over once during the last two years. Future developments will be directed toward the bench claims, which up to 1900 were practically untouched, and toward reworking the creek gravels with more refined methods of separation. In the lower course of the creek dredging may also be found profitable.

Anvil Creek gold is both coarse and fine. Nuggets up to $300 in value have been found, and $2 and $3 nuggets are very common. It is irregular, generally chunky rather than flat, and has a dark yellow, sometimes almost brown, color. The fineness of the gold, according to Dr. Cabell Whitehead, is 0.890, or $18.33 per ounce. Quartz and fragments of a schistose rock are often found attached to nuggets. Among the heavier minerals in the concentrates magnetite and garnet are most common and occasionally scheelite is found.

Anvil Creek receives a number of small tributaries on both sides of its valley. These streams have incised V-shaped gulches in the valley slope and in many cases have trenched the benches. The richest of these gulches are those flowing from the east and heading in the gravel-capped divide between Dexter and Anvil creeks. Those joining Anvil from the west are reported not to pay as well. Nikolai and Specimen gulches are the richest that have thus far been reported. Their gold is derived from the placers of the terrace gravels in which they head, and this reconcentration makes them very rich. On Specimen Gulch the gravels under the soil are about 6 to 10 feet deep and all carry values. On Nikolai Gulch the bed rock is crystalline blue limestone and mica-schist. The gravels, which are chiefly mica-schist and quartz, are about 3 feet thick, and the whole carries gold. The rich part of the pay streak, which is said to average $1.50 to the pan, lies chiefly on bed rock. The gold is coarse and of a rusty color;

its purity is somewhat greater than the Anvil gold, as it runs $18.65 to the ounce. A $14 nugget has been found, and several worth about $5.

Glacier Creek.—This stream enters Snake River 8 or 10 miles above the mouth of Anvil Creek, and is about 6 miles long. The lower half of its course lies in the flat valley of Snake River, above which its valley is comparatively narrow. The creek always affords plenty of water for sluicing. The bed rock as far as determined is mica-schist and chloritic-schist. The valley slopes of the creek are gravel-capped up to an elevation of about 1,000 feet, and remains of several terraces are distinctly traceable. The most prominent terrace, 150 feet above the creek bed, is on the north side of Glacier Creek, opposite the mouth of Snow Gulch. Prospecting on this bench was undertaken in September, 1900. Coarse colors of gold were found from the moss down, and the outlook was very promising.

The developments on Glacier Creek are confined to the vicinity of the mouth of Snow Gulch. Near the mouth of Snow Gulch the bed rock is mica-schist, and this is overlain by about 6 feet of gravel, the pebbles of which are chiefly mica-schist and quartz. The rich pay streak is about 2 feet thick, but the gravels all carry values and are put through the sluices. The gold is fine and the miners employ mercury in saving it. In the concentrates garnets and scheelite are abundant. Some work has been done above the mouth of Snow Gulch, where the conditions are similar, but the gold is coarser. One $83 nugget is reported from these claims.

Snow Gulch is the only tributary of Glacier Creek which has thus far produced gold. It joins Glacier Creek about 3 miles from Snake River. Its source lies in a shallow basin, which is gravel filled, while its lower course is through a rather sharply cut gorge; the total length is about a mile.

The bed rock near the mouth of Snow Gulch is chloritic schist, and the strikes are about at right angles to the course of the stream. Near its head some blue limestones are exposed. A quartz vein near the divide has been found to carry some gold. The gravels are 3 or 4 feet in thickness, and are chiefly quartz and mica-schist.

Its topographic form makes Snow Gulch almost ideal for the concentration of gold. In point of fact, it has proved the richest stream of its size so far discovered, for in the two seasons that it has been worked it has produced upward of a million dollars. At present the stream gravels have been practically all worked over, so that the gulch has reached its maximum production.

Dexter Creek.—This stream is tributary to Nome River from the west, about 12 miles from the sea. The lower mile of its valley is incised in a broad terrace of Nome River. Its headwaters are in a basin which is carved out of the high gravel terrace that has been described. Below this basin the valley contracts and has gravel-covered walls, but is cut to bed rock, which is limestone and mica-schist.

Near its mouth gold has been found on a blue-clay layer some 5 feet below the surface. About 3 feet of gravel, consisting chiefly of mica-schist, limestone, and quartz pebbles, with some greenstone, carries values. In this part of the creek the gold is comparatively fine, the largest grain being worth perhaps 10 cents.

This deposit on blue clay continues up the stream for about a mile, when the first bed rock, which is blue limestone, is exposed. Here the gravel is 4 to 6 feet thick, the pay streak being at the bottom. The gold is coarse, the largest nugget found having a value of $22. In going upstream the claims are found to be richer and the gold coarser. There is progressive decrease in the thickness of the gravel. The bed rock of mica-schist and limestone lies nearly horizontal.

Several tributary gulches have been shown to contain rich placers. These head for the most part in the high gravel terraces. The important gulches are the Left Fork of Dexter, Grass Gulch, Deer Gulch, and Grouse Gulch. On the latter a $67 nugget has been found. The terraces on Dexter Creek, except at its source, have received no development, and as the creek bed becomes exhausted the mining enterprises will be turned toward them. The developments of Dexter Creek have been much hampered by the lack of water. For the lower claims water was pumped from the river. So rich were some of the claims near the source that during the dry season water was brought 2 miles, at a cost of $2.50 a barrel.

Dry Creek.—This stream heads in a flat divide which separates it from the South Fork of Dexter Creek. It reaches the sea at Nome, after crossing the coastal plain, in which it has incised a shallow trench. The lower part of the creek will be discussed under the heading "Gravel-plain placers." In its general form it much resembles Dexter Creek, as its source lies in a high gravel terrace, in which it has cut a basin and below which the valley contracts. About one-half mile from its head the bed rock, consisting of chloritic schist, is about 6 feet below the surface. The upper layer is muck about a foot thick, below which is 3 feet of sandy clay with some rock fragments, and below this 2 feet of gravel which carries gold. Underneath this gravel is a thin layer of clay, which overlies the bed rock. The gravels are limestone, mica-schist, and quartz, with some fragments of biotite-granite.[1] A number of claims have been worked on Dry Creek, and work has also been done on Bear Gulch, a westerly tributary which heads in the high gravels.

Extra Dry Creek.—Extra Dry Creek is about 2 miles long, and flows into Nome River from the west about a mile and a half below the mouth of Dexter Creek. At its extreme head it has a narrow channel,

[1] The source of this rock has been traced to the Kigluaik Mountains, and its occurrence has been described under the heading "Geology."

but for most of its course it flows through the flat valley of Nome River. Near the head of the creek a few $5 nuggets were found. A section in the creek bed about one-half mile from its head, where the richest placers have been found, shows 1 foot of muck, 1 foot of sandy clay, 6 feet of schist and quartz gravel on mica-schist lying nearly flat. Only the lower 2 feet of gravel are worked with rockers, the water being obtained from springs. The largest nugget found was worth $13, and several averaging from $3 to $6 have been found in this part of the creek, some with attached quartz. In the lower part of the creek the gold is fine and little work was done.

High bench placers.—The flat divide between Anvil and Dexter creeks is covered with gravel having a varying thickness. A similar gravel deposit occurs in the divide between Dexter and Dry creeks, and the gravel layer found on the divide between Anvil and Glacier, and on the north side of Glacier, belongs probably to this same period of deposition. The upper surface of this gravel marks a plain, but its thickness is extremely variable. Its deposition has been assigned to a period of depression when the entire region stood 500 or 600 feet lower than it does now. The gravels were probably laid down in estuaries and along the shore. As the floor on which the deposits were laid down was irregular, we should expect to find great variations in thickness. The facts that have been gleaned from a few prospect holes show a depth to bed rock of only a few feet in some localities, and in others 150 feet. The deposits include gravels, sands, and clays. Lithologically the gravels are composed of the various types of country rock that are exposed in the immediate vicinity, but also include fragments of biotite-granite, which must have been brought from a distance. The transportation of the latter has elsewhere been ascribed to floating ice.

During last season considerable prospecting of some of these high gravels was carried on.[1] At the head of Grouse Gulch 60 feet of clay is reported to overlie 98 feet of sand gravel which rests on a limestone bed rock. The sands and gravels are said to carry gold. Another hole on the same divide gave the following section:

	Feet.
Yellowish gravel and clay	5
Dark-gray gravel	6
Blue clay and sand	20
Cemented gravel	7
Schistose bed rock	5

The lower 7 feet are reported rich in gold, some of which is rather coarse, one 80-cent nugget having been found. An attempt is to be made to drift in on the pay streak during the winter.

[1] In their "Preliminary report" (p. 20) Messrs. Schrader and Brooks called attention to these high gravel deposits and suggested the probability of placer gold being found in them. This prediction, which was made (1899) before any prospecting had been done in this form of deposit, has been amply verified by the developments of last season (1900).

On the divide between Nikolai Gulch and Dexter Creek some rich claims have been developed in the high gravels. At this point the following section was developed by the test pitting:

	Feet.
Moss and muck	$1\frac{1}{2}$
Clay with some gravel	2
Dark-brown sand	2
Gravel of mica-schist and quartz	14
Bed rock.	

A rich pay streak has been found in a layer of gray sand close to bed rock, and also in the bed rock, which is disintegrated to a depth of about 3 feet. The gravels on this divide have been found very rich, it being estimated that $150,000 has been taken out of two claims. The washed gravels on the divide between Dexter and Dry creeks reach an elevation of 1,000 feet. A test pit which has been sunk to a depth of 50 feet did not reach bed rock or any gravels which yielded values. Comparatively little investigation has been made of these high gravels, but they will probably become important gold producers.

OTHER STREAMS TRIBUTARY TO NOME AND SNAKE RIVERS.

Buster Creek.—Buster Creek flowing from the northeast enters Nome River a short distance below Dexter Creek. It is only about 3 miles long, and, like the other creeks of this region, has a relatively narrow upper valley, while its lower course is through a wide gravel plain. The creek furnished ample water for sluicing except in July.

Some claims on this creek made good returns in 1899 and again in 1900. The creek affords from 2 to 3 feet of gravel containing pebbles of schist, quartz, greenstone, and some granite overlying bed rock of mica-schist. The gold is coarse, and the largest find is said to have been worth $18.

Near the mouth of Lillian Creek, a tributary of Buster from the north, 5 or 6 feet of schist and quartz gravel containing some granite pebbles overlie bed rock.

Four claims at the head of Lillian Creek were worked during 1900. Here from 3 to 5 feet of schist and quartz gravel overlie mica-schist bed rock. Only the lower 8 inches of this gravel are worked. The largest nugget found was worth $4.10. About twenty varying from 80 cents to $1.50 are reported. The gold is coarse and rough.

Dewey Creek.—This stream rises in the limestone hills a mile and a half north of the head of Lillian Creek and flows into Nome River about 4 miles above Buster Creek. At its head Dewey Creek has cut a gorge from which it emerges to flow through the gravels adjacent to Nome River. Some gold has been taken from this creek, but not very much. A claim at an elevation of 300 feet probably has yielded the most. The section in the creek bed, to which work has been confined, is 1 foot muck, 1 foot sandy blue clay, 3 feet gravel with pebbles of schist, quartz, greenstone, limestone, and granite. The gravel carries gold. Below is a false bed rock of sandy clay. The gold is rather light in weight, the largest piece being worth only a dollar. Considerable scheelite and garnet are associated with the gold and not much magnetite. It has been reported that a natural amalgam occurs in the gravels of Dewey Creek, but was not found by us; nor did we find any cinnabar. Colors have been found in the high gravels, which run up to 800 feet in the neighborhood.

Banner Creek.—This is a small stream tributary to Nome River from the west, about 3 miles above Dexter Creek. Its bed rock is schistose greenstones and limestones. Colors have been found on this stream, but no paying placers. It must be said, however, that but little prospecting has been done. The stream is a small one, and during dry weather does not furnish a sluice head of water.

Basin Creek.—This is an easterly tributary of Nome River, about 4 miles below Hobson Creek. It emerges from the eastern valley wall of Nome River through a narrow canyon cut in limestone. Above this canyon the creek broadens out into a basin which suggested its name. Just above the canyon the gravels are about 10 feet thick, overlying a limestone and greenstone bed rock. Some gold has been found on this creek, and one claim has undergone considerable development.

Hobson Creek.—This stream joins Nome River about 20 miles from the sea. It has a rather narrow valley and a southerly course. The bed rock is similar in character to that of Dorothy Creek. Considerable prospecting and some development have gone on in this stream, and the miners report good colors.

Dorothy Creek.—This stream is tributary to the upper part of Nome River. It flows through a small canyon having a general northerly course. Above the canyon the valley broadens out to a small basin having a gravel floor. The bed rock is limestone with greenstone intrusives, which strike in a northeasterly direction and dip northwest. Mineralized quartz veins are very plentiful. Where it emerges from its canyon into the broad valley of the Nome, Dorothy Creek has a gravel flood plain. This gravel is about 3 feet thick and overlies a greenstone-schist bed rock. Considerable prospecting has been done along the whole length of the creek, and in its lower course a number of claims have received some development. A bench which lies about 20 feet above the creek bed would seem to be worthy of attention by the prospectors. As high as $1 to the pan on bed rock has been reported. The gold is of a bright color and flat in form, and is said to be very pure. The stream is, unfortunately, a very small one, and during dry weather does not yield a sluice head of water.

The description of the streams of the Upper Nome might be indefinitely prolonged, as nearly every tributary, no matter what its size, has been staked and named. Comparatively little prospecting has, however, been done on any of these streams, and our time was too limited to visit them all.

The Upper Snake drainage basin has, to the present time, yielded but little gold. The bed-rock geology has already been referred to, and in general the streams are in character similar to those described on Nome River. The North Fork of the Snake and also Goldbottom Creek are said to have yielded gold, and some sluicing is said to have been done. As in the case of the Nome River Valley, the entire drainage basin has been staked, but with the exception of the well-known creeks lying near the sea, which have been already described, there has been very little prospecting. Gold has been found on Last Chance Creek and a little sluicing has been done. According to Mr. E. C. Barnard, Twin Mountain Creek has produced some gold.

Bar diggings.—Both Nome and Snake rivers are known to carry gold in their bars, but this has received little or no attention. An attempt was made to dredge on the Nome, but was abandoned before it had received a fair trial. The gold of the bars is fine, and is comparable to the beach and the coastal plain deposits. In sections of their upper courses these rivers flow near bed rock and are known to carry colors, but have not been prospected. A good test could be made of the gold contents of the Upper Nome by examining the gravels of the upper basin just above the constricted portion of the valley, which seem to offer favorable conditions for concentration of the gold.

GRAVEL-PLAIN PLACERS.

General description.—The crescent-shaped coastal plain which intervenes between the highlands and the sea in the vicinity of Nome has already been described. The sandy beach slopes up from the ocean at an angle of about 5° to an escarpment 10 to 20 feet high (Pl. IX, *A*). This same slope is carried seaward at a lower angle and gives the shallow bottom which extends out about a half mile from shore. From this escarpment the plain extends inland to another escarpment, which marks the seaward limit of a second bench which is about 50 feet high. In some places this second bench lies within a quarter of a mile of the shore, while elsewhere it has receded much farther inland. A third bench, 100 feet or more in height, lies still farther from the coast, and from this the coastal belt merges with the upland in a succession of smaller and less-marked benches.

It has already been shown that the region has been gradually elevated during recent geological time. The coastal-plain terraces, like the high benches already described, are made up of material that was deposited along the margin of the shore while the land stood at lower elevation relative to the sea than it does now. The successive benches mark a series of interruptions in the uplift, when the land stood at a constant elevation long enough to permit the accumulation of the material of which the terraces are formed.

The sediments of the coastal plain are predominatingly of fine material, usually sand and sandy clay, with some coarser gravel layers, and frequent beds of clay. Broadly speaking, these sediments increase in coarseness in an inland direction. They were contributed by the streams and rivers, which gradually built out their deltas. These coastal-plain deposits were laid down on a rock surface which had been more or less channeled by streams and which must have been very uneven, and the consequence is that there is probably great variation in their thickness. Near the town of Nome, bed rock reaches close to the surface, and in close proximity pits 30 feet deep have failed to reach bed rock. Locally the thickness may be 100 feet or more. Therefore mining enterprises which depend on reaching bed rock must in every instance make a preliminary determination of thickness by boring or by sinking test pits, as generalizations regarding thickness are liable to be entirely in error.

The gravels and other sediments of the coastal plain have the same origin as those of the creeks and gulches which have already been described, and hence we should expect them to be auriferous, and such is the case. The gold of the coastal plain, having been carried farther from the parent rock than the creek and gulch gold, is much finer. In character it is more closely allied to the gold of the river bars.

The gold deposits of the coastal plain may be grouped under two headings: The first are the gravel-plain placers, in which the gold first accumulated. The gold is more or less disseminated through the gravels, sometimes concentrated on a clay bed, but characteristically in an unconcentrated form. The placers of this description have received but little attention. Where they are unconcentrated they can be worked only on a large scale, with improved machinery. The success of such mining would be dependent on handling a large quantity of material and on saving all the gold by refined methods, rather than on the finding of the rich pay streaks.

As these coastal-plain deposits were laid down at the margin of the ocean we should expect old sea beaches to be found in these gravels. If such beaches are found they are likely to prove as rich as the present beach at Nome. It would therefore be well for the prospectors to examine carefully the seaward side of the different escarpments which mark the limits of the terraces. These bluffs are quite likely to mark an old sea beach. In such types of deposits we should expect their extension to be more or less parallel to the present coast line.

The second form of deposits is composed of the gulch and creek placers of the coastal plain. This class of deposit includes the placers of the smaller streams whose sources lie within the coastal plain. As these streams do not reach bed rock their placers must have derived their gold from the gravels in which they flow. These placers are in fact reconcentrations of the auriferous gravels of the coastal plain. They form natural sluices in which the disseminated gold of the gravel-plain placers has been collected. This concentration has usually taken place on a stratum of clay, or "false bed rock," as the miners term it. As these layers of clay are liable to be encountered at different horizons in the gravels, there may be a number of pay streaks, one above the other, separated by sands and clays.

Most of the development that has been made so far is in that part of the coastal plain which lies between Nome and Snake rivers. The probabilities are that this area includes the richer portion of the coastal-plain deposits. This corresponds in a general way with the distribution of the richer placers of the Nome beach, which, as will be shown, derived their gold from the coastal-plain deposits. In the detailed descriptions which follow, the heterogeneity of the coastal-plain deposits is well illustrated. Test pits but a few yards apart show very different sections. In the coarser gravels cross bedding such as would be expected in deltas is not uncommon. The surface layers in all the sections consist of a foot or two of moss, other vegetable growth, and muck. Below this mantle the ground is usually found to be frozen, in summer as well as in winter. The few sections that were obtained, as will be seen, show a pay streak consisting of rather coarse gravel, 1 to 3 feet in thickness, and always overlying a clay bed. The pay streaks which have thus far been mined were found from 1 to 10 feet below the surface. The sands and gravels are usually found to carry gold from the surface down, but are never concentrated except on a bed of clay. The creek and gulch placers of the coastal plain at Nome are estimated to have produced about $150,000 during last season.

Detailed description of placers.—Dry Creek heads on the east side of Anvil Mountain and flows southward about 6 miles to Bering Sea. Its upper 2 miles are within a narrow valley and have been described elsewhere. The remainder of its course is in a shallow trench across the coastal plain. About 1½ miles from the foot of the upland the workings on this creek showed the following section:

	Feet.
Moss and muck	3
Sandy clay	3
Gravel, composed of mica-schist, limestone, etc. (the pay streak)	8
Clay (thickness unknown).	

The depth to bed rock at this place is not known. One mile above, near where the creek debouches on the coastal plain, a shaft has been sunk 32 feet through gravel to bed rock. Colors were found, but no well-defined pay streaks. The gold found along Dry Creek is light colored and of varying coarseness. A $1 nugget was the largest piece reported. The concentrates in the sluice boxes consist of much black sand and considerable scheelite.

Newton Creek is an easterly tributary of Dry Creek, which it joins about a mile from the foot of the upland. During our examination (September 20, 1900) three claims were being worked. Near the point where the creek emerges from the hills three men were sluicing in the bed of the creek, where from 2 to 6 feet of gravel overlies mica-schist bed rock.

One-quarter of a mile below this point a pit 30 by 50 by 10 feet deep had been excavated about 50 feet to the east of Newton Gulch, exposing the following section. The claim was being opened up preparatory to drifting during the winter.

	Feet.	in.
Sandy clay	3	
Schist gravel, somewhat cross bedded		6
Sand	2	6
Gravel		7
Sand and gravel		3
Pay streak, consisting of schist gravel	3	
Clay (thickness not known).		

About three-quarters of a mile from the hills considerable stripping was done during the summer, though sluicing was not begun, for want of water, until about the 1st of September. Several dams were constructed, two drains dug, and a volume of gravel 400 by 40 by 5 feet stripped. Several test holes were also sunk in the adjacent tundra to a depth of about 15 feet. In the upper part of this claim digging exposes the following section:

	Feet.
Muck and moss	2
Schist gravel and clay	2
Reddish sandy clay	3
Pay streak, gravel	3
Clay (thickness not determined).	

Prospects in the bed of the creek are said not to be so good as in the tundra just west of the creek.

Bourbon Creek rises on the tundra and empties into Dry Creek from the west side about half a mile above its mouth. At claim No. 2 the following section is exposed, from the surface down:

	Feet.
Blue and red clay	4
Gravel, the pay streak	2
Quicksand (of unknown thickness).	

A ditch 200 by 3 by 6 feet has been dug 20 feet east of this creek. It was said that it hardly pays for rocking, though it might pay for sluicing.

About one-half mile below the above claim the following section is exposed in the tundra 10 feet east of the creek bed:

	Feet.
Moss and muck	2
Rock and blue clay	6
Gravel	1
Blue clay	$\frac{1}{2}$
Schist gravel, pay streak	1
Clay (of unknown thickness).	

In a gulch called Holyoke Creek, about a quarter of a mile west of No. 3, Bourbon Creek, some developments had been made to the west of the stream bed. The section showed 1 foot of muck, 1 foot of clay, and 1 foot of gravel carrying gold, below which is a bed of clay. A nugget of the value of a dollar was found here, but in general the gold is much finer.

A little work was going on at the foot of the uplands in the dry bed of Cooper Gulch. Here four men were rocking, but claimed barely to make wages. The section is as follows:

	Feet.
Moss and muck	1
Gravel carrying values	8–10

A short distance to the west of Cooper Gulch a test pit showed some 30 feet of gravel carrying little if any gold.

Saturday Gulch, a small tributary of Wonder Creek, had one claim in operation about a mile from the foot of the mountain. When the claim was visited, in the latter part of September, six men had been at work a month. They had dug a ditch 200 by 20 by 5 feet in the bed of the gulch, exposing 2 to 3 feet of muck, below which is 3 feet of schistose gravel containing the gold. This is generally bright yellow, though some is dark, and all is rather coarse. The largest nugget found here was worth $14.50. Nuggets worth from 25 cents to a few dollars are common. Some of the gold is smooth and some rough. Frequently quartz is attached to the gold. The concentrates consist of magnetite and garnets, with some scheelite.

Most of the mining developments in the coastal plain are west of Nome River, but at several localities prospects have been opened up to the east of the river. Stevens and Washington gulches flow through the tundra from the hill south of Osborn Creek into Nome River. Sections in the stream bed show 1 to 1½ feet of moss and muck, then 3 feet of schistose quartz, greenstone, and granite pebbles over a clay "bed rock." The gold is fine, and is associated with garnet and magnetite. No rich pay streak has been found.

Three miles up Nome River, in the bench just east of the river, several prospects have been opened up which seem to promise well. Possibly this is the site of an old beach deposit. Below 2 feet of muck and moss and 10 feet of gravel composed of schist, quartz, greenstone, and granite pebbles gold is said to be distributed throughout the gravel and to be both coarse and fine. Some nuggets are said to have been found at this locality, the largest of which was worth $6.

BEACH PLACERS OF NOME REGION.

General description.—It has been shown that the lowest bench of the coastal plain ends in an escarpment, 10 to 20 feet high on the seaward side (Pl. IX, *A*). From the base of this escarpment the beach slopes to the sea at an angle of 4 to 5 degrees, having a width of about 50 to 75 yards. Ordinarily the wave action is confined to the lower third, but during severe storms the surf sometimes rolls up the full width of the beach.

The surface material of the beach is usually sand with occasional shingle and gravel. The pebbles, which have the characteristic oblate spheroidal form of beach shingle, are composed largely of quartz, but also of the various types of country rock of the adjacent region. Pebbles of more than an inch or two in diameter are relatively rare, but occasionally small bowlders are found, which probably owe their position to the drifting of shore ice.

The beach sand consists largely of quartz, usually stained with iron, and mica- and chlorite-schist fragments. Reddish garnets form an important constituent, sometimes predominating over all the other minerals, and then constituting the "ruby sands" of the miners. Magnetite is always present, but usually forms less than 1 per cent by weight, though in the concentrated form found in the pay streaks it may run as high as 10 per cent. Such percentage, where the material is fine, gives the sand a dark color, and it is then termed "iron sand" or "black sand" by the miners. Mr. Collier made a separation, by sifting, of a typical beach sand taken from a prospect hole near Nome, with the view of determining approximately the relative proportion of the different sized particles by weight. A sample of sand was put through sieves of different meshes, with the following results:

38 per cent coarser than 20-mesh sieve.
42 per cent coarser than 40-mesh sieve.
16 per cent coarser than 60-mesh sieve.
3 per cent coarser than 80-mesh sieve.
1 per cent finer than 80-mesh sieve.

The coarse material was chiefly quartz and schistose rock fragments. The garnet percentage was about 4 or 5 by weight and the magnetite less than 1. Mica is plentiful, but forms a relatively low percentage by weight.

An average cross section of the beach sands, as determined by an examination of the pits made during the mining operations, was as follows: Near the edge of the tundra a blue clay bed is found close to the surface, and seems to slope seaward. Halfway down the beach toward the water this clay bed can usually be recognized at a depth of 5 to 7 feet. These statements in regard to the clay bed have a general application, but the writer does not wish to imply that this one bed can be traced the entire length of the beach. In some cases several seams can be recognized, and in others the clay seems to be entirely lacking. It is true, however, that in most of the workings a clay bed has been found a few feet below the surface which slopes toward the sea. The thickness of this clay stratum has not been determined, but it must aggregate several feet. Immediately above the clay are usually fine sands, though sometimes coarse gravels. This layer of sand, which includes the gold of the beach placers, contains, as a rule, a larger percentage of the heavier minerals than the beds above. The higher beds include coarser and finer material, such as sands and gravels, with occasional thin seams of clay. Sometimes fragments of wood and other vegetable matter are found in the beach sands, but these are relatively rare. When traced horizontally the various layers which make up the beach sands above the clay bed are found to be thin lenses, which rapidly thin out and seldom can be traced a hundred feet. The coarse gravels are usually found in pockets, often but a few feet in lateral extent.

Occurrence of the gold.—The beach sand, from Cape Nome to Rodney Creek, a distance of about 30 miles, nearly everywhere carries colors of gold. Broadly speaking, the richest diggings have been confined to about 20 miles of the shore in the central part of this stretch. In this belt colors are obtainable nearly everywhere at the surface, but the beach proper, as a rule, carries values only some feet below and on clay beds. The pay streak measures from 6 inches to 3 feet, and rests on a clay bed at nearly every locality that was examined. The thickness of the productive sand layer at any one locality is a variant, depending on the refinement of methods used in mining and extracting. Where the ordinary cradle is used, from 6 inches to 2 feet of sand are washed. With the employment of more elaborate methods, where larger amounts of material are handled, all of the sand and gravel from the surface down to the clay bed is often sluiced. Sometimes two pay streaks are found, one on the clay and one a foot or two above, separated by intervening layers of nearly barren sand. The gold-bearing sand slopes with the clay bed fron the coastal plain escarpment toward the sea. Near the margin of the tundra it is often found close to the surface, but near the sea it is from 3 to 6 feet below. Irregularities in the occurrence are introduced by the presence of two pay streaks, each resting on a minor clay bed. The accompanying photograph (Pl. IX, *B*), taken by Mr. Schrader, and reproduced from the report already cited, gives a typical section of the beach sand near Nome. The lowest pay streak seen in the picture, which is said to run $1 to the pan, is among the richest that have been found in the beach.

A. NOME BEACH DIGGINGS.

Shows relation of beach to coastal plain.

B. NOME BEACH GRAVELS, 2 MILES WEST OF NOME.

Layer of garnetiferous sand near base.

The richest part of the pay streak in its horizontal extension, similar to the layers of sand and gravel, is found to be of lenticular form, thinning out toward the margins. The sand of the pay streak differs in no way from that of the beach, except that it is usually finer and carries a larger percentage of the heavy minerals. There is often a progressive increase of the heavier minerals toward the pay streak. While in the surface sands the percentage by weight of the magnetite is often less than 1, near the clay bed rock it may run up to 8 or 10 per cent. In any given section the amount of garnet also increases toward the bottom of the sand layers.

A sample of gold-bearing "ruby" sand from a locality east of Nome River, 5 feet below the surface, was sifted by Mr. Collier, and the following percentages by weight were obtained:

3 per cent larger than 20-mesh sieve.
29 per cent larger than 40-mesh sieve.
53 per cent larger than 60-mesh sieve.
11 per cent larger than 80-mesh sieve.
3 per cent larger than 100-mesh sieve.
1 per cent smaller than 100-mesh sieve.

A rough mineralogical separation of the same sample resulted as follows:

38 per cent quartz stained with iron, with some fragments of schistose rock.
61 per cent garnet.
1 per cent magnetite.

Another sample of auriferous sand gave the following results:

65 per cent chiefly quartz and mica, with some fragments of schistose rock.
34 per cent garnet.
1 per cent magnetite.

A third sample from Nome Beach, 7 feet below the surface, was constituted as follows:

96 per cent quartz and schist fragments, mica, etc.
3½ per cent garnet, magnetite, etc.

The above separations show that the minerals of beach sand can not be regarded as having anything like a fixed ratio.

Time has been lacking to make a complete mineralogical examination of the auriferous sands. The following minerals, however, have been noted in abundance: Quartz, muscovite, chlorite, and garnet; and as accessories magnetite, ilmenite, and pyrite.

Large flakes of gold are occasionally found (compare photograph of gold, Pl. XII), but these are relatively rare. Some small nuggets have been reported, running up to the value of $1, but are very exceptional. In purity it is about 0.890, has a bright-yellow color, and amalgamates readily.

The gold is flaky, and the average grains as saved by panning will run from 70 to 80 to the cent, valuing the gold at $14 an ounce. A comparison of it with beach gold from other localities shows it to be rather coarser. The beach gold from Randolph, Oreg., averages about 110 colors to 1 cent. That from the Sixes mine near Denmark, Oreg., averaged about 600 colors to the cent. The river bar gold from the Snake River, Idaho, which is mined at a profit, runs from about 900 to 1,000 colors to the cent.[1] In making these comparisons it should be remembered that much of the fine gold of the Nome deposit is lost during the process of separation, and that this will increase the average size of the colors that are saved.

Origin of beach placers.—The source of this beach gold has been the subject of much discussion among the miners and prospectors of Nome. Theories as to its glacial origin are common, and hypotheses which assign its source to volcanic or meteoric agencies are not without supporters. The more careful students of the question, be they prospectors who have gained their knowledge by practical experience, or mining engineers who have had theoretical as well as practical training, are generally agreed that the beach gold has the same source as the creek gold, and are at variance only on the question of its mode of distribution.

There can be no doubt that the beach gold found its source in the bed rock of the adjacent region and that it was transported to its present position by water. A theory which is often advocated assigns its distribution to the action of shore currents—that is, that the gold was brought down by the rivers and distributed along the shore by currents. In support of this theory attention is drawn to the fact that the richest deposits occur near the mouths of rivers which have their source in the gold-bearing area. The objections to this mode of distribution are: First, we have no evidence that such currents exist along the coast, and to suppose that the beach gold was distributed by currents at Nome we must believe that the currents run in both directions from the mouths of the rivers. For instance, beach gold is found along the shore in both directions from Snake River. If this river contributed the gold, it is difficult to understand why it should be found in both directions from the mouth. Second, objection is made that the river bars do not contain as much gold as we should expect if they had been the immediate source of the beach gold. Third, the gold is too coarse to be carried by ocean currents. Fourth, its distribution in the beach sands shows that it must have been concentrated by wave action. If we are to suppose that the gold was brought alongshore by ocean currents, the waves must have washed it up on the shore, and subsequently given it its peculiar form of concentration. If the gold was borne by ocean currents, we should expect to find it in the present ocean bottom of the same degree of coarseness

[1] Gold in the Snake River gravel bars, by William H. Washburn, Mining and Engineering Press, December 29, 1900.

as it is found on the beach. As a matter of fact, the little gold that has been obtained off the coast of Nome has been much finer than the beach gold. These objections to the theory of current distribution seem to be insuperable.

Attention has already been directed to the fact that the sand and gravels of the coastal plain are auriferous. Evidence has been given that points toward the conclusion that these deposits were laid down at the mouths of streams when the land stood at a lower elevation relatively to the sea than it does now. The streams and rivers gradually encroached on the sea floor by the building out of their deltas. In these delta deposits gold was laid down with the other material, and was more or less disseminated.

In the "Preliminary report" Mr. Schrader and the writer advanced the theory that the gold was concentrated from the coastal plain gravels by the wave action which cut the seaward escarpment of the plain. The diagrammatic sketch (fig. 1) which we published to illustrate this point is here reproduced. In this sketch the edge of the coastal plain escarpment is marked and the position of the beach

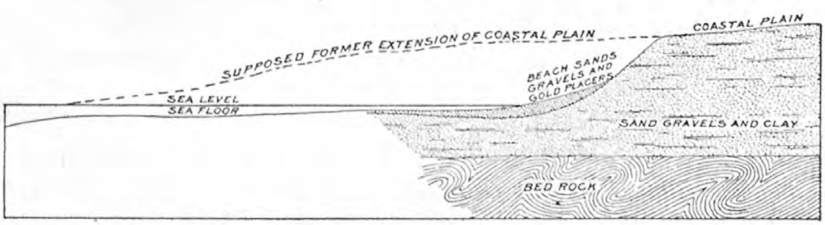


Fig. 1.—Diagrammatic section of beach placers.

placers in reference to it is shown. During high storms the waves even now reach the margin of the escarpment and cut away the base of the bluff. The materials which go to make up the coastal plain are sorted by this wave action, and the heavier particles, such as the gold, sink into the sand. It is a well-known fact that this fine gold will make its way through sand for some distance, provided its passage is not interrupted by any impervious layer. This downward movement is brought about near the surface of the beach by the constant motion which is given the sand by the waves. The percolating waters will also help to carry the grains of gold downward. It should be noted here that the beach sand, being well drained, is not frozen in summer. In the course of its downward passage the gold finally reaches a clay layer, and here becomes concentrated as it is found. There is another factor which may have accelerated the downward movements of the heavier particles. In the spring months southerly storms frequently pile up the ice on the Nome beach to a great height. When large floes are driven ashore on the shelving beach they must cause considerable movement in the underlying sands, and this motion is probably transmitted to a depth of several feet, and causes a disturbance among the grains of sand. A sort of sifting process would take place by which the heavier particles would always descend and eventually be concentrated beyond the line of movement or on impervious layers which they could not penetrate.

The explanation by wave sorting may perhaps account for other beach placers. Mr. J. S. Diller informed the writer that the richest beach diggings on the Oregon coast are at points where waves have access to high bluffs. In fact the Oregon and California beach placers have many things in common with those of Nome, but their gold seems to be much finer. In the early developments, however, of these southern beach deposits some diggings were mined which were more comparable to those of the Nome region in their richness and the coarseness of their gold. But these were long ago exhausted, and the operations are now confined to localities where careful and economic mining and separating methods enable the operators to work deposits which are of comparatively low grade.

A question of interest is whether there may not be old beach placers in this region similar to those that are found in Oregon. It has been assumed that this part of Seward Peninsula has in comparatively recent times been elevated to a height varying from 600 to 1,400 feet. Attention has been drawn to benches which are believed to represent former shore lines. It is a logical conclusion that during this period of uplift similar beach placers have been formed in the region, and a search for them should be a fruitful field of investigation. It has been suggested elsewhere that some of the escarpments in the coastal plain may mark former shore lines.

Conclusion.—Mining operations on the Nome beach have all been carried on in a very haphazard way. During the first year the methods used were those of the hand rocker, and it was everybody's object to secure a rich patch of ground which would pay for the mining by this crude method. There was then ample room for the men who took part in the beach diggings. No claims were staked, and no serious quarrels arose because of trespass. In the second year of the operations a vast deal of mining machinery was imported, and many attempts were made to handle the beach sands at small cost. These enterprises were, on the whole, not paying ventures. The high freight rates in the Nome region and the great cost of fuel, as well as high wages, made the expense of running these plants very great. It was impossible for the operators to obtain exclusive right to any part of the beach, and the enterprises were constantly interfering with one another. Moreover, during the previous year the richest part of the beach diggings had been gutted, and, as the evidence of the working had been entirely destroyed by the ice of the winter, it was impossible to pick out fresh portions of the beach for mining operations. The choice of location had to be made at haphazard. The large number of men who were engaged in beach mining made intelligent prospecting previous to location entirely impossible. In August, moreover, a heavy storm destroyed a large part of the machinery along the Nome beach and put an effectual stop to many of the enterprises. In view of these facts it is not surprising that there were more beach mining companies that lost money than there were that made money. A large amount was, nevertheless, taken out of the beach, which Dr. Whitehead estimates at $350,000.

As to possibilities of future mining developments, it can be prophesied that no large enterprises can be successfully carried out unless in some way a title for a given stretch of the beach can be obtained. A large percentage of the beach sand is probably far richer than that which is mined on the Oregon and California coast at a profit. Indeed, the fine gold, such as that found in the Oregon beaches, is not saved at all at the Nome beach.

Cripple River and Penny River regions.

Late in September Mr. Collier reached Nome from Port Clarence with instructions to make a hasty reconnaissance of the gold diggings of Penny and Cripple rivers. He entered the region by the usual route of travel along Penny River, and spent several days on Hungry and Oregon creeks, depending on prospectors and miners for subsistence. Then a trip was made down Cripple River and over the Cape Rodney hills to the beach at the mouth of Quartz Creek, returning to Nome along the beach. As only five days were spent on the entire trip, no great amount of detailed information could be gathered.

The crescent-shaped plain which extends inland and east and west from Nome has Cape Rodney at its western apex. Near this apex, and about 12 miles west of Nome, Cripple River reaches the sea, while the mouth of Penny River is about 2 miles to the east. Both rivers have their sources in the dissected upland which extends inland, and the headwaters are in both cases cut off from the Kigluaik Mountains by the comparatively broad valleys of the Upper Sinuk and its tributaries.

Until it reaches the costal plain Penny River has a narrow valley and flood plain. The sides of the valley rise rather steeply to the uplands. The valley of Cripple River is, on the other hand, wide, with gentle slopes and a broad flood plain. At its upper end this flood plain is separated by a very low, flat divide from the flood plains of Stewart River, tributary of the Sinuk. A study of the topographic map of this region leads to the conclusion that in comparatively recent times the headwaters of Cripple River have encroached upon the drainage area of Stewart River, turning some of its tributaries southward.

At elevations of 700 to 800 feet, broad, gravel-filled gaps are found, interrupting the continuity of the ridges and corresponding in height to a series of well-marked benches. These gaps and benches are remnants of older drainage systems.[1] Distributed over the hillsides to an elevation of 800 feet angular bowlders of granite from the Kigluaik Mountains are of frequent occurrence and are attributed to the action of floating ice.

The bed-rock geology of these basins is comparatively simple. The strikes are rather uniform, and only two rock types can be distinguished in the field. The first is limestone, occurring in thin-bedded masses more or less metamorphosed; the second is a chloritic schist, occurring in large masses interbedded with the limestone and having its schistosity parallel to the bedding planes of the limestones. Microscopic examination of the chloritic schists show them to be composed essentially of quartz and chlorite. One specimen examined, however, showed graphite associated with quartz and chlorite, while another was essentially graphitic quartz-schist, chlorite being absent. An examination of the accompanying geological map will show that these green schists form a belt which has been traced from the mouth of Penny River north-northwest to Oregon Creek, a distance of about 8 miles in a direction parallel with the strike of the inclosing limestone. East of this belt a smaller belt of greenstone-schist crosses the head of Oregon Creek. The Cape Rodney Hills constitute a third area.

It is a striking fact in the region that the placer deposits usually occur near the contact of the green schists and limestone.

ECONOMIC DEVELOPMENT.

On Penny River and its tributaries there has, as yet, been no development, although colors of gold have been found in a number of places. On Cripple River and its tributaries a considerable amount of prospecting was done last summer. During Mr. Collier's visit active mining operations were confined to five claims on Oregon Creek, two on Hungry Creek, and one on Nugget, the latter two being tributaries of Oregon Creek. The output of the whole region is estimated at $50,000.[2]

Oregon Creek.—Oregon Creek joins Cripple River from the east side 10 miles from the coast. The creek has a length of about 5 miles and a drainage area of about 15 square miles. Its important tributaries are Hungry Creek, Nugget Creek, and Mountain Creek.

Along the lower 2 miles of the creek's course bed rock is not exposed. One-half mile below Nugget Creek decomposed chlorite-schist is reached at a depth of 2 to 5 feet. From Nugget Creek to Mountain Creek the bed rock is heavy limestone, dipping downstream and jointed and broken into irregular fragments. Frequently at

[1] See section on Physiography.
[2] Dr. Cabell Whitehead, United States Mint.

stages of low water the creek is nearly lost in underground channels through this bed rock.

At Mountain Creek the bed rock is chloritic schist, but the limestone for 100 yards or more from the contact is flaggy and schistose, so that the line where the limestone ends and the schist begins can not be easily seen. Above this point the creek was not examined in detail, but its source undoubtedly lies in limestone.

Oregon Creek joins Cripple River in a broad, basin-like valley, with very gently sloping sides. Looking up Oregon Creek from this point, its valley appears to be a great amphitheater carved from the limestone mountains which encircle its headwaters. The crêek is trenched in its valley floor to a depth of from 20 to 50 feet, leaving broad benches which rise gently toward the inclosing hills. Toward its upper end this trench is rather narrow and is cut partly in bed rock. In a few places where prospecting has been done the benches have been found to be capped with gravel of undetermined depth.

This creek was staked during the winter of 1898–99, but active mining operations did not begin till the summer of 1900. There has been much confusion and litigation, due to overlapping claims, so that several promising claims have not been worked. For the first 2 miles up from its mouth the creek spreads over wide bars and has nowhere been properly crosscut or thoroughly prospected. It is reported that a number of claims that have been worked here have failed to pay, possibly owing to the inexperience of their operators.

One-half mile below the mouth of Nugget Creek a crosscut shows three pay streaks, one 50 feet wide, one 75 feet, and one not determined. The bed rock is partially decomposed chlorite-schist dipping downstream. The gravel is from 2 to 5 feet deep. Above this mine the bed rock changes to hard limestone.

One-fourth mile below the mouth of Nugget Creek a strip of gravel about 20 feet wide along the creek bed was being worked. The bed rock is a hard, thin-bedded limestone, in the crevices of which gold is deposited. Above this bed rock is about 2 feet of washed gravel, consisting principally of rounded limestone pebbles and a few granite bowlders. This gravel is washed in sluice boxes, and the bed rock is cut and cleaned to the depth of a foot.

At the mouth of Nugget Creek very little work has been done, owing to disputed title. The limestone bed rock is broken and irregular. Some gold has been taken from a "false bed rock" consisting of fragments of limestone embedded in reddish clay. On the south side of the creek a cut bank shows the following section:

	Feet.
1. Moss and muck	1.5
2. Red, sandy clay	6
3. Gravel, consisting of broken fragments of limestone	2
4. False bed rock, consisting of clay with fragments of limestone embedded	?

One-half mile above Nugget Creek a sluice box was running; about 1 foot of gravel was being shoveled from a red clay layer which is probably close to bed rock.

Near the mouth of Mountain Creek it is reported that two men with rockers have taken out 2 pounds of gold in less than a day, getting as high as $27 in one pan. The bed rock is chloritic schist dipping downstream. Pay dirt extends from the surface to the bed rock, a depth of 2 to 5 feet. About one-fourth mile above Mountain Creek the pay streak is confined to the creek bed and is not more than 20 feet wide. The bed rock is near the surface, and the best pay is found in the crevices of this bed rock to a depth of 18 or 20 inches. The gold is coarse, but grains are usually well rounded and bright. During the summer one nugget worth $130 was taken out. Two other large nuggets, one worth $42.60 and the other $13.20, have been washed out at this point. The bed rock is a hard, chloritic quartz-schist, dipping downstream and affording a good lodgment for gold. The bed rock contains small stringers of mineralized calcite, which, on assay, showed no trace of gold.[1]

Hungry Creek.—This creek is a tributary of Oregon Creek, about 2 miles long, flowing in a northwesterly direction. One and one-half miles from its mouth it forks, the southern branch being known as May Gulch. The valley of Hungry Creek is broad, and the creek has trenched its floor to a depth of about 20 feet. At its junction with Oregon Creek the bed rock is not exposed. One mile up the creek the bed rock is a quartz-graphite-schist containing considerable chlorite. This bed rock strikes across the direction of the creek's course and dips downstream. At this point the bed rock is exposed in the bench, indicating that the gravel on the wide benches may not be of any great depth.

The north fork has its source at the foot of the steep slopes of a limestone mountain. The south fork, May Gulch, comes down from a broad pass toward Penny River. Through the lower part of its course it cuts a narrow gorge obliquely across the strike of a black graphitic schist.

Gold was first discovered in paying quantities on the creek in July, 1900. The creek, however, had been staked in the snow during the previous winter. Only two mines were in operation on the creek when it was visited in September, although during the summer the creek was worked unsystematically throughout nearly its whole length. One mile from the mouth of the creek, where mining was in progress, the bed rock is a graphitic chlorite-schist more or less decomposed at the surface, so that about 1 foot of the top can be easily shoveled into the sluice boxes. This schist strikes across the direction of the creek and, dipping downstream, offers a good lodgment for gold. Above

[1] Assay by R. H. Officer & Co., Salt Lake City.

this bed rock is a gravel, the pay streak of the mine, consisting principally of scarcely rounded fragments of schist, but containing a few well-rounded bowlders of granite. Above the gravel outside the present stream bed is a stripping of tundra moss and muck, perhaps 1 foot thick.

The section from the surface down is as follows:

	Feet.
1. Moss and muck, about	1
2. Gravel, consisting mainly of chloritic schist fragments and containing bowlders; pay dirt of mine	4
3. Decomposed chloritic schist which can be cut with the shovel	1
4. Chloritic schist, containing no gold in crevices.	

Associated with the gold a small amount of bismuth occurs in well-rounded nuggets sometimes weighing as much as 1 ounce. In the sluice boxes the coarser concentrates are largely rounded grains of magnetic iron and garnet. The finer materials consist mainly of small crystals of magnetite, garnet, and other heavy minerals. A specimen of these concentrates was found to be 51 per cent magnetite, the remainder being mostly garnet, with some limonite, pyrite, ilmenite, rutile, gold, and bismuth.

An area 50 by 100 feet along the creek yielded about $4,000. In a clean up, seen by Mr. Collier, of a sluice box that had been running three days, there was about $300 in gold, which was considered a fair average. Most of the gold is bright in color, but there is some darker gold intermingled. It is all comparatively coarse. In a pan of gold estimated to contain about $300 there were as many as fifty nuggets worth as much as $1.

May Gulch, the south fork of Hungry Creek, heads in a broad, low divide about 700 feet above the sea. Near its head prospect holes have been sunk to a depth of 20 feet through washed gravel without finding bed rock, but colors are reported all the way from the surface down. On Delta Creek, which flows to Penny River from this divide, some prospecting has been done without reaching bed rock.

Nugget Creek is a tributary of Oregon from the east side, about 2 miles above Hungry. It is about 1½ miles long and flows northwest, and was not examined in detail. The creek heads in a pass toward Penny River and flows between a limestone mountain on its south side and a broad, high, and probably gravel-covered bench on its north side. One mine was in operation on this creek about one-half mile from its mouth. In a clean up of a box that had been running one day there were about 2 ounces of bright gold containing no nuggets larger than 25 cents. The bed rock, as far as determined, is chiefly limestone.

Mountain Creek is a westerly tributary of Oregon Creek, about 1 mile above Nugget Creek. One or two good claims are reported on this creek, but as no active mining was going on, the creek was not visited.

Other creeks in the neighborhood.—Some mining was done during the summer on Stella Creek, a tributary of Cripple River from the east side just below Oregon Creek. In September, when this region was visited, the works were shut down. Sluicing was done during the summer on Jessie Creek, a tributary of Stewart River, but the results were not ascertained.

Quartz veins.—No locations of quartz veins are reported on either Oregon or Hungry creeks. On the east side of Penny River opposite the head of Hungry Creek a number of quartz locations have been made and some prospecting has been done. A specimen from this locality given the writer by J. S. Smith, one of the locators, yielded a trace of silver and one one-hundredth ounce of gold per ton [1]. Other assays of this ore are said to range from $12.50 to $46 per ton. From descriptions given by Mr. Smith it seems probable that the ore consists of very numerous stringer veins of quartz in mica-schist.

Sinuk Basin.

This river was not visited by any of the geologists, though it was mapped topographically by Mr. Barnard's parties. It rises in the Kigluaik Mountains, which it leaves through a narrow valley, then flows westward about 10 miles, and then, bending southward, reaches Bering Sea 25 miles west of Nome. From the reports of prospectors it seems probable that the lower course of the river lies within the area occupied by the Nome series.

Colors of gold have been reported from many localities in the Sinuk Basin. As far as known to the writer, the only creek in the basin which produced any gold is Charley Creek, which is tributary to its headwaters. Some sluicing is said to have been done on this creek.

General description of placer deposits of southeastern part of Seward Peninsula.

The area blocked out by Nome River on the west, the Bendeleben group on the north, Golofnin Bay and Lower Fish River on the east, and Bering Sea on the south, was investigated by Mr. Richardson, the writer being personally familiar with only the northern and eastern margins. Mr. Richardson is entirely responsible for the work in the Eldorado, Flambeau, Solomon, and Koksuktapaga drainage basins, and the Topkok regions, as well as the investigations of the upper portion of Ophir Creek.

The Bendeleben group rises at the north to elevations of 3,500 feet, south of which is an upland whose altitude is from 1,200 to 2,000 feet. The summits are rounded, with occasional sharp pinnacles, and fall off to broad valleys by gentle slopes. The drainage finds its way, by the Niukluk and Fish River valleys, to Golofnin Bay,

[1] Assay by R. H. Officer & Co.

and by a number of rivers which flow southward, emptying directly into Bering Sea. The deep indentation of Golofnin Bay is carried inland by the broad, flat valley of Fish River. To the west of Golofnin Bay, as far as Topkok, the highland lies close to the shore, while beyond, a broad coastal plain, across which the rivers meander sluggishly, intervenes between the sea and the uplands.

The bed rock of this region includes all the various formations that have been described in the section on Geology. A section from the Bendeleben Mountains to the southward shows as the basal member the Kigluaik series with the associated granitic intrusives. Above this series are the graphitic schists of the Kuzitrin series, which occupy an area in the upper drainage basin of Ophir Creek. Overlying these is the Nome series, which forms the country rock over the greater part of the area under discussion. Greenstone intrusives are also plentiful, occurring as large intrusive stocks, and also as intruded sheets.

The structure of the northern part of this area, with which the writer is personally familiar, is of the dome type, which has already been described. Farther to the south, Mr. Richardson found a number of broad, open folds, having considerable irregularity of strike and dip, and suggesting in a broad way the dome type of structure.

In the western half of this region Mr. Richardson was able to differentiate a number of formations in the Nome series. Our data was, unfortunately, not sufficient to trace these formations into adjacent regions, so it was not thought advisable to distinguish them on the map. The succession, as determined by Mr. Richardson, is as follows: The lowest rock exposed in the Koksuktapaga-Solomon region is a dense, black graphitic quartz-schist about 500 feet thick. The outcrops of this rock generally are prominently exposed. Notable occurrences are: east of Solomon River, south of Big Hurrah Creek, on the highest hill between the headwaters of Solomon River and Coal Creek, and at the heads of Big Four and Penelope creeks. The hilltops capped by this quartz-schist are always bare and the surface is strewn with broken bits of the rock. Under the microscope schistose structure is seen to be prominently developed. Quartz preponderates and streaks of graphite parallel to the structure are abundant. Flakes of muscovite sometimes occur and occasionally the rock carries iron pyrite.

This formation is in many respects similar to the rocks of the Kuzitrin series. As it is the basal member in this region of the Nome series, as determined by Mr. Richardson, further investigation is quite likely to show its equivalence to a part of the Kuzitrin series.

Above the quartz-schist is a series of calcareous mica-schists, intercalated with which are thin beds of blue and gray crystalline limestone, occasional thin beds of black graphitic quartz-schist, and sills of garnetiferous greenstone, none of which are more than 10 feet thick. These are the prevailing rocks of the Koksuktapaga and Solomon valleys. Good exposures occur in the Right Branch of Solomon and in Canyon and Penelope creeks.

Succeeding is a massive gray crystalline limestone from 2,500 to 3,000 feet thick. Typical occurrences are at the head of Shovel Creek and between Willow and Wilson creeks, tributaries of the Left Fork of the Koksuktapaga.

Above the limestone are more schists similar to those below. Over 5,000 feet of these schists are exposed in West Creek. Across the divide of West Creek, in the Bonanza River drainage, and apparently lying above the West Creek schists, is a series of green chloritic schists and sills of greenstone. These chloritic schists are the prevailing rocks of the divide between Eldorado and Bonanza rivers. The abundance of chlorite suggests that these green schists are of igneous origin, while the structure, which is conformable with the underlying limestone series, with no observed indication of igneous intrusion, implies a sedimentary origin. Further study is required to determine this question. The interbedded sills of greenstone are distinct from the chloritic schist in composition and structure. As elsewhere throughout the Nome series, the greenstones are clearly altered igneous intrusions which were forced into the rocks between the bedding planes previous to the development of schistosity.

The structure of these rocks was not studied sufficiently to determine the details. Schistosity is parallel to the bedding planes of the rocks as defined by the limestone contacts. There is a distinct system of joints that extend in an east-west direction. In the Koksuktapaga region the general strike is north-south, with a westward dip of 30° to 45°. In the Solomon River country the prevailing attitude of the rocks is flat or gently undulating, forming the axis of a broad anticline. East of Solomon River the dip is eastward, and west of the river the dip is westward, constituting the eastern limb of an indistinct syncline, which includes the chloritic schists of the Eldorado-Bonanza River region.

Quartz and calcite veins and lenses, some of which are mineralized with copper and iron pyrite, are common, extending parallel both to the schistosity and to the system of joints, but no true fissure veins have yet been discovered. Samples of small quartz and calcite veins and lenses with pieces of the inclosing schist from the mouth of Canyon Creek upon assay yielded a trace of gold.[1] A mineralized quartz vein about an eighth of a mile up the first fork of the Koksuktapaga likewise showed a trace of gold.

The source of the gold in the Koksuktapaga-Solomon region seems to have been these small veins. Whether large veins exist or not can be determined only by careful prospecting. During the destruction of the rocks incident to subaerial exposure gold was separated from

[1] Assay by R. H. Officer & Co., Salt Lake City.

the vein and bed rock and laid down with the other products of rock disintegrations in creek beds and in littoral deposits. Upon the elevation of the country much of the gold which was thus deposited has been removed by stream action from its first resting place, redeposited, and reconcentrated in the placers where it is now found. Coincidently gold was derived from the original sources and mingled with that previously brought down. So that, of the placer gold now found, some has been derived primarily from its source in the veins and some secondarily from auriferous gravels.

Eldorado River Basin.

This river has its source within a few miles of Salmon Lake, from which it is separated by a low divide. It flows southward through a broad gravel-filled valley and empties into Port Safety Lagoon. Its headwaters reach the limestones of the Nome series and much of its course lies in the chlorite-albite-schist belt which has been described. Mr. Richardson was able to examine only the lower half of this drainage basin, where no placer gold has been found. This part of the basin lies in the chloritic schists, which, as far as our observations go, are not mineralized.

Gold has been reported from a number of the headwater tributaries of Eldorado River. Among others, San José, Mulligan, Fox, and Venetia are mentioned, and sluicing is said to have been done on the three latter streams.

Venetia Creek.—We are indebted to Mr. E. C. Barnard for the following notes on this stream. It rises near the headwaters of Canyon and Iron creeks, tributaries of the Kruzgamepa. Its length is about 10 miles, and its valley is rather broad. Some development has been done on two claims, and sluicing was in progress in August, 1900. The bed rock is 2 to 3 feet below the surface. The gold is coarse and occurs in pumpkin-seed-shaped grains.

Bonanza River Basin.

Bonanza River flows from the north into the western end of Port Safety Lagoon. In its general character it is similar to Eldorado River. The headwaters were not visited by Mr. Richardson, but the lower course of the stream flows across the chloritic schist belt which has been referred to. No gold has been reported from this drainage basin. The headwaters lie close to Venetia Creek and the Koksuktapaga, which suggests that they may be in the gold-bearing series.

Solomon River Basin.

Solomon River heads close to the Koksuktapaga, from which it is separated by a low divide, and empties into the eastern end of Port Safety Lagoon. Its length is about 20 miles; its valley is broad and gravel filled. The bed-rock geology has already been described, and it has been shown that the drainage basin lies in the Nome series.

Solomon River was named by Pierce Thomas, who staked Discovery claim in June, 1899. During that season the river and its tributaries were prospected, and some gold was taken out, enough to cause the circulation of good reports concerning the basin. But the results of the season of 1900 were not up to expectation. The country, however, has not been thoroughly exploited, and the season of 1901 will show more definitely the capabilities of this district. It is estimated that Solomon River and its tributaries produced about $10,000 in 1900.

Some gold has been taken out of the gravel deposits of Solomon River itself, and with the use of dredges it is hoped that these placers can be worked with profit. At the mouth of Big Hurrah Creek the flood plain of the river is about half a mile wide, and into it a channel has been cut, exposing a thickness of about 10 feet of gravel. In the river bed the gravel varies from 1 to 3 feet. Bed rock is mica-schist, into which gold has worked its way down a foot or more. The gold is relatively fine, the largest piece found being worth only 50 cents. Mint assays give the gold a fineness of 905. In 1899 about $150 was taken out in prospecting by three men, working, respectively, eight, ten, and eighteen days. Little gold was taken from this part of the river in 1900, but as, the result of prospecting, it is expected to develop these placers by use of a dredge in 1901.

Above Coal Creek, near where the trail leaves Solomon River to cross the divide to Ruby Creek and the Koksuktapaga, several claims were being worked. In the bed of the river about 4 feet of gravels overlie a calcareous mica-schist. The gold is fairly coarse. Several $3 and $4 nuggets have been found, but in general the larger pieces do not go over 25 cents. It was reported that the claims carried values to work, but not enough to yield "wages" at a dollar an hour.

About twenty men are reported to have visited Johns Creek during the summer. Water was scarce and no well-defined pay streak was found. Not more than $25 is said to have been taken from this creek.

At the time of Mr. Richardson's examination no developments were being made below the mouth of Big Hurrah Creek. There had been some developments on Jerome and Manila creeks, which are tributary to the Solomon from the west, several miles from its mouth. These two streams have their sources within the coastal plain. Some bench diggings had also been developed and abandoned on the east side of Solomon, opposite the mouth of Jerome. These occurrences of gold, even though they were not worked profitably, are of interest, because they go to prove that there is gold in the coastal plain. They suggest that this tundra belt may contain placers similar to those of the Nome region.

Shovel Creek.—This stream, the principal tributary of Solomon River, is about 8 miles long, and in its lower course flows in a broad gravel-filled valley. Little or no mining has been done in Shovel Creek itself.

Problem Gulch is about a mile long, and empties into Mystery Creek, which flows into Shovel about 2 miles above its mouth. Bed rock is mica-schist, on which, in the creek bed, there is a thickness of 2 to 3 feet of gravel. This gravel and about 2 feet of disintegrated schist are sluiced. The gold is rather coarse and of a bright-yellow color. Crosscuts in an ill-defined bench on both sides of the gulch for about 20 feet are said to pay, but not so well as the creek bed. It is reported that this gulch will pay $10 a day to shovel. This statement, however, was based on only one clean-up for two days' work.

West Creek is a tributary of Shovel Creek, and is about 2½ miles long. The rocks in this drainage basin are limestones, mica-schists, and graphitic quartz-schist, dipping N. 20° W. at an angle of 45°. In the creek bed from 3 to 4 feet of gravel overlie bed rock. In the lower part of the creek the gold is rather fine, but it increases in coarseness toward the head of the creek. One nugget worth $3.60 was found, associated with quartz embedded in schist. From this occurrence there is no doubt that the gold from the upper part of West Creek is derived immediately from small veins and lenses of quartz in the adjacent schist. Garnet, magnetite, and some pyrite, chalcopyrite, and arsenopyrite are associated with the gold in the sluice boxes in West Creek.

Kasson Creek enters Shovel from the east between West and Adams creeks. It heads in mica-schist, but flows principally through limestone. Kasson Creek is little more than a gulch, and was dry even after the rains of August. Two parties were at work with rockers near the mouth, carrying water from Shovel Creek. The day before Mr. Richardson's visit five men reported taking out $11.60.

Adams Creek is about 2½ miles long. It flows in a valley that contains a well-defined terrace, elevated about 5 feet above the creek, and 20 feet wide on each side. The bed rock at the head of the creek is schist, while that in the lower course is limestone. There is plenty of water in the creek for sluicing. The gravel in the stream bed varies from 4 to 6 feet in thickness. Magnetite and garnet are associated with the gold, which is both coarse and fine. The largest nugget found on Adams Creek was worth $4.20. Several $2 nuggets have been found. The assay value of the gold is $19.40 an ounce. From 50 to 60 ounces are said to have been taken out during twenty days' sluicing on one claim.

Penny Creek.—This stream enters Solomon River about 2½ miles below Big Hurrah. Penny Creek is about 3 miles long and occupies a relatively broad valley, the greater part of it being through the broad terrace of Solomon River. The rocks in the divide are schists and limestones, lying approximately flat. Limestone is the bed rock just above the mouth of the creek, and above this is a belt of mica-schist. Limestones with vein quartz are found outcropping on the adjacent divides. The gold lies close to a clay seam which overlies the limestone bed rock. In the mining operations this clay seam and about a foot of the bed rock are removed. The gold is separated by being washed in a tub. Mr. Richardson reports it to be rather coarse, having seen one $18 and several $4 to $5 nuggets.

Big Hurrah.—This stream is an eastern tributary of Solomon, and is about 5 miles long. It has a relatively wide valley and broad flood plain, into which it has incised a shallow trench. The bed rock consists of two belts of mica-schist separated by a belt of graphitic schist, with limestones and quartz-schists outcropping on the adjacent divides. In the mine working near the mouth a section showed 4 to 5 feet of gravel overlying a clay seam. Bed rock had not been reached, but good pay was found on this clay. In the concentrates garnets are very plentiful, but not much magnetite is found. The gold is rather fine, but a $10 nugget was seen by Mr. Richardson, as well as some smaller ones.

Topkok region.[1]

General description.—Under this general heading will be included a description of the region lying south of Klokerblok River, east of Cape Topkok, and west of Golofnin Bay, which was studied by Mr. Richardson. Cape Topkok is a promontory which marks the northwestern extremity of a series of bluffs that skirt the coast in a narrow belt for a distance of 30 miles northwestward from Golofnin Bay. To the west of Cape Topkok the highland trends inland, and between it and the sea is a low coastal plain composed of moss-covered sand and gravel which extends about 30 miles to Cape Nome. This series of bluffs is interrupted here and there by small coastal plains that were formed in embayments at the mouth of the larger streams. Topkok, Ryan, and Daniels Creek valleys occupy such embayments. The highland to the north of the escarpment forms a part of the dissected upland which is drained by rivers flowing into Port Safety Lagoon and Bering Sea to the south and into Golofnin Bay to the east. The drainage of the immediate vicinity of Cape Topkok is carried directly into Bering Sea by Topkok, Little Anvil, Ryan, Daniels, and Koyana creeks. These are all small streams, for the watershed lies not more than 2 miles from the coast. The northward drainage is taken to Golofnin Bay by Klokerblok River.

The developments in this region have to the present time been confined to Daniels Creek, and more especially to the beach near its mouth.

[1] Topkok Creek is included in the Nome recording district; Daniels Creek in the Cheenik recording district.

The valley of Daniels Creek lies within one of the small, gravel-filled embayments already referred to. Just east of the mouth of Daniels Creek the plain is bounded by bold bluffs, which rise directly from the sea. These recede inland, and, forming a deep reentrant angle, reach the coast again west of Ryan Creek and block out a triangular bit of coastal plain, which includes the drainage basin of Ryan and Daniels creeks. This plain is now covered with moss and grass, and as far as known is underlain by stratified gravels, sands, and clays. On the seaward side the plain falls off to the beach by an escarpment about 20 feet high. A low hill, made up of limestone, lies within this gravel plain, between Daniels and Ryan creeks, and about a mile from the coast. The origin of this embayment must be ascribed to former stream erosion. After the valleys had been cut a depression caused an invasion of the sea, and the gravels and sands were deposited in this embayment by tributary streams. The floor on which these were laid down was an irregular one, as shown by the outliers of bed rock found in the plain, and thus the coastal plain deposits vary in thickness. Along the beach, one-half mile west of Daniels Creek, limestone is exposed, affording at this point a measure of these deposits, which gives a thickness of about 20 feet.

The rocks of this area are mica-schists and limestones belonging to the Nome series, which are divisible into three parts. The lowest formation exposed is a massive, gray crystalline limestone. Above this limestone is a series of quartz-mica-schists interbedded with thin bands of massive white and blue-black graphitic crystalline limestone. The schists contain stringers and lenses of quartz, which adjacent to Daniels Creek are mineralized with pyrite and chalcopyrite, and are commonly stained red by hematite. A sample of vein quartz from this region, assayed by R. H. Officer & Co., showed a trace of gold. This schist series is believed to be the source of the Daniels Creek gold. Overlying these beds are highly crystalline white limestones several hundred feet thick, which are succeeded by a considerable but undetermined thickness of quartz-muscovite-biotite-schist. All of these rocks are traversed by east-west joint planes, and the schistosity is parallel to the bedding as defined by the limestone.

A short distance west of Cape Topkok is a small area of chloritic schist whose composition and structural relations imply an igneous origin.

The rocks separating Golofnin Bay from Norton Sound on the southwest are chiefly garnetiferous quartz-mica-schists, with some crystalline limestones and graphitic mica-schists, and some chloritic schists which are probably of igneous origin. The dips are low and to the west. At the end of the sandspit on the western shore of Golofnin Bay, 5 miles south of Cheenik, is a dike of biotite-granite which doubtless belongs to the same period of intrusion as the granites east of Golofnin Bay.

The dominant structure in close proximity to Daniels Creek is that of a low, broad anticline pitching to the north. The southern part of this uplift is cut off by the coast line. There is some evidence that the western limit is extended parallel to the coast to Cape Topkok. If this be a part of the same fold, some irregularities of structure have been introduced by minor folding, which occurs in the vicinity of the chloritic schists that have been already described as being probably altered intrusives.

Placer gold.—Gold is reported to have been found at the mouth of Daniels Creek in September, 1899, by William Hunter and Frank Walker, but they did not take up claims. In December the creek was staked by J. S. Sullivan, George Ryan, and others. In January, 1900, H. C. Malmquist, William Hunter, and three others staked five tundra claims along the beach adjacent to Daniels Creek. Later these men, who had organized as the Black Chief Mining Company, bought the claim at the mouth of Daniels Creek.

The find on the creek was kept secret for a time, but by the middle of March the rush from Nome began and soon many people were on the ground. A miners' meeting decided that 60 feet back from high water belonged to the beach and, as such, could not be claimed. The crowd worked on this ruling, every man where he could, until July 8, when United States troops under Lieutenant Erickson stopped work on the claim at the mouth of Daniels Creek pending litigation. During the few months of work it is estimated that nearly three-quarters of a million dollars were taken from a strip of beach less than 1,000 feet long and 50 feet wide. Two men on an area of 27 square feet reported taking out $37,000. It is said that three men took out $10,000 in five days. It was common for rockers to make from $100 to $300 a day. These extraordinary returns were of short duration, for the richest part of the small strip of beach was soon exhausted. The first week of August, when Mr. Richardson visited the camp, called Bluff, about 200 men were present. There was little inducement for them to stay, however, for the rich beach had been gutted, and the whole region had been staked.

The rich part of the beach extended about 500 feet west of the mouth of Daniels Creek and about 50 feet east to a cliff that projects into the sea. The beach pay streak was 3 to 4 feet thick, overlain by a foot of barren sand and underlain by clay of undetermined thickness. Gold occurred disseminated in schist gravel in which were scattered bowlders of mica-schist averaging 10 to 15 pounds in weight and smaller pieces of limestone. The "ruby sand" so prominent about Nome is inconspicuous here, though some garnets are present in the gravels. The heavy minerals associated with the gold are magnetite, nodules of limonite, small pieces of ilmenite, and bits of cinnabar. Cinnabar is fairly abundant in the tailings, ranging from specks to rounded pebbles the size of marbles, but it has not been found in place. The beach gold is rather coarse, much coarser than that from the Nome beach. It averages about 12 pieces to the cent and assays show a purity of 870.

Daniels Creek has its source within the coastal plain, in which it has carved a shallow trench. Near the mouth gold occurs on a clay bed of undetermined thickness. The pay streak is about a foot thick and is composed of fine gravels, the pebbles of which are chiefly of mica-schist, with some vein quartz. Locally the pay streak is cemented by oxide of manganese, making a black conglomerate which seems to carry more gold than the ordinary pay streak not so cemented. It is reported that pans of this material will run from \$2 to \$3. As a whole the pay streak is said to average 8 to 12 cents a pan. The gold is bright yellow and rather coarse, an average sample from the creek running 1½ cents to the individual grain. It is angular in character and bears evidence of not having traveled far. Some of the pieces show rudimentary crystal faces.

Higher up the creek most of the development in 1900 was preparatory to sluicing when the arrangements for pumping sea water to the claims should have been completed. The test pits show a surface layer of 5 or 6 feet of clay overlying the pay streak, which is irregular, averaging possibly 2 feet, and resting on a mass of broken angular limestone. This mass, which is thought by the miners to be a "slide," has the appearance of bed rock which has been fractured in places by frost or other disintegrating agencies. About the head of Daniels Creek but little development has been done and reports of preliminary tests indicate poor prospects. In the tundra a few hundred feet west of the middle course of the creek a few test pits have been sunk about 30 feet in stratified clay and gravel. Some colors are said to have been found, but the prospects were not promising.

Gold has been found in limited quantities in the beach sands at several other localities in this region. One of the first discoveries of gold was in the sands of the small beaches on the west side of Golofnin Bay. During the season of 1900 rocking was done in the beach sands about 3 miles east of Bluff, but the miners were reported to be making only \$2 to \$3 a day per man. Between Daniels Creek and Cape Topkok some mining was done at several localities. Except on Daniels Creek no gulch claims were developed and but little prospecting was done.

It has been shown that the richest placers of the area under discussion occur as beach deposits, near the mouth of Daniels Creek and in creek placers in Daniels Creek itself. The fact that the basin of Daniels Creek lies entirely within an area of superficial gravels shows that the gold was deposited with these gravels, which were probably laid down at the mouths of small streams that flowed into the embayment from the uplands. The adjacent rocks are made up in part of highly mineralized schists, which must have been the bed-rock source of the gold. Probably a secondary concentration of the gold of the gravel plain deposits has taken place in Daniels Creek, and it seems probable that the surf action on the shore has reconcentrated the gold at the mouth of the creek, forming the rich beach placers. These deposits are in many ways comparable to those at Nome, except that here the beach gold is nearer its bed-rock source, and hence the gold is coarser. It is possible that other workable placer deposits will be found in this region, for there is no reason to believe that during the formation of these gravel deposits the deposition of gold was limited to Daniels Creek. The gravels of the tundra, therefore, are worthy of investigation by the miners, as are also the creeks at the mouths of which beach gold has been found. It is possible that the gravels underlying the tundra may carry small values that can be worked at a profit by improved machinery, even where they are not rich enough to be mined and separated by the crude methods now employed.

Niukluk Basin.

Niukluk River.—The topography of this basin has already been described. Niukluk River rises in the Bendeleben group and, after flowing across a broad valley lowland for about 15 miles, enters a narrower valley, in which it flows for about 20 miles. Below the mouth of Melsing Creek the valley broadens out and merges with that of Fish River, to which the Niukluk is tributary. It receives many tributaries, of which the Koksuktapaga, joining it from the south, is the largest. In Niukluk River itself colors are found to its head, though they are most abundant below the mouth of American Creek. No developments have been made along the main river, except that just below the mouth of Ophir Creek a little gold has been rocked out on the bars. The broad gravel flood plain in this part of the basin is said to be auriferous, and as high as 10 cents to the pan has been obtained. It seems probable that these deposits might be worked at a profit if the development were carried out on a comprehensive plan. Below the mouth of Ophir Creek the river has cut a small rock canyon 50 feet below an old valley floor, leaving broad benches on either side. These benches are sheeted over by a few feet of gravel, and there is every reason to believe that this gravel carries some gold. Like the flood-plain gravels, these deposits could be worked only on a large scale.

American Creek.—This stream rises in the highland to the south of the Niukluk-Kruzgamepa flat and flows northward through a narrow canyon-like valley until it reaches the flat, then makes a right-angled bend to the east and joins the Niukluk 4 miles above the mouth of the Koksuktapaga. We did not reach its headwaters, but its length is probably about 5 miles. Near where it emerges from the canyon it cuts limestones, which here strike nearly at right angles to the stream valley. These limestones are much broken and faulted. Higher up the stream some black slates, also much broken and faulted, were observed. These slates contain many quartz veins, which are often pyritiferous, and in places the slates grade into mica-schists. The relation of the two beds could not be definitely determined, as there has been much faulting along the line of contact, but the slate is believed to overlie the limestone. A reference to the geological map and section (Pl. III) will show that the slates and limestones are classed with the Nome series, and that this locality lies in the southern limb of an anticlinal uplift. Colors have been found, but up to the present time no paying prospects. During dry times the creek would probably not furnish a sluice head of water.

Koksuktapaga[1] *Basin.*—The river of this name has a general northeasterly course and a length of about 30 miles. Its headwaters lie near those of Solomon and Bonanza rivers, and its junction with the Niukluk is about 25 miles from Fish River. According to Mr. Richardson, the Koksuktapaga flows in a broad gravel-filled valley. A well-marked gravel terrace occurs in its valley at an elevation of 30 feet, and there are traces of other terraces up to elevations of 600 feet above the river bed.

The Koksuktapaga was first prospected in 1898 by Mordaunt, Libby, Nelson, and Blake. These pioneers are known as the Big Four, from whom the largest tributary of the Koksuktapaga receives its name. Claims as far up as Goose and Quartz creeks were located in 1898, but most of the staking on the Koksuktapaga and its tributaries was done in 1899. Quartz, Boulder, Dixon, and Spruce creeks are reported to have yielded a few thousand dollars in 1899. This was taken out in the course of prospecting rather than in systematic mining.

In 1900 there was a general delay in getting into the country, and later on the low water, consequent to the dry season, delayed transportation of supplies. In the fall, but a short time after sluicing had begun, floods washed away many dams, ditches, and sluice boxes. The season of 1900 must be regarded chiefly as a period of further prospecting. It is expected that the actual possibilities of the country will be more clearly shown in 1901. The output of the Koksuktapaga region for 1900 is estimated to be $15,000. This has been taken mostly from the tributary streams, as little mining has been done on the main river. At the time of Mr. Richardson's visit, in July, some developments were being made on Dawson, Dry, and Thorpe gulches, and on Penelope, Goose, Quartz, Canyon, Boulder, Banner, Ruby, and Wilson creeks, on which he reports as follows:

Dawson Gulch joins the river nearly opposite Big Four Creek. The 30-foot bench of the river valley, across which the gulch flows, carries colors. On the mica-schist bed rock, which was reached by test pit, fine gold is found associated with garnet.

[1] Koksuktapaga is Eskimo, and is said to signify the "river with a loon at its mouth.

Several gulches on the east side of the creek between Big Four and Dixon creeks were reported to give good prospects. Of these Thorpe Gulch, opposite Dixon Creek, was being worked. Four men had dug a ditch about 40 feet long by 4 feet deep in the bed of the gulch, which is a channel across the terrace of the Koksuktapaga. Bed rock was not reached. Mica-schist, graphitic quartz-schist, and limestone are exposed at the head of the gulch. The gold is fine and is associated with quartz and magnetite. The claim was reported to be paying small wages.

Dixon Creek was dry in July, and no work was being done on it. A claim near its mouth is reported to have yielded a few thousand dollars in 1899. The workings were at the base of the terrace in the creek channel. Massive gray crystalline limestone caps Mount Dixon north of the creek. Below the limestone is mica-schist carrying small quartz veins.

Dry Gulch is a small channel incised in the terrace of the main valley. No measure was obtained of the thickness of the terrace gravels, but it may reach 50 feet. The workings in the terrace have reached a depth of 8 feet, and colors have been found from the grass roots down. The gold is usually fine; one $2 nugget was obtained. Pans are said to average 3 cents.

An important consideration relative to the gold resources of the Koksuktapaga is the fact that the gold of Dry Gulch and similar streams is not found on bed rock, but occurs in the gravels of the terrace, and is usually concentrated on clay seams. These bench gravels are said in many places to carry 3 cents to the pan. If this proves to be the case, the ample water furnished by the main river would offer good possibilities for hydraulic mining.

At the time of Mr. Richardson's examination the lower valley of Spruce Creek was buried in a remnant of ice of the previous winter and no work was being done. It was reported that 40 or 50 ounces of gold were taken from this creek in 1899.

Some development was made on Penelope Creek during 1900, but in the lower part of the creek bed rock had not been reached. Pans are said to average 5 cents. The adjacent country rock is quartz-muscovite-schist and graphitic quartz-schist. This creek seems to have ample water for sluicing at all times.

Goose Creek, which joins the Koksuktapaga opposite the mouth of Penelope Creek, was dry in July. Mining operations were going on, however, to be ready for the fall rains. Gravel is from 4 to 8 feet thick. The lower 2 to 3 feet usually carry values, and pans are said to run from 2 to 5 cents. Quartz Creek is a tributary of Goose Creek. The gravel is about 3 feet thick, and is said to average about 8 cents to the pan. Mr. Richardson saw one pan taken from bed rock which yielded 80 cents. The gold is flat, and coarser than Goose Creek gold.

Mint receipts give its value at $18.60 an ounce. The concentrates from sluices carry much garnet and magnetite. Bed rock is quartz-muscovite-schist with thin-bedded limestone.

A mass of ice averaging 10 feet high filled the mouth of Canyon Creek and extended up its bed for a mile. The lower course of the creek lies in the river terrace, through which it has cut its valley into the quartz-mica-schists. About 2 miles from its mouth some work has been done, exposing 3 feet of gravel on bed rock.

Boulder Creek, a northerly tributary of Canyon, is said to have yielded 50 ounces in 1899 as a result of a few days' work. In July work on one claim showed about 2 feet of gravel on bed rock, of which about 18 inches are said to carry values.

Banner Creek had some water in it in July, but not enough for sluicing. One claim, in 1899, is reported to have yielded $400 to four men who sluiced two days and a half. When Mr. Richardson visited this creek two men were at work near the mouth, where the gravel is 8 to 10 feet thick. The gold is rather coarse, though flattened, and assays $19.20 an ounce. Farther up the creek more or less work had been done, and the prospects were reported good. Limestone is bed rock in the mouth of the creek and outcrops on the divide to the north. Graphitic quartz-schist caps the hill at the head of the creek, and mica-schist forms the divide between Banner and Ruby creeks.

Left Fork of the Koksuktapaga is about 5 miles long. Like Canyon Creek, in its lower course it cuts through the wide terrace of the main river, while above the valley it is confined by adjacent hills. The rocks in the lower course of the Left Fork are mica-schists dipping S. 65° W. at an angle of 30° to 60°, and jointed N. 70° E. Between Wilson and Willow creeks is a belt of gray limestone about 2,500 feet thick interbedded in the schistose series. Small quartz veins are frequent throughout this series. Pebbles of garnetiferous greenstone are common in the creek, but no outcrop of this rock was seen. No developments have been made on this stream.

Willow Creek is a small branch at the head of the Left Fork, from which good reports came toward the end of the season. A low, narrow bench, about 6 feet high, extends along the creek. Gravel is shallow in the creek bed. Preliminary development, it was claimed, showed that a man could average $10 a day with a rocker. One $8 nugget and another worth $4.35 have been found. The gold is coarse and dark. In the lower part of the creek bed rock is limestone, while farther up it is mica-schist.

Ruby Creek, so named for the numerous small garnets found in it, is about 3 miles long and flows in a comparatively broad valley. Bed rock is mica-schist dipping S. 65° W. at an angle of 45°, and jointed E.-W. Numerous small quartz veins parallel both to the schistosity and to the joints occur in the schists. Pebbles of garnetiferous greenstone are common in the creek, but the rock was not seen in place. At the head of the creek gray limestone and graphitic quartz-schist are exposed. In July there were about twenty men on the creek. Almost every claim had at least one representative on it, though prospecting and preliminary work rather than actual mining was being done. Several ditches have been dug in the creek bottom and cross cuts have been made into the adjacent bench. In the lower part of the creek there is a depth of 2 or 3 feet of gravel through which the gold is pretty well distributed. Many garnets and a little black sand are associated with the gold. The gold is coarse, rather dark colored, and is said to assay $19.35 an ounce. The largest nugget found was worth $5.50.

Elkhorn Creek.—This stream joins the Niukluk from the south about 5 miles above Ophir Creek. It is about 4 miles long, and the greater part of its valley is incised in the broad terrace of the Upper Niukluk. Its valley varies from 150 to 500 feet in width. Near the mouth of the creek 2½ feet of gravel overlie 6 inches of clay and disintegrated bed rock. It is reported by miners that the pay streak is in patches and that the average yield of pans is 5 cents. The bench near the mouth gives colors, but has not been developed. The bed rock is mica-schist, interbedded with limestone, and the strike is at right angles to the course of the stream, with almost vertical dip, giving favorable conditions for concentration of gold. The gold is medium coarse and bright yellow in color. Some very coarse gold has been found stained with iron. The average of assays shows its value to be $19.12 per ounce. Quartz is often found attached to the placer gold, and one nugget was attached to a piece of mica-schist. This goes to show that it is of local origin. One nugget worth $55 has been found, and several worth from $12 to $16.

Goldbottom Creek.—This stream is tributary to the Niukluk from the south, about 5 miles below the Koksuktapaga. Its drainage basin is within the upland which lies to the south of the Bendeleben Mountains. Goldbottom Creek and its chief tributary, Warm Creek, have broad gravel-filled valleys. The bed rock is chiefly mica-schist, sometimes graphitic, with some intrusive greenstone. The dips show the structure to be an anticlinal uplift which points to the east between Warm Creek and the Ophir Creek drainage basin. The rocks have been correlated with the Nome series (compare geological map, Pl. III).

Quartz veins often containing pyrite are not uncommon. Some mining operations have been begun on Warm Creek and on the lower part of Goldbottom Creek, but at the time of our visit, in July, not much gold had been produced. Near the mouth of Goldbottom Creek the section is something as follows: 2 feet of soil, 5 to 6 feet of gravel, and 1 foot of weathered bed rock, which is there a chloritic schist. The gold is round, seldom flaky. The largest nugget obtained was worth about $8. The creek has ample water at all times for sluicing. On Warm Creek, about 2 miles above its mouth, a section showed 6 feet of gravel on a bed rock of mica-schist. The gravel carried some gold. The pebbles include many of quartz, often mineralized.

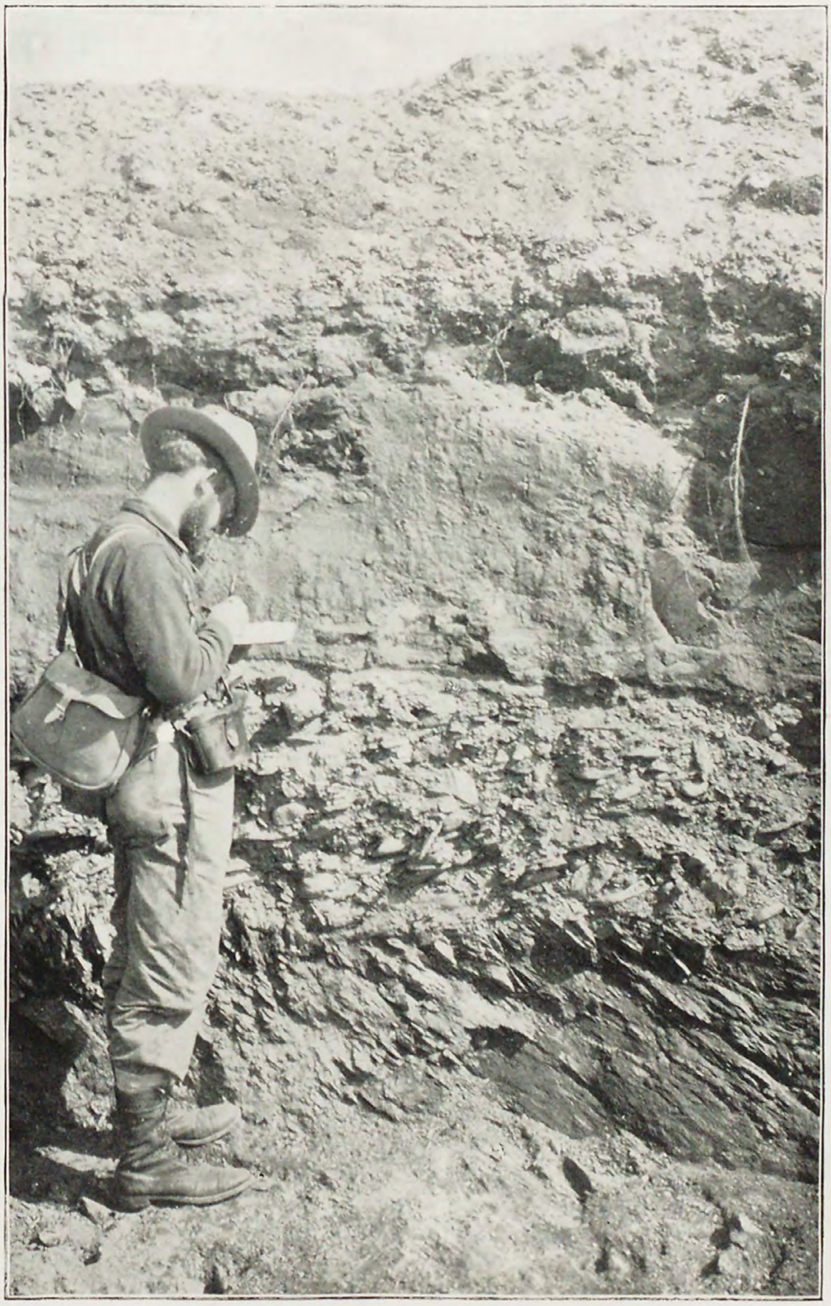
Ophir Creek.—This stream is 17 or 18 miles long, rises in the Mount Bendeleben group, and flows southerly to the Niukluk, which it joins about 2 miles above Council. The first 3 or 4 miles of its course are through a broad, tundra-covered, gravel-filled valley. This it leaves and flows for a mile or so through a narrow canyon with walls about 50 feet high. Thence, to within 2 miles of its mouth, the creek flows as a normal stream, with gentle curves, in a somewhat narrow valley. From divide to divide the valley is less than 2 miles. The valley walls descend uniformly to a low terrace that averages an eighth of a mile on each side of the creek, which has been incised to a depth of 10 or 15 feet. Toward its mouth the creek approaches within 200 feet of the Niukluk, and then flows parallel with the main river in its broad flood plain for over a mile before debouching into the Niukluk. Ophir Creek is not navigable, though when the water is high small boats can be taken up it for a few miles. A fair trail extends along the creek, up which pack animals can easily pass.

The mountains at the head of Ophir Creek are made up of the Kigluaik series, with the associated granites and gneisses. A narrow belt of the Kuzitrin series is found crossing the headwaters, but the rocks for the most part are quartz-mica and chlorite schists and limestone belonging to the Nome series, with some sills of greenstone.

Schistosity is well developed parallel to the original bedding planes as defined by the limestone contacts. The schists are more or less crumpled, and up Ophir Creek there are minor folds with axes parallel to the schistosity. In the lower course of the creek the strike of the rocks is about N.-S., varying from N. 20° E. to N. 20° W., and the dip is from 30° to 50° E. The rocks at the head of Ophir align with the trend of the mountains and strike a little north of east, dipping 45° S. On the Niukluk, in the vicinity of Council, the schists are characteristically graphitic. A prominent type is a black, fine-textured, dense, though somewhat fissile rock, which under the microscope is found to be a graphitic quartz-schist, composed chiefly of quartz and graphite, with a few small rods of muscovite and considerable disseminated pyrite. The arrangement of the minerals is distinctly schistose. Another conspicuous rock is a fissile, blue-black crystalline limestone. These quartz-schists and dark limestones rarely exceed 50 feet in thickness in any one bed, and are subordinate members of the schistose series. The prevailing rock is calcareous mica-schist, which frequently is graphitic. Staurolite occurs in the schist in the hill a mile and a half northwest of Council. Massive gray crystalline limestone is prominently developed in the hills that form the western divide of Ophir Creek. A mass of greenstone lying to the west of Ophir Creek and another to the south have been described elsewhere. The sills of greenstone are composed chiefly of secondary minerals; their relations to the sediments show them to be intrusives. Numerous small veins and lenses of quartz and calcite occur in the schist parallel to the general structure, but no veins have been found carrying high values. Pyrite, however, sometimes occurs with the quartz veins and is disseminated more or less commonly in the schists. Although no workable quartz has been found, colors of gold can be got in most of the stream beds of this region. At one locality, in a bluff on the north bank of the Niukluk, about 3 miles up from the mouth of Ophir Creek, colors were obtained by panning stringers of quartz in disintegrated schist. From these facts it seems probable that the gold is disseminated in the schist and associated with the small veins and stringers of quartz.

In 1866 colors of gold are said to have been found along the Niukluk River by Daniel B. Libby, of the Western Union Telegraph Company's expedition. No attempt, however, was made at that time to follow up the discovery. In March, 1898, Libby with three others (L. Melsing, A. Mordaunt, and H. L. Blake) discovered gold on Melsing Creek, and later they made locations on Ophir Creek, Discovery claim being made at the mouth of Sweetcake Creek. The region was organized under the name of "Discovery district," April 25, 1898. This discovery of gold, therefore, antedates by some months that on Anvil Creek at Nome. Most of the claims in Discovery district were staked in 1898, but very little actual work was done that year and in 1899. The season of 1900 marked the practical beginning of active mining in the region, but because of difficulty of getting in supplies, scarcity of water, and the fact that the working of some claims was impeded by litigation, the gold returns for 1900 were not commensurate with the importance of the district. Ophir Creek and its tributaries are staked for nearly their entire lengths, but active mining in 1900 was being carried on at only a few localities. Near the mouth of Sweetcake Creek the mining operations show 6 feet of gravel, but had not reached bed rock. The gravel is mostly fine and consists of schist, limestone, greenstone, and granitic pebbles, associated with clay. Gold occurs throughout this gravel. Two nuggets, worth $20 and $14, were found in 1899, and in 1900 one worth $30 was found in the gravel less than 2 feet from the surface. The gold is rather coarse, rounded, and not particularly flaky. It is generally of a clear, bright, yellow color, but some pieces are stained with iron. This gold is said to assay $19 an ounce.

On Sweetcake Creek the discovery was made on August 12, by S. E. King, N. S. Vestal, Charles Phillips, Tom Baer, and Nicholas



SECTION OF AURIFEROUS GRAVELS, SWEETCAKE CREEK, TRIBUTARY OF OPHIR CREEK.

Credel. The bed rock of this creek consists of mica-schists, calcareous schists, and thin-bedded limestone with some chloritic schists and white crystalline limestone. Some chloritic schists were also observed, which are probably altered intrusives. Near the mouth of Sweetcake Creek the following section was observed (see Pl. X):

	Feet.
Fine, micaceous sand	45
Gravel and sand	2
Decomposed rock	1
Bed rock exposed	8

The gravels contained much mineralized quartz and calcite. The gold is found mostly in decomposed rock. On Sweetcake Creek pans on bed rock run 40 to 50 cents. A $9 nugget is the largest that has been found. In 1898 about $36,000 was taken out of one claim. The upper part of Sweetcake Creek had not been much prospected, but deserves the attention by the miners.

On Ophir Creek about a mile above the mouth of Sweetcake Creek are remains of abandoned workings of the previous year. Judging from the gravel torn up and the relics of their camp, considerable, but possibly ill-directed, work was done. Little is known of the results except that the attempt did not pay.

About 5 miles up Ophir Creek from its mouth 12 men began work the last of July, 1900. The water was cut off by a dam, at the head of the claim, and conducted through a ditch in the flood plain, exposing the creek bed, and this was being sluiced. The gravel is about 2 feet thick, and bed rock is a mica-schist striking parallel with the creek and dipping eastward 45°. Gold occurs through the gravel, with the pay streak on bed rock, which is carefully scraped. One nugget worth $5.25 was found. The gold is fine and flaky; garnets and black sand are associated with it. Half a mile above 18 men began sluicing the middle of July. They worked a low divide immediately west of the channel of the creek. The upper 8 feet of sand contains no gold and is stripped. The pay streak is 3 or 4 feet of low-grade gravel. All of this is sluiced with about 6 inches of underlying clay. There are some 3 to 6 feet of this clay above mica-schist bed rock. The gold is fine, and many garnets and some black sand are associated with it. Half a mile farther up the creek bed was being worked. Here the gravel varies from 3 to 10 feet in thickness. Over the gravel is a layer of clay from 1 to 8 feet thick. A few nuggets have been found—the largest worth $6. In general the gold is fine and bright, and besides garnets and magnetite, scheelite occurs in the sluice boxes with the gold.

Besides Sweetcake Creek, the only tributaries of Ophir where mining was being carried o. were Dutch and Crooked creeks. In July a few parties were doing desultory work on Dutch Creek without success.

Crooked Creek was being worked at its lower end with promising results. It is estimated that $25,000 was taken out in 1900. An area about 20 feet square in the creek bottom had been stripped to bed rock, a graphitic mica-schist. The gravels are 3 to 4 feet thick, underlain at the mouth of the creek by clay, and farther up the creek by graphitic mica-schist. The gold is medium coarse, and is accompanied by considerable black sand.

Mr. Richardson reports that some attempts were made in 1900 to work the bench along the middle course of Ophir Creek. One section, which did not reach bed rock, was as follows:

	Feet.
Soil and muck	1
Gravel	6
Sand	4
Gravel	?

The gold is fine and no nuggets have been found. No very accurate data could be obtained, but it seemed as if there was great variation in the gold contents of the gravel, for sometimes hardly a color can be obtained, and again the gravels are reported to yield 5 to 10 cents to the pan. It seems probable that this bench could be worked to profit by use of hydraulic methods.

Melsing Creek.—This stream is about 8 or 10 miles long and flows into Niukluk River a quarter of a mile below Council. Its lower course is through a broad plain. The creek had a little water in it in the dry season, but was not navigable even for small boats. Practically no development was going on in July, but toward the last of August it was reported that 40 men were at work in the lower part of the creek. The gold is fine and is taken both from creek beds and from adjacent terraces.

Bear Creek and Fox River.—Lack of time prevented Mr. Richardson from examining the drainage basins of these streams. They are tributary to Niukluk River from the southwest and are streams of considerable size. As far as known, no gold has been found on Bear Creek. Prospects have been reported from Fox River, but very little gold has been taken out.

Klokerblok River.—This river rises a few miles from the coast, north of Cape Topkok. It flows in an easterly direction, and joins Fish River in its delta mouth. Mr. Richardson was unable to visit this drainage basin. No gold has been reported from the Klokerblok, but from the fact that some of its tributaries lie near Topkok and Daniels creeks it would seem to be worthy of attention by prospectors.

Kruzgamepa region.

The Kruzgamepa[1] has its source in Salmon Lake, which lies in a broad valley at the southern base of the Kigluaik Mountains. It flows

[1] The drainage basin of the Upper Kruzgamepa was first organized as the "Golden Gate mining district," and is now included in the "Kugruk mining district." This river is sometimes known by the name of Pilgrim River.

to the northeast, and sweeping around the eastern limit of the range reaches the head of Imuruk Basin by a northwesterly course. Salmon Lake has a number of tributaries of considerable size; the largest, which may be regarded as the true source of the Kruzgamepa, is called the Grand Central and heads well in the heart of the Kigluaik Mountains. The southern and western tributaries of Salmon Lake and the Upper Kruzgamepa, which rise in the mountains, flow through glacial valleys and have steep rock walls. The valleys of the streams coming from the south are broader and are not glaciated. In the broad flat which connects the Kruzgamepa and Niukluk valleys, Killkuhn Creek joins the former stream from the east. The Lower Kruzgamepa receives several tributaries from the north flank of the Kigluaik Mountains. These leave the range through narrow mountain valleys as mountain torrents, and then, after meandering sluggishly across the broad flat, join the river on the north side of the valley.

The bed-rock geology (compare the geological map, Pl. III) in this region affords considerable variety. The core of the mountains is made up of massive granite, associated with crystalline limestone and schists. These rocks have been named the Kigluaik series. Above the limestone is a series of quartz-schists, graywacke, and clay slates, carrying much graphite, which has been named the Kuzitrin series, and is found on both sides of the range. The Kuzitrin series is overlain by the Nome series, which here consists of flaggy limestones and some calcareous schists, overlain by heavier beds of limestone, often white and crystalline. With them are found a great number of greenstone-schists and some mica-schists.

Of the gold resources of this region no very definite statements can be made, for there has been almost no attempt at development. The rocks are the same as those that in other areas produce placer gold and in many localities show evidence of mineralization. Large quartz veins seem to be more abundant than elsewhere, and some have been shown to contain gold, though none have been found which carry commercial values. Up to the time of our examination of this region no workable placers had been discovered, and, in fact, no real prospecting of the creeks had been attempted. The following notes on the occurrence of gold are based in large part on Mr. Collier's field observations.

Kruzgamepa River flows in a broad gravel-filled valley. Above the mouth of Iron Creek broad gravel terraces about 50 feet above the water can be traced on both sides of its valley. Much of this gravel, as has been explained elsewhere, was contributed by glaciers that flowed from the Kigluaik Mountains. Below Iron Creek the river flows through a rock canyon, about 100 feet deep, with broad rock benches above, for about 3 miles, and then continues in a broad valley to Imuruk Basin. What little prospecting has been done along the upper river has not led to encouraging results. The bed rock belongs to the gold-bearing series, but, as will be explained elsewhere, this does not necessarily imply workable placers. This valley contains a great deal of unassorted glacial gravel, and in this the gold, if present, would not be concentrated. If they are found to be auriferous many of these gravels could be hydraulicked. Between the lake and the mouth of Golden Gate Creek the river has an average fall of 20 feet to the mile and ample water at all times for all purposes. A ditch could easily be brought from the lake to any point in the valley. A careful cross cutting of the gravels just above the canyon, where the concentration would be greatest, should show conclusively whether they were to a marked extent auriferous.

Iron Creek is the largest of the southern tributaries, and is about 15 miles in length. It has its source near the headwaters of Eldorado and Bonanza rivers, and, flowing northeast, joins the Kruzgamepa near its northerly bend. The headwaters of this creek we did not have opportunity to visit, but in its lower course it flows through a rock canyon with walls rising a hundred feet. The creek flows nearly parallel to the strike of the bed rock, which, as far as we know, is a thin-bedded limestone with numerous greenstone intrusives. Colors are plentiful near the surface along Iron Creek, 1 or 2 cents to the pan being common, but as yet no one has penetrated the gravels to bed rock. One party of prospectors who attempted to reach bed rock went down 5 to 6 feet, but were prevented by the water from continuing operations. A quartz vein about 2 miles up the creek is said to have yielded $12 to the ton in gold. There is ample water for sluicing at all times in the year, and the stream has good fall. About 6 miles above its mouth Iron Creek receives an important tributary from the west, known as Canyon Creek, in whose gravels colors are said to have been found.

Willow Creek, which is about 3 miles long, joins the Kruzgamepa from the south about 8 miles above Iron Creek. Near its mouth this stream flows through a small rock canyon about 50 feet deep, above which is a bench on either side covered with gravel. This bench represents an old valley floor into which the stream has incised its present valley. The bed rock on which the creek flows includes limestones with interbedded quartz-schists, which are of sedimentary origin. With it occur greenstones which are igneous. The strikes are nearly directly across the course of the stream, and the dips south—i. e., upstream.

Gold has been found in limited quantities on this stream. On bed rock we know of pans yielding 25 cents. The dips being upstream and the rocks often rather heavily bedded, the lodgment for gold is not so good as in regions where thinly laminated rock with downstream dips forms a natural riffle. During the dry months the creek would probably not afford a sluice head of water. The gravel deposits on the bench are of the same character as those in the stream, and therefore probably carry gold.

Slate Creek, which is about 2 miles long, joins the Kruzgamepa from the south 2 miles above Willow Creek. It has one large tributary named Rock Creek, and two smaller ones, known as Pennsylvania Creek and Madeira Gulch; a third small confluent stream is unnamed. The character of the bed rock is the same as that of Willow Creek. It also has a rock bench and canyon similar to those of Willow Creek. Twenty-five cents to the pan has been obtained. From both streams the gold is bright colored and flat.

Jasper Creek flows into Salmon Lake from the south. Both it and its tributary have their courses in broad, flat valleys, unfavorable for the concentration of gold.

Grand Central River has its source in a glacial amphitheater in the Kigluaik Mountains, and, flowing through a broad valley, in a southeasterly direction, discharges into Salmon Lake. Its length is only 10 miles, but it carries an abnormally large quantity of water for the size of its basin. The valley is U-shaped in cross section and is more or less filled with glacial material.

The headwaters of this stream cut the Kigluaik limestone and the associated granite and crystalline schists. In its lower course the valley lies in the graphitic schists of the Kuzitrin series. As far as known no colors have been found on this stream. The character of the valley and the nature of the erosion which has produced it make it improbable that gold could be found concentrated in its gravels. It is of interest to note that some graphite deposits occur in this basin.

Fox Creek enters Salmon Lake opposite Jasper and has its source in a glacial amphitheater well in the heart of the mountains. About 3 miles up it receives a tributary from the west, called Paso Robles Creek, and one from the east, known as Warren Creek. Its original valley floor was U-shaped, similar to the Grand Central Valley, and in this former valley bottom glacial material was deposited. Near its mouth Fox Creek has cut a narrow trench, about 50 feet deep, in the bottom of this old valley. This trench decreases in depth upstream and finally merges into the old valley floor.

In its upper course this stream cuts into the older rocks which are found on the head of the Grand Central, and, like that stream, it crosses the Kuzitrin series. Near its mouth limestones and greenstones belonging to the younger Nome series are exposed.

Colors are found on Fox Creek and its tributaries. Some prospecting has been done, and attempts have been made to reach bed rock, but these have failed because the inflow of water stopped the work. One mile above its mouth some quartz veins were found cutting a greenstone-schist, which, on assay, are found to carry a trace of gold. The stream affords abundant water for sluicing at all seasons of the year.

Crater Creek, the largest tributary of the Kruzgamepa, joins the latter river from the north side about 4 miles below Salmon Lake.

One mile above its mouth it debouches upon the valley of the Kruzgamepa from a large U-shaped valley in the east end of the Kigluaik Mountains. It is said to be only 5 miles in length, heading in a large cirque, which, being mistaken for a volcanic crater, gave the name to the creek. About its mouth the Kruzgamepa Valley is filled with morainic deposits, which include many characteristic kettle-hole lakes and which extend from the foothills to the river. Through this morainic material, which rises 100 feet or more above the river, and in the floor of the U-shaped glacial valley above, Crater Creek has cut a broad gorge. It is not known whether colors of gold have been found on this creek. The valley of the creek lies chiefly in the older rocks, which have not been found to be gold bearing, and the present form of the valley was not favorable to the concentration of gold.

Big Creek joins the Kruzgamepa about 4 miles below the mouth of Crater Creek. It is about 5 miles in length and has its source in a glacial amphitheater in the heart of the Kigluaik Mountains. About a mile and a half up it receives a good-sized tributary from the west, called Grouse Creek. In its lower course the U-shaped valley is sharply trenched, similar to that of Crater Creek.

The bed-rock geology in Big and Crater creeks is very much the same. The headwaters reach the crystalline schists, and these streams cut across a series of graphitic schists which belong to the Kuzitrin series. In the Kuzitrin series is found a number of intrusives of a basic character. Near the mouth of Big Creek occur exposures of the flaggy limestone which is the lowest member of the Nome series. No prospecting has been done on this stream, but colors are found at the surface. Several mineralized veins were observed, and one of these, on assay, showed a trace of gold. At all except during the driest times the creek will probably furnish a sluice head of water.

Homestake Creek, which is about 2 miles below, needs no special description, as in its valley form and the character of its bed rock it is similar to the stream just described.

Golden Gate Creek, which is the next stream below, and which reaches the Kruzgamepa near its big westerly bend, also has its source in a glacial cirque; its valley is U-shaped and covered with glacial deposits. The reports from this creek are not encouraging. The bed rock probably belongs chiefly to the crystalline-schist series, which, so far as we know, does not carry gold. Between Golden Gate Creek and its junction with the Kuzitrin the Kruzgamepa receives several small creeks, some of which have their sources in small glacial cirques which were visible from our route of travel. We did not have opportunity to study these creeks in detail, but our conclusions would be that their drainage basins lie chiefly in the older crystalline rocks and that they are probably not gold bearing.

Attention will here be called to some graphite deposits that were found by Mr. Collier in this region. These deposits occur in the heart of the Kigluaik Mountains, on the pass between the Sinuk and the Grand Central rivers. The bed rock of the region, associated with the deposits, is a highly crystalline schist, probably of sedimentary origin and belonging to the Kigluaik series. The graphite was found in bowlders on a talus slope, the largest of which were a foot in diameter. These bowlders unquestionably had their source in close proximity, but unfortunately time was lacking to trace them to their parent rock. A specimen from this locality consists of pure graphite with a little disseminated quartz in small grains. The quartz grains contain a little pyrite.

In both the Kuzitrin and the Kigluaik rocks graphite is not uncommon, and is also found in slates belonging to the Nome series. It, however, is usually disseminated in siliceous or argillaceous rock and can not be obtained pure except in small flakes. This locality, found by Mr. Collier, is the only one where we observed it in considerable masses. Prospectors report its occurrence at other points in the mountains.

Kugruk region.[1]

Under this heading is included an ill-defined area lying north of the Bendeleben Mountains and drained by Kugruk and Kuzitrin rivers (see map, Pl. XI). North of the mountains the upland, as defined by the summits of the hills, has somewhat of a plateau character, where the surface stands at about 1,200 feet, and in which the larger streams have cut broad valleys. The drainage of the area is to the southwest, via Kuzitrin River to Imuruk Basin. This river rises in a broad valley lowland, about 20 miles wide, which extends to the northeast, toward the Arctic Ocean. In this lowland the Kuzitrin receives from the north a number of tributaries of considerable size. Kugrukruk, Garfield, and Taylor creeks and Kugruk River rise in the upland to the north, and, after leaving the highland through narrow valleys, debouch on the gravel-floored lowland. None of these streams have been explored to their headwaters, but their positions are approximately indicated on the accompanying map (Pl. XI), from notes furnished by prospectors. The Kugruk in its lower course follows close to the western margin of the valley lowland. Here an escarpment is formed by a gravel terrace about 100 feet high (Pl. V, *A*) and in places 3 or 4 miles wide. Into this terrace Quartz Creek and other western tributaries of the Kugruk have cut sharp valleys. The gravel deposit which forms this terrace at one time extended much farther east, across a portion of the present valley lowland. Proofs of this are given by the small flat-topped hills formed of stratified

[1] This region was first organized in two districts, named "Kugruk district and Bunker Hill district." Under the latest subdivision they are both included in the present Kugruk district. See appendix.

gravels which are to be found in the valley lowland to the east of the escarpment described above. Such a one is represented on the map (Pl. XI) about 3 miles northeast of Checkers. This is plainly a portion of a larger gravel deposit which covered the present valley floor and has since been removed by erosion.

Our studies of the bed-rock geology were far from being satisfactory. Some general relations were, however, established. Though our exploration was extended nearly to the head of Garfield Creek, no outcrops were found north of Quartz Creek, and we therefore had only the stream gravels as clews to the character of the bed rock. Mr. Richardson's investigations at the head of Ophir Creek, and ours along the lower Kruzgamepa, leave but little question that the main mass of the Bendeleben Mountains is made up of a mass of granite flanked on either side by crystalline schist. In places limestone or marble is found associated with this schist, and seems to form the basal member of the sedimentary rocks. Of this lower limestone, however, we saw nothing in the Kugruk region. Along the constricted portions of the Kugruk Valley a schistose series is well exposed, striking in general northeast and dipping northwest. The lower part of this series is of a quartzose nature, with considerable graphite. Some pegmatite dikes were found cutting these schists, but there was a marked absence of greenstone. These series are jointed, with many quartz and calcite veins, often carrying sulphides. These quartz-schists were correlated with those of the Upper Kruzgamepa and were called the Kuzitrin series (see section on General Geology). The schists of the Kuzitrin series merge into and are overlain by more calcareous schists, which are regarded as belonging to the Nome series (cf. section on General Geology). The Nome series, judging from the character of the river gravels, extends to the northward, probably including Harris Creek. There are many pebbles of greenstone and greenstone-schist. Baldy Mountains we know to be made up of limestone.

The geological section (Pl. III) brings out these general relations and shows the rocks of the Kugruk to be similar to those found south of the range. The great fold which was produced by the intrusions of the granite found in the heart of the range has brought up the same series on both flanks, giving thus an anticlinal structure.

Quartz Creek.—This stream, on which gold was discovered in July, 1900, joins the Kugruk about 5 miles from the Kuzitrin. In its lower course its valley is narrow and is incised in a floor of the gravel terrace already described. At the mouth of Quartz Creek this terrace is about a hundred feet above the water. Going upstream the gradient of the creek gradually increases, and the relief of the terrace is therefore less. Small benches mark the former positions of the stream beds. The present flood plain is usually not over 50 to 75 feet wide,

Notes on drainage of Agiapuk furnished by Messrs. Kemp and David Fox

SKETCH MAP OF THE KUGRUK MINING REGION

BY ALFRED H. BROOKS

Scale of miles

5 4 3 2 1 0 5 10 15 MILES

Contour interval about 200 feet

JULIUS BIEN & CO. LITH. N.Y.

Probable drainage, and contouring in regions not surveyed, are indicated by broken lines and often narrows down to very much less. In its headwaters Quartz Creek probably reaches bed rock, but as far as the mouth of Dall Creek it does not entirely penetrate below gravel (fig. 2).

The gold which is now being mined lies 2 or 3 feet below the surface, on what the miners call "bed rock," which is a blue clay apparently intercalated in the gravels. We were informed that one pit which was sunk to a depth of 18 feet passed through the clay into gravels, but did not reach bed rock. The pebbles are predominantly quartz, mica-schists, vein quartz, and greenstones, with some limestone and calcareous schist. This blue clay offered a floor on which the gold was concentrated. In their horizontal extension the pay streaks are of rather irregular form, suggesting old stream channels existing previous to the present stream bed. On one claim on Quartz Creek we washed out two pans of gravel, one of which yielded 50 cents and the other 75 cents. This gravel was taken from the clay bed rock described above.

The creek was discovered late in the season, and it being far from supplies and lumber, but relatively little development has been made

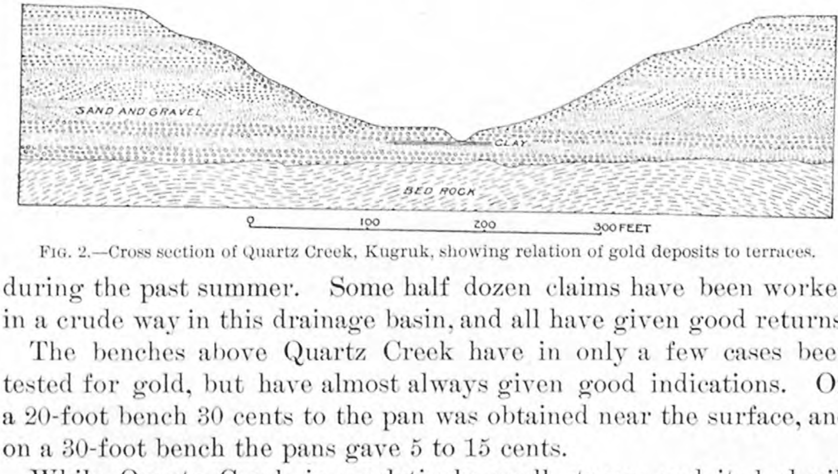


FIG. 2.—Cross section of Quartz Creek, Kugruk, showing relation of gold deposits to terraces.

during the past summer. Some half dozen claims have been worked in a crude way in this drainage basin, and all have given good returns.

The benches above Quartz Creek have in only a few cases been tested for gold, but have almost always given good indications. On a 20-foot bench 30 cents to the pan was obtained near the surface, and on a 30-foot bench the pans gave 5 to 15 cents.

While Quartz Creek is a relatively small stream and its bed will soon be mined out, there is strong probability that the benches will yield profitable returns. In dry weather it hardly furnishes a sluice head of water. The important question, then, of water supply will have to be solved, and this can probably be done only by those who command sufficient capital to control a large block of claims and can afford to work them on a comprehensive scale. In the neighborhood of Quartz Creek there are a number of small streams whose drainage basins lie entirely within the terrace gravels, which promise well, but have not received much development. The gold is coarse and of a bright color. The average color is worth about one-seventh cent (Pl. XII). Quartz grains are not infrequently found attached to the gold nuggets.

Garfield Creek.—This stream, which is considerably longer than Quartz Creek and has a broader valley, joins the Kuzitrin about 5 miles above the mouth of the Kugruk. It heads in the uplands in the vicinity of Baldy Mountain, and, flowing through a rather broad valley, crosses the valley lowland and joins the Kuzitrin. It was discovered after Quartz Creek and has received relatively less attention, but promises equally well.

The gold which has been mined occurs under about 2 feet of gravel on a clay bed rock. This clay resembles a decomposed metamorphosed schist, but from the best data available seems to be underlain by the gravels. The pay streak on bed rock is said to be very rich.

The gravels consist largely of chloritic schists and limestones, with many large quartz bowlders. These bowlders are often several feet in diameter, and can not have been carried very far by the comparatively insignificant stream in which they are found. As there is no evidence of ice transportation, we are forced to the conclusion that they have a local source.

The pay streak is found in the flood plain of the present creek bed. It is of irregular outline, similar to that on Quartz Creek.

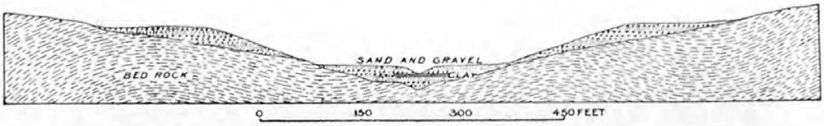


FIG. 3.—Cross section of Garfield Creek, Kugruk, showing terraces in creek valley.

The valley of Garfield Creek is not incised in a gravel terrace, as is that of Quartz Creek, yet benches are frequent along the valley walls, and these, together with the dense growth of moss, cover the bed rock. A profile of a cross section of the valley is shown in fig. 3. It will be seen from this that, as in the case of Quartz Creek, the gravels which are now being worked are only of limited horizontal extent. There is every reason to believe, however, that terraces found along the creek and shown in the profile will also carry gold.

At the time of our visit some half a dozen claims were receiving more or less development. Rockers and sluices were being used. On account of the lack of lumber the sluice boxes were very short and most of the fine gold must have been lost. The gold is coarse, dark colored, and of irregular outline, similar in character to the Bluestone gold. The average grain of sample obtained by us was worth about 1¼ cents (Pl. XII).

Harris Creek.—This creek flows in a northwesterly direction from Baldy Mountain and enters the East Fork of the Kugruk. The country rock is said to be limestone. The creek was discovered April 24, 1900, when colors were found. The creek bed is said to be 50 feet wide and to have benches and sides similar to those of Quartz and Garfield creeks. The bed rock on which the gold occurs is a yellow clay. The highest pans reported from this creek were $1.25. Two or three claims received more or less development last season, but, in consideration of the fact that the first discovery in the region was made on this creek, the development has not been pushed very rapidly. The benches on the side of the stream are said to give colors. The gold is bright in color, similar in character to that of Quartz Creek.[1]

Kugrukruk Creek.—At the time of our visit to the Kugruk district a prospector arrived from this creek and reported having found valuable gold prospecting. The Kugrukruk joins the Kuzitrin about 20 miles above the mouth of the Kugruk. The prospector claims to have found gold on Goose Creek, a tributary of Kugrukruk, and brought in gold worth $8.64, which he claimed to have taken out at the surface.

Idaho Creek.—This stream joins the Kuzitrin about 8 miles below the Kugruk. It has its source near the head of Quartz Creek. It is a narrow valley with steep talus slopes on either hand. The bed rock is chiefly mica-schists and chloritic schists.

At one locality, about a mile above its mouth, some prospectors put down a test pit about 18 feet deep during the winter of 1899. They informed the writer that while they got good colors they did not reach bed rock, and were much hampered in their work by the many large fragments of rock, which were evidently derived from the steep talus slopes.

From the above descriptions it will be seen that these streams evidently lie in a rich placer district. As far as could be determined, the rocks are identical in lithology with the gold-bearing rocks of the Nome region and occupy a similar stratigraphical position. The strikes, lithological characters, and structural evidence all point to the conclusion that they are the extension of the same series with which the Bluestone placers are associated. We would call special attention to the gravel terrace lying west of Kugruk River, which has been described. All the evidence seems to show that the Quartz Creek deposits are concentrations from the gold in these gravels. It would seem, therefore, that these gravels would be worthy of the investigation of capitalists who are looking for hydraulic mining properties. Kugruk River would furnish ample water supply for such purposes. In this connection it would be well to note that in the lower 15 miles of its course the gravels of the Kugruk nearly everywhere yield good colors.

The stream benches of the present drainage courses are also worthy of attention by prospectors. These have been described as occurring on Garfield and Quartz creeks, and there is every reason to believe that they carry gold. The reported discoveries on the Kugruk are of importance, because they suggest a northeasterly extension of this

[1] For the above notes on Harris Creek we are indebted to Mr. Zimmerman, one of the four discoverers.

gold field. No accurate figures of the production of the district during the season of 1900 can be given, but it was probably between $30,000 and $50,000.

In the first attempts to exploit this district we have a good example of the course too often pursued in newly discovered placer-gold fields, especially those of Alaska. During the period of excitement and speculation which followed the discovery of the Nome gold fields prospectors rushed from every direction into this new Eldorado. During the first summer their operations were confined to the region near the coast. As they became more familiar with the country and when the winter's snow made traveling easier, they gradually worked their way farther inland.

In March, 1899, some of these men discovered colors of gold on Harris Creek. The news of this "strike" soon reached Nome and a "stampede" across the snow took place, although no prospecting could be done with the ground frozen and covered with snow. Still much of the region was staked and even restaked. It was reported at Nome that a quartz ledge carrying $700 to the ton had been found, and the discoverer, it is said, received a large sum of money for guiding a party to the locality. The assay of this fabulously rich vein finally showed the gold contents to be something under $2 to the ton.

Another typical incident in this stampede was the locating and naming of a certain creek said to be extraordinarily rich, which, when the snows melted, was found to be only an abandoned channel in the flood plain of Kuzitrin River.

Mining districts were formed at this time, first the Bunker Hill or Kuzitrin district, and a little later the Kugruk district. The reaction, however, which always follows these stampedes, took everyone out of the region except a few persistent men who still believed that gold would be found in paying quantities.

The second excitement was the boom set on foot when navigation opened and thousands of enthusiastic but inexperienced gold-seekers were landed on the Nome beach. It was quietly fostered by some of the smaller transportation companies who ran vessels to Port Clarence, and was also encouraged by the first and now disappointed set who hoped thus to be able to sell their claims which they had come to consider as of doubtful value.

The second rush, in which about 300 persons took part, was almost as futile as and far more ridiculous than the first, for while the first lot of prospectors really could do nothing on account of the snow, their successors adopted the same course and followed one another like sheep across the tundra, making scarcely any attempt at prospecting. This original method of looking for gold was naturally without results, and most of these men returned disappointed to Nome.

Meanwhile, however, a few wiser and more experienced men had begun to prospect on some of the creeks, and on August 9 rich diggings were found on Quartz Creek and somewhat later on Garfield Creek. These miners were already sluicing out gold when the second group of stampeders were straggling back into Nome reporting the region to be worthless.

A small settlement has sprung up at the junction of the Kugruk and the Kuzitrin, which is near the point where the trails to Quartz and Garfield creeks diverge. This place, which is usually known as Checkers, is about 100 miles distant from Nome by the pack-horse route and about 75 miles from Teller by water. During the past season supplies were brought to Mary's Igloo, on the Kuzitrin, by flat-bottomed river steamers from the lower end of Grantley Harbor and thence to Checkers in small boats.[1] From Checkers they were carried by pack horses to the placer camps. The trip from Nome to Checkers has been made with horses in three days. The route usually followed is up Nome River and across the low divide to Salmon Lake; then along the west side of the Kruzgamepa, keeping well away from the river, to the big bend, thence across the mountains in a straight line to Checkers.

In the future probably all of the supplies for the Kugruk will be landed at Teller and then brought by steamer to Mary's Igloo. From this point they will be brought by small boat to Checkers or by pack train directly to the placer camps. Pack animals can be used to advantage in this region everywhere except in the flat which encircles the upper part of Imuruk Basin, where there is much boggy ground and often a thick growth of willow.

Agiapuk region.[2]

Agiapuk River is a stream of considerable size which enters Imuruk Basin from the north. At its mouth it has a broad delta with innumerable channels, in which the tide ebbs and flows. We were unable to explore this river, and its drainage as represented on the map (Pl. XI) is based chiefly on notes furnished by Messrs. Kemp and David Fox. About 25 miles from the bay the river is said to fork. The easterly and larger fork has been called American River[3] by the prospectors. The East Fork is said to head far to the northward, near Shishmaref Inlet, while the West Fork is said to take the drainage of the region immediately to the north of Port Clarence. Near the junction the East Fork receives a tributary called Igloo Creek, which heads near Kugruk Basin. About 10 miles above another creek of considerable size joins the river, which also has its source near Kugruk waters

[1] In August, 1900, 30 cents a pound was charged for transporting supplies from Checkers to the upper part of Quartz Creek, a distance of less than 10 miles.

[2] This is included in the Port Clarence mining district.

[3] Some confusion has been caused by this misapplication of names. On some maps the East Fork is called American River, on others the name is applied to the West Fork.

and was named Budd Creek by the prospectors. A few miles above a smaller tributary joins the East Fork, also flowing from the east, which is known as Burke Creek on some maps.

Gold was found on this stream in commercial quantities in September, 1900.[1] Since then there have been rumors of further discoveries in this drainage basin. Colors are said to be found on many other creeks. What little information we could gather about the bed rock would lead us to believe that the same rock series occurs on the Agiapuk that is found on the Kugruk. What we know of the trend of the beds on both sides of this basin would tend to confirm this view. If the region becomes a gold producer, it will be found to be easily accessible from Port Clarence either by boat or by pack train.

Grantley Harbor region.[2]

Two creeks of considerable size enter Grantley Harbor from the south and four from the north. These streams, which are 2 to 3 miles in length, have cut rather sharp valleys in the upland, which has been described as a dissected plateau. Above this upland plain rise some isolated knobs, of which Mount Mukacharni is a conspicuous example.

The bed rock, as far as could be determined, belongs to the Nome series, which has been described in the notes on the geology. The stream valleys, entering the bay from the south, lie for the most part in a graphitic slate, which is often intensely folded. This slate is sometimes carbonaceous, which has led to the belief that workable coal veins occur in the region. This view was not corroborated by any exposures that we examined. In every case the percentage of carbonaceous matter was too small to give the rock any fuel value.

A reference to the geological map (Pl. III) will show a large mass of greenstone immediately south of the eastern end of the bay. Our best evidence goes to show that this is an intrusive mass in some thin-bedded limestones that underlie the slate. The strikes south of the harbor are about northeast-southwest.

On the north side of the harbor the streams cut a series of limestones with intruded greenstones and some slates, and the strikes are about N. 20° E., with northwesterly dips. To the west of the harbor north of Reindeer Station is a series of thin-bedded earthy limestones, in which, as has been stated, Ordovician fossils were found.

These creeks, tributary to Grantley Harbor, were all staked during the Kugruk excitement of the summer of 1900. Colors have been found on several of them, but no attempt has been made to find out by prospecting whether gold was present in workable quantities. The rocks have a general lithological similarity to those that are gold

[1] My authority for this statement is Mr. Earnest G. Rognon, of Teller, Alaska, United States Commissioner for the Port Clarence mining district.

[2] Included in Port Clarence mining district.

bearing elsewhere, and frequently carry mineralized quartz. Our conclusion is that these creeks are worthy of investigation by the prospector.

Bluestone region.

Under this heading it is proposed to describe an area lying southeast of Port Clarence, in which Bluestone River is the chief water course.[1] It is roughly blocked out by the Kigluaik Mountains, Grantley Harbor and Imuruk Basin, Port Clarence, and Bering Sea. Along Bering Sea a low plain extends inland 4 to 5 miles, in which the water courses meander sluggishly and which is dotted by ponds and lagoons. Elsewhere the coast line is more abrupt. Most of the area is occupied by a rolling upland, which rises to a generally uniform crest line at about 1,000 feet and in which the larger streams have carved broad valleys. The Kigluaik Mountains rise rather abruptly from this upland to elevations of 3,500 feet. The drainage is characterized by the great irregularity of the larger streams. While the small streams have a general radial arrangement, with comparatively straight valleys, the larger waterways have the most unexpected turns and twists. The best example is the Bluestone, which, rising about the center of this area, flows through a broad, flat valley nearly east, then turning northward at an angle of 80° continues in this direction with the same character of valley for about 4 miles, then, turning northeasterly, enters a narrow rock canyon. On emerging from the canyon, about 5 miles below, it enters a broad valley again, and after two more right-angle bends flows into Tisuk Channel. These irregularities—and all of the larger tributaries of the Bluestone show similar ones—are due, as has been shown in the section on Physiography, to change of drainage.

As only a few days were spent in an examination of the Bluestone, and that after the ground was covered with snow, not much could be determined in regard to the bed-rock geology. The rocks in general have a northeast-southwest strike, but there are many irregularities. Near Teller, at Port Clarence, are bluff exposures of a series of calcareous schists with some interbedded metamorphosed slates and some greenstone intrusives. These are gently folded. Rocks of similar character were found on Tisuk Channel just below the mouth of the Bluestone, but there closely folded and crushed. North of Grantley Harbor similar rocks occur. Four miles south of Teller are found black slates, much crumpled, often carrying graphite and frequently much altered. The slates occupy a belt 2 or 3 miles in width, and to the south are found calcareous schists. These are similar in character to those near Teller, and have been correlated with them in the accompanying section. Some massive greenstones are found in these schists, which are unquestioned intrusives. The rocks exposed still

[1] The mining district which embraces this region was first organized under the name "Bluestone district," and is now included in the Port Clarence district. See Appendix.

farther south in the canyon of the Bluestone are largely greenstone-schist, with some calcareous beds. Above the canyon for several miles, as far as could be determined, greenstone-schists predominate. These calcareous schists and greenstones are believed to belong to the Nome series, and are so colored on the geological maps. The gravels of the Upper Bluestone, which is known as Gold Run, contain graphitic quartz-schists that are identical in character with those mapped elsewhere in Seward Peninsula as the Kuzitrin series. As this is the stratigraphical position of the latter series, they have been so represented on the accompanying map. The core of the Kigluaik Mountains we know to be made up of granite, hence it is so indicated on the accompanying map.

Gold.—Placer gold has been reported from many creeks of the district, but so far the only claims that have been worked are on Gold Run, a name given to the Upper Bluestone, and on Alder Creek, a tributary of Gold Run. At a number of other creeks sufficient prospecting has been done to show the presence of placer gold.

The placers which have thus far produced gold in the region all lie immediately above the canyon on Gold Run and its tributaries. In the canyon the stream has scoured out its channel, and the conditions are as a rule unfavorable for the deposition of gold. Above the canyon the stream bed broadens out and has a flood plain a hundred yards or more wide. While the stream has been cutting down its channel in the canyon more or less deposition has gone on above the canyon, and the conditions are peculiarly favorable for the accumulation of gold. Near the upper end of the canyon the gravel is only 2 to 3 feet thick, but increases in thickness upstream. A mile above the canyon it is 6 feet thick. With this increase of gravel the valley widens out, which makes it more difficult to locate the pay streak.

The bed rock of the region where sluicing is going on is a chloritic schist, probably an altered intrusive, and is full of vein quartz, which is often mineralized. It is deeply decayed, and in this decayed bed rock the richest placers are found. The gravels are coarse and frequently contain large bowlders, which suggest ice transportation. The surface indications are usually not particularly favorable, though as high as 50 cents to the pan has been obtained. On bed rock fabulously rich pans have been reported, and $2 to $3 pans are not uncommon. The largest nugget which had been found at the time of the writer's visit was worth somewhat under $100. The gold is, as a rule, coarse, dark colored, and of irregular outline (see Pl. XII).

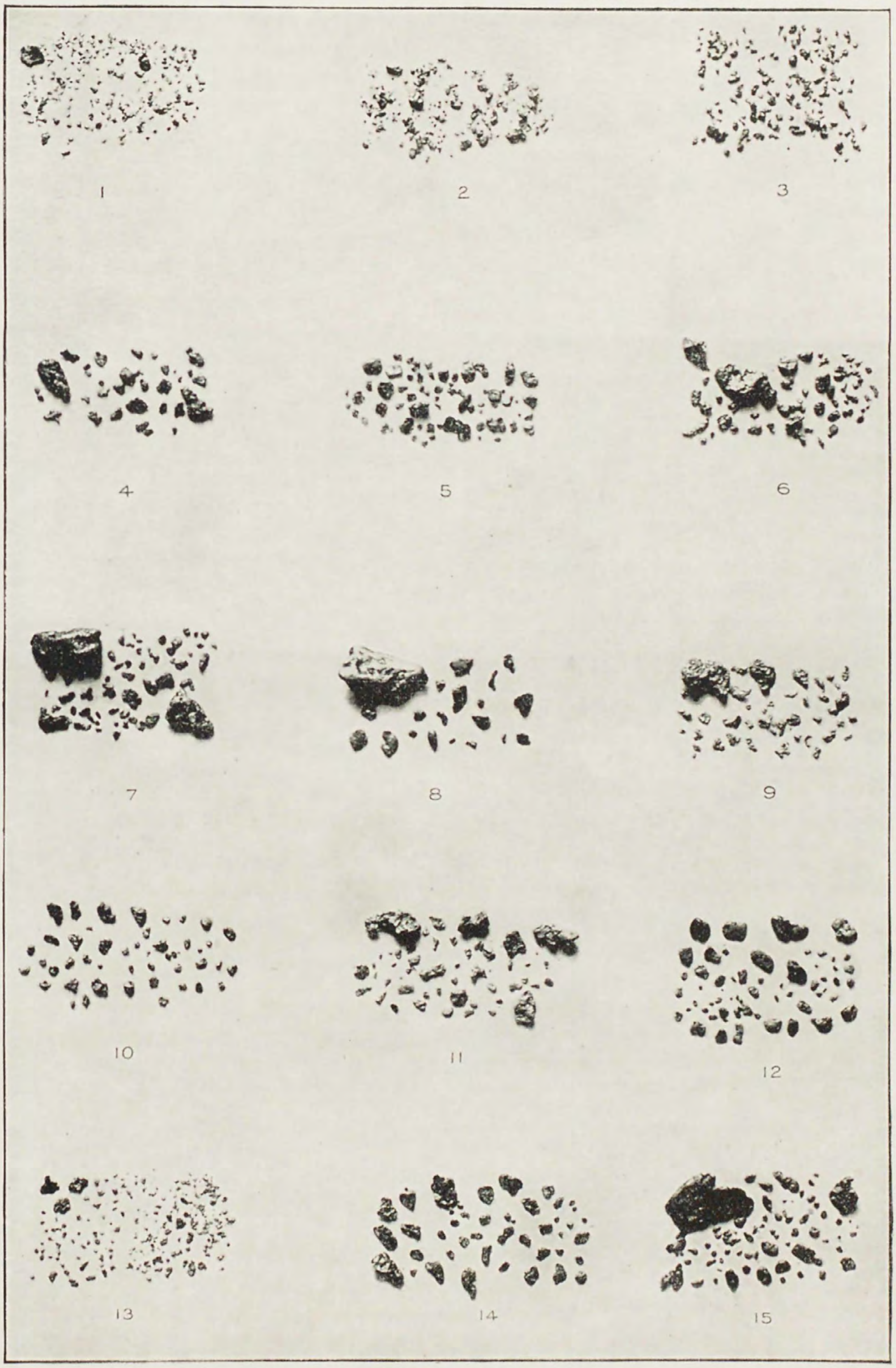
The mining thus far done has been practically confined to the present stream channel. Dams are built to divert the stream, and then where the gravel is only 2 to 3 feet thick it is all put through the sluice boxes, together with a varying amount of the underlying bed rock. Where a greater thickness of gravels is encountered some stripping is done. A large part of the gold was taken out with rockers.

PLATE XII.

PLATE XII.

Placer gold from Seward Peninsula (slightly reduced).

FIG. 1. Nome beach gold.
2. Gravel-plain placer gold from Bourbon Creek.
3. Topkok and beach gold.
4. Dexter Creek gold.
5. Buster Creek gold.
6. Daniels Creek gold.
7. Big Hurrah Creek gold; Solomon River.
8. Ruby Creek gold; Koksuktapaga.
9. Elkhorn Creek gold; Niukluk River.
10. Crooked Creek gold; Ophir Creek.
11. Hungry Creek gold.
12. Deer Creek gold; York region.
13. Quartz Creek gold; Kugruk region.
14. Garfield Creek gold; Kugruk region.
15. Goldbottom Creek gold; Bluestone region.



PLACER GOLD FROM SEWARD PENINSULA.

No paying claims have been found below the canyon, though colors have been found on the north fork of the Bluestone, and also on Dease and Coyote creeks, which are tributary to Grantley Harbor. Above the claims that are being worked, but little prospecting has been done. Good indications have, however, been obtained for several miles up Gold Run. In its upper course Gold Run has a flood plain 200 or 300 yards wide, and the gravel covering it is probably very deep. On some of the smaller tributaries, such as Little Skookum, the cross cutting of the creek has given good colors—from 10 to 15 cents to the pan. At Sunset Creek good colors were also obtained. The bed rock of the upper part of the basin, as far as determined, belongs to the greenstone-schist series, and vein quartz is usually quite abundant. No attempt has yet been made to develop any bench claims in the Bluestone region. There is every reason to suppose that some of these may yield gold in profitable quantities. Evidence of benching was found at various localities, some as high as 1,000 feet.

The Bluestone is one of the districts that was staked during some of the stampedes of the summer of 1899 and during the following winter. It was, however, not prospected, and up to the middle of last summer there was no definite knowledge that gold occurred in paying quantities in the region. At that time a party of prospectors going over from Port Clarence found gold on the creek and inaugurated an era of rapid development. During the last season probably no claim has been worked more than two or three weeks in the aggregate, and yet the district has made a very good showing. The deeply decayed character of the bed rock and the wide stream bed with ill-defined banks made it very difficult to build dams strong enough to hold the floods which came with the fall rains. Hence, most of the claim owners were busy a large part of the time in repairing their dams.

No definite statement can be made in regard to the production of the district. It is probable that the gold from Bluestone aggregated certainly not less than $50,000 and probably not more than $75,000. Considering the short time during which the creek was worked and the adverse conditions, this is a remarkably good result.

This district can be reached from Teller or Bering City at Port Clarence by a trip of 12 to 18 miles across the tundra. The trail is a difficult one, but offers no insurmountable obstacles to the use of horses. Lumber is usually brought up the Bluestone by small boats, which in good water can reach the mouth of the canyon, and is thence transported by horses to the diggings. The more direct route from Nome is to follow the beach as far as Shays and Fairview River and thence go overland to Gold Run. This route is reported to offer fairly good traveling, the only serious difficulty being the crossing of the mouths of the larger rivers, which in the fall has to be accomplished with boats. As Port Clarence affords a fairly good harbor, the settlements on its shores will in future undoubtedly be the landing place for supplies for the Bluestone region.

York region.

Topographic features.—The York region[1] extends westward from the York Mountains to the extremity of Seward Peninsula, an area of about 120 square miles (see Pl. XIII). Its general topography has already been described. It is a plateau about 600 feet in height, bounded on the east by the York Mountains, which rise rather abruptly from the plateau level to elevations of 2,600 feet. Cape Mountain, a sharp pinnacle of like elevation, marks its western margin. A shelving shingle beach, usually not more than 100 or 200 yards wide, lies between the escarpment of the plateau and the ocean. To the north the plateau seems to slope more gently toward Lopp Lagoon. A number of isolated hills rise above the plateau level, which usually have flat tops or are benched at elevations of 1,000 feet. The southward drainage of the region is by a number of streams which have trenched sharply into the plateau surface; those flowing to the north have broader valleys with more gently rising slopes. The smaller tributaries of the main drainage system flow in small but typical canyons. The remarkable evenness and level character of the plateau is very striking; by avoiding the large waterways and making detours around the smaller canyons, a horse and wagon can be driven anywhere on the plateau surface as on a good roadway.

This plateau surface is probably due to denudation by wave action during a period when the land stood at a lower elevation than it does now. Since its elevation some minor stream adjustments have taken place. An examination of the accompanying topographic map (Pl. XIII) will show that a drainage channel once existed which carried the drainage at the head of Kigezruk and Baituk creeks into Anakovik River by way of Deer Creek Valley. The causes of this change in drainage are difficult to discover.

Geology.—The general features of the bed-rock geology are brought out by the geological map (Pl. III). A reference to this map shows that Cape Mountain is made up of a mass of granite. This granite furnished some distinctive topographic forms. Along the crest of the mountain pillars and pinnacles of the granitic rock are common, and are due to the existence of a double system of jointing. The granite,

[1] This region is usually known to the prospector as the York district. The part that was organized in 1899 was named the Kanaugok district. In the winter of 1900, another portion of the Kanaugok was reorganized under the name Arctic district. By decision of the judge of the United States district court of Alaska, second division, both these districts are included in the Port Clarence recording district. Compare appendix to this report.

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except for this jointing, is entirely massive and is usually coarsely crystalline. Near the margin of the mass it contains large crystals of feldspar. Under the microscope it is seen to consist of microcline, quartz, and biotite as the essential minerals.

Northeast of the granite is a belt of limestone, usually coarsely crystalline, often beautifully banded, with occasional intercalated beds of mica-schist. This white limestone must be regarded as the oldest rock in the region. In the hurried visit no contact of the granite and limestone was actually observed. It is plain, however, that the former rock must be intrusive. On the north side of Cape Mountain the limestone was found dipping away from the granite, as we should expect if a larger intrusive stock existed. The limestones strike a little west of north, with varying dips. They are well exposed along the coast between Baituk Creek and Cape Mountain, and here occur in a number of open folds. This limestone is to be regarded as the equivalent of the white limestones found associated with the granites and gneisses in the heart of the Kigluaik Range and named the Kigluaik limestone.

To the north of the limestone has been mapped a belt of slates and siliceous schists, about 5 miles in width, which are regarded as overlying the limestones conformably. The strikes have a general parallelism to those of the limestones, and the dips are variable, suggesting about the same amount of folding as has taken place in the limestone belt. The slates, and especially the schists, are usually traversed by numerous jointed planes, by which they are split up into rhombohedral forms. They are occasionally calcareous and more often graphitic. They have been correlated with the Kuzitrin series found to the east.

With the slate series greenstones of various descriptions are frequently found. These greenstones, unlike those of the Nome region, are usually massive, though they have suffered some jointing like that found in the slates. Only a few fresh specimens of these rocks were obtained; they are apparently largely of a diabasic character.

Some evidence was obtained that a larger area of these greenstones lies in the York Mountains northeast of the head of Anakovik River, beyond the region investigated last season.

To the northeast of this slate series there was found a belt of earthy limestone with some slates, similar in character to the rocks found north of Port Clarence. This belt is, so far as known, less altered than the slate series. Only a few exposures of this series were studied, however, and no details can be given. They have the stratigraphical position of the Nome series, but are less altered.

Numerous inquiries among the prospectors elicited the information that still farther to the northeast exists a body of slates similar to those found at York, and beyond that a belt of white limestone, and beyond that granite. If such are the facts, they may indicate that we have in the York region a broad syncline, which possibly includes the York Mountains. The oldest rock of the series is the white limestone which is reported to be cut by granite on both margins of the syncline, while above it lie the slate series and the younger limestones. Until further investigations have been made this explanation of the structure must be regarded as purely hypothetical.

Gold.—The gold of the York region, as far as could be determined, is derived from mineralized portions of the slates which have already been described. The York district proper, in which gold has been found, will probably not exceed 30 or 40 square miles. It is possible, however, that gold exists in the northern portion of the region. In fact, colors have been found on some of the rivers flowing into the Arctic.

Anakovik River.—Anakovik River heads in the York Mountains about 15 miles from the coast. As it leaves the mountains it has a westerly course, but, bending sharply to the south, it flows in that direction to the sea. It has a broad, flat flood plain, from 100 yards to half a mile in width.

In the upper part of its course the river flows in greenstones, but below its bend to the south it cuts the phyllites and slates which have already been referred to. It carries colors for the lower 10 miles of its course, but no paying claims have yet been developed on it. On some claims about 2 miles from the sea a little prospecting has been done, and it is claimed that the yields show 10 to 15 cents to the pan. The nuggets are sometimes chunky and sometimes flat. The former are probably from the quartz-calcite blebs and the latter from the mineralized slates. The gold is usually rounded and well polished. Much magnetite occurs with the gold. A rough estimate of the fall of Anakovik River makes it about 15 to 18 feet per mile.

Deer Creek is a small stream, about 2 miles long, which joins the Anakovik about 2 miles from the sea. The bed rock exposed along the stream is chiefly a gray slate or phyllite, with occasional greenstone bands that are probably altered intrusives. The slates are frequently mineralized, carrying blebs of pyritiferous quartz and calcite that in several instances were found to contain gold. The bed rock is usually overlain by clay and weathered rock, sometimes to a thickness of a foot or more. Above this lies the gravel, 4 to 5 feet thick at the mouth of the stream, decreasing in thickness toward the headwaters.

A rock bench, covered 2 feet of gravel, several feet above the present bed of the creek is noticeable at the mouth. It carries colors of gold, but from the little prospecting that has been done it appears that it does not carry values. Colors of gold have, indeed, been found throughout the stream bed, but as yet, except near the mouth, no workable claims have been prospected. In these three claims the gold occurs in the weathered rock and probably in a foot of the gravel above it. The miners say that the gold is found chiefly where clay overlies the bed rock. This clay is a product of weathering.

Near the mouth of Deer Creek a 40-cent nugget was found in a limonitic nodule which occurred in a carbonaceous layer in the slate. The lowest claim on the creek, which includes a part of the gravel of Anakovik River, is said to carry two kinds of gold—the ferruginous, somewhat angular gold, identical with that found on Deer Creek higher up, and a rounded, highly polished gold similar to that of Anakovik River.

Buhner Creek joins Anakovik River about 2 miles above the mouth of Deer Creek. It is a small stream and, as far as known, its waters all lie within the belt of slates and phyllites. There are, however, occasionally some beds of greenstone. The slates are sometimes graphitic or carbonaceous. Blebs of quartz and calcite are not uncommon in this slate and are probably the source of the gold.

The gravel layer overlying the slate is very thin, being not over 2 feet in thickness on the Discovery claim, which is a quarter of a mile above the mouth. The material now being sluiced is largely decomposed bed rock. The largest nugget that has been found on this creek is valued at 80 cents. The stream bed in which prospecting is being done is upward of 50 yards wide at the Discovery claim. Small benches occur above this, but they have not been prospected, though they are said to carry colors.

It was on Buhner Creek that the original discovery of coarse gold in the York district was made, but so far no paying claims have been developed on this creek.

Banner Creek joins the Anakovik about 3 miles from the sea. It rises in the York Mountains and flows in part across the slate series. Some colors have been found on this creek, but there has been but little prospecting as yet.

Ishut Creek.—No prospecting has been done on this stream, but it carries colors, and in much of its course flows across the slate and phyllite series. It joins the Anakovik about 4 miles from the sea, and for the first mile of its course flows in a small canyon. Above this canyon the valley is more basin shaped. If the stream is gold bearing, this basin deserves the attention of the prospectors.

Kigezruk Creek.—This stream flows into the sea about 2 miles west of York. In its lower course it is a rather broad valley, above which is a canyon, and above that a basin. The bed rock of the creek is the same as that of those previously described and the stream is reported to carry some colors. The basin at the head of the creek should receive attention from prospectors, as one may there, if anywhere on the creek, expect to find gold.

Baituk Creek.—This water course flows into the ocean about 3 miles west of York and has a valley very similar to that of Kigezruk Creek—

in its upper course a broad basin above a constricted portion, and then a broad valley to the sea. Most of its drainage basin lies in the slates and phyllites.

Streams to the west of Baituk Creek lie for the most part out of the belt of slates and very probably carry no gold. On Ocean Creek, the most easterly of these, a few colors are said to have been found.

Kanauguk River.—During his short stay at York the writer had no opportunity of visiting the drainage basin of the Kanauguk, and gave only a hasty examination to a few of the western tributaries which lie close to the Banner Creek divide. These tributaries are in the slate and phyllite series, but the main drainage basin of the river, it is believed, lies outside of these series, and probably, therefore, does not carry gold.

Stream tin.—During the examination of the placer gold of the York region the writer's attention was called to the occurrence of stream tin found associated with the placer gold at two localities. The first locality is on Buhner Creek, where 2 to 3 feet of gravel overlie the bed rock, which consists of arenaceous schists, often graphitic, together with some graphitic slates, as has been described. They strike nearly at right angles to the course of the stream, and offer natural riffles for the concentration of heavier material. A hasty reconnaissance of the drainage basin of this stream, which includes an area not of more than a square mile, showed the same series of rocks throughout its extent. At a few localities some deeply weathered dark-green intrusives were found, which on examination by the microscope were found to consist almost entirely of secondary minerals. In some cases, however, a little plagioclase was still unaltered and a suggestion of ophitic structure remained, so that these are probably of a diabase character. The slates and schists are everywhere penetrated by small veins, consisting usually of quartz with some calcite, and frequently carrying pyrite and sometimes gold. These veins are very irregular, often widening out to form blebs, and again contracting so as not to be easily traceable.

The stream tin is concentrated on the bed rock with other heavy minerals and was found by the miners in the sluice boxes. A sample of the concentrate in one of the sluice boxes was examined by Mr. Arthur J. Collier and yielded the following minerals: Cassiterite, magnetite, ilmenite, limonite, pyrite, fluorite, garnet, and gold. The determination of percentage by weight was 90 per cent tin stone, 5 per cent magnetite; other minerals, 5 per cent. The cassiterite occurs in grains and pebbles, from those microscopic in size to those half an inch in diameter. They have subrounded and rounded forms. In some cases there is a suggestion of pyramidal and prismatic crystal forms. The cassiterite varies in color from light brown to lustrous black.

The second locality of this mineral was found on Anakovik River, about half a mile below the mouth of Buhner Creek. Here the cassiterite is also found with the concentrates from the sluice boxes of miners. One specimen from this locality was about 2 inches in diameter.

The above occurrence is of considerable interest, but its commercial value is dependent on finding the cassiterite in larger quantities. In any event it is worth while to call the attention of the prospectors and miners to the desirability of being on the lookout for stream tin, and, if possible, of tracing it to its source in the bed rock. From the description of the occurrence which has been given it is plain that its source can not be far distant.

Conclusions in regard to gold placers.—The discovery of coarse gold on Buhner Creek in 1899 led to the belief that the York region would become an important gold producer. This conclusion was not verified by the development made during the succeeding season. The miners report that the gold is rather coarse (see Pl. XII), but that it is very spotted. As a matter of fact the developments made have been largely in the bed rock, out of whose weathered nodules the gold has been obtained. The creek valleys are comparatively shallow, and compared to other auriferous creeks of the region little material has been removed while these were being cut. Elsewhere in this report it is shown that the placers are the result of the setting free and concentration of the gold which was formerly disseminated in the bed rock. In the York region the relief is slight, so that no very large amount of bed rock has been eroded. This is especially so in the case of the smaller creeks, in which normally the richest deposits would be expected, as they are nearer the source of the gold.

The climatic conditions have also affected the concentration of the gold to a limited degree. During the early summer months the creeks of the York district are low and their erosive power is correspondingly small. In late summer and early fall violent rain storms are frequent, and as a result of the peculiar topographic conditions the water runs off almost as rapidly as it falls. The streams consequently have swift currents and cut away their channels very rapidly. The gravel and débris which have been deposited in the smaller streams during the low stages of the water are borne away rapidly without much sorting and the gold is carried into those larger drainage channels, the developments of which seem to be richer than the gulches lying near the source of the gold. The stream-tin deposits on Buhner Creek do not seem to have been affected as much by these floods as the alluvial gold. This is probably because the grains of stream tin are larger and not so liable to be removed by a rise of the water.

The plateau of the York region was probably produced by marine benching when the land stood at a lower level. Where examined by the writer but little gravel remains on the plateau, but it may be thicker in other localities. The wave action on the gold-bearing rocks may have formed placers, and it might be well for prospectors to examine this old benched surface with a view of determining whether old beach placers exist.

Development.—A small settlement at the mouth of Anakovik River, known as York, is the distributing point for the York region. This place is about 85 miles distant from Nome and 45 miles from Port Clarence. With the latter point local steamers make connection during the summer. A post-office is established at York, having fortnightly mails. Port Clarence is the nearest harbor. The lack of shelter from southerly storms makes the landing at York during the fall months often both difficult and dangerous.

From York the interior of the peninsula can be conveniently reached with pack horses, there being ample grass during the three summer months. There is still a limited supply of driftwood along the coast, which will, however, at the present rate of consumption, soon be exhausted. In the interior the prospector has to depend on the stunted willow, which is, however, amply sufficient for fuel for cooking.

Rivers tributary to the Arctic.

The arctic drainage of the peninsula has not been explored, and only the mouths of the larger rivers have been accurately located. Their courses, as represented on the map (Pl. XVIII, p. 186), can be regarded as only approximately accurate. The topography, as far as we know anything of it, is an upland in which the rivers have cut broad valleys and above which rise many isolated knobs and mountains.

The bed-rock geology is probably similar in character to that of the southern part of the peninsula. Prospectors report limestones, slates, and greenstones. Some basalt flows are also reported, probably similar to those found in the eastern part of the peninsula by Mr. Mendenhall. North of York a number of streams flowing northward to the Arctic Ocean are said to carry gold. The writer had no opportunity to visit these streams, but from the best information he could obtain he gathered the idea that the bed rock is in character similar to that of the York district—i. e., it consists of limestones, slates, and granites. No workable claims have been found in this northern region, though there is no doubt that colors have been found, and there are further reports of good indications.

In their lower courses these rivers meander over the flat tundra and would not seem to be favorable for the concentration of gold. Farther from the sea they have broad, flat valleys, and near their headwaters sharply cut ravines. This region can easily be reached from York, either on foot or on horses.

Shishmaref Inlet, which lies on the north Arctic coast 60 miles northeast of Cape Prince of Wales, is a deep indentation, with numerous tributary streams. A few prospectors who have visited this region report the finding of colors and good indications of gold. Mr. Charles McLennan, who visited the region southeast of the inlet, reports garnetiferous bed rock and slate. He has kindly furnished us with the following information concerning some hot springs which are about 20 miles south of the inlet. In a distance of 300 yards three springs were found. The largest had a diameter of 16 feet. The temperature of the water was 212° F. Though the visit to the spring was made in the spring, when the ground was covered with snow, the springs were surrounded by green grass. A pit, sunk to a depth of 8 feet in the gravels, gave good colors, but did not reach bed rock. It was discontinued on account of the inflowing water. The region was organized under the name Hot Springs mining district, and is now included in the Port Clarence district. Mr. McLennan reports that there are a number of small native settlements in the neighborhood of Shishmaref Inlet. Other prospectors who have been in this region in summer report good grass and along the river valleys abundant fuel supply of willows.

Some prospectors who have crossed to the Arctic drainage north of Kugruk report a similarity in the general character of the country to that south of the divide, and the same types of bed rock. They claim to have found good colors of gold, but say that toward the Arctic Ocean the gravel mantle thickens and that it is difficult to reach bed rock.

SUMMARY OF ECONOMIC GEOLOGY.

INTRODUCTION.

In the foregoing description the more important facts regarding the mineral resources have been presented, and it has been shown that, so far as now known, the mineral wealth lies chiefly in the gold placers. Detailed descriptions have been given of many of the placer fields, and some correlations have been suggested. It is here proposed to summarize briefly the more important results, to suggest a classification of the placer deposits, and to attempt to deduct some general conclusions on the source and occurrence of the placer gold of the region.

DESCRIPTION OF ECONOMIC MAP, PL. XIV.

The existing knowledge of the distribution of the placer gold is graphically summarized on the economic map. With very few exceptions, the facts presented on this map regarding the occurrence of gold are based on the field observations of one of the members of the party. The use of a map on so small a scale has necessitated some generalizations, but it is believed that the data will be found entirely reliable.

Areas known to have produced placer gold in commercial quantities are represented by a solid color on the map. The stippled areas are those in which auriferous gravels are known to occur and regarding which the best evidence available leads to the conclusion that they are likely to carry commercial values. Predictions in regard to the occurrence of workable placers can be only tentative, but by indicating the distribution of the auriferous gravels it is hoped to help the prospector, although the final test in any creek of the presence or absence of workable placers must be made by actual prospecting.

It has been thought best to include also the distribution of the Pleistocene sands and gravels. Many of these have been shown by actual tests to carry colors of gold, but it is usually fine and much disseminated. There is reason to believe that some gravels and sands which have been included in the Pleistocene deposits carry commercial values.

The names by which the various districts are locally known are given on the map. These are in such constant use by every one in the region that it has been thought best to give them. These names should not be confused with those of the recording districts which are now established by law, a description of which will be found in the appendix.

DISTRIBUTION OF GOLD PLACERS.

Zonal arrangement.—On the economic map (Pl. XIV) the areas in which placer mines are being worked have been indicated, and also the distribution of auriferous gravels, so far as it has been determined. An examination of the map will show that the important placers have a certain zonal arrangement and, broadly speaking, group themselves into belts which have a northeasterly-southwesterly extension. The southern belt includes the auriferous deposits of Cripple River, the Nome region, the Kruzgamepa Valley, and the drainage basins of Solomon and Niukluk rivers. The northern belt embraces the placers of the Bluestone, the Agiapuk, and the Kugruk. These two zones are separated by the Kigluaik Mountains and the Bendeleben group. The relation of the placers of the York region to the others has not been determined. These, with those reported from the Arctic coast, may form a third belt. In the discussion of the geology it has been shown that, broadly speaking, these mountains owe their origin to uplifts and to the intrusion of larger masses of granitic rock along their axes. One result of this structure is a duplication of the same metamorphic series on both sides of the range. As the placer gold is derived from these metamorphic series, its distribution will be affected by their occurrence, and there result two zones of placers corresponding with the two belts of gold-bearing bed rock. While these two areas lying on either side of the anticlinal uplift, which is the dominant structural

ECONOMIC GEOLOGICAL MAP OF SEWARD PENINSULA ALASKA

Geology by Alfred H. Brooks, G. B. Richardson, and Arthur J. Collier

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feature in the region, can be claimed as auriferous, the writer does not wish to imply that the entire areas of these two belts will carry workable deposits of gold. On the contrary, the facts indicate that the gold belts are not continuous.

Local distribution of placers.—The detailed descriptions which have been given lead to the conclusion that within these two zones only certain creeks seem to carry placer-gold values; some others carry colors of gold, while from many gold is, as far as known, entirely absent. These facts are so well known in the region by every intelligent prospector that they do not need to be here exemplified. The question arises, What is the reason for this irregular distribution of the placer gold? In answer we must consider, first, the source of the gold, meaning thereby its immediate source in the bed rock, and, secondly, the manner in which the gold has reached its present position in the placer.

SOURCE OF GOLD IN BED ROCKS.

Local origin of gold.—In the discussion of the source of the gold the most serious difficulty is that the bed-rock geology is not yet known in sufficient detail to afford a good foundation of fact. In the previous publication, already cited, Mr. Schrader and the writer made the statement that the Anvil Creek gold was of local origin. The studies of the last season would confirm this view and would extend it to include practically all the placers of the region. We are led to this conclusion by the character of the drainage basins, of the gold itself, and of the gravels with which it is associated. In nearly every instance the source of the gravel of any given auriferous deposit can be assigned to a local source. Local origin, being only a relative term, does not admit of any exact definition. In most of the gulch placers the gold is believed to have its source in the drainage basin of the streams in which it is found. In the case of deposits that belong to an older drainage system, the same is true of the gold of their drainage basins. In the gravel plain and beach placers, local origin for the gold implies that the source is in drainage basins of the streams of the immediate vicinity, and that it has reached its present position by water transportation. Many theories are popular among the miners, which involve a glacial, volcanic, and even meteoric origin for the gold. The facts to be presented will show that no such agencies have played any part in the formation of the placers.

Occurrence of gold in bed rock.—In many instances gold is found attached to fragments of vein quartz or of schist, showing conclusively that it is of vein origin or from impregnated zones. Assays have shown that traces of gold and silver are quite common in the veins and mineralized schists of the shear zones. In a few cases veins were assayed which carried commercial values, but they are relatively rare.

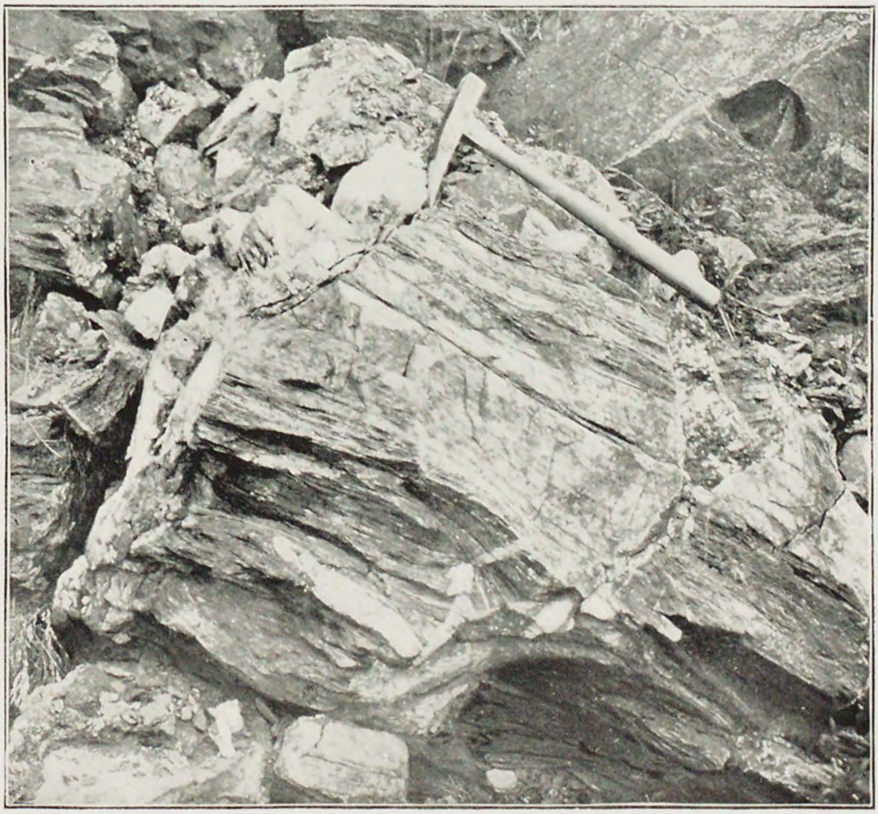
Derivation of placer gold.—These facts point to the conclusion that the placer gold of Seward Peninsula has its source in veins and impregnated beds which occurred close to the present location of the placers. The mechanical destruction of the bed rock and its included veins and mineralized zones has set the gold free, and it has been subsequently concentrated in the gravel deposits where it is now found.

It has been noted that in some localities there is evidence of an older drainage system and that the source of the gold is not, necessarily, to be sought within the drainage basin in which it is now found. The main point which seems to be established is that the gold has not been brought far and that its source is within bed rock identical in character with that which is now exposed.

Concentration of gold in placers.—The question is often asked, If the gold be of local origin, why is it that there are such rich placers in a region where the quartz veins seldom carry values, and, in fact, are often entirely barren of gold? This is a practical question and one which it is not always easy to answer. To tell the average miner and prospector that the gold has been concentrated out of a very large amount of bed rock is but to state to him a fact of which he is already well aware. At the same time one who is not accustomed to measure time in terms of geology can not, as a rule, easily conceive what geological time signifies. The average man knows by his own observations that rivers and streams erode their channels, and that the topography is more or less the result of erosion; but, unless he has made a study of the matter, he will hardly realize that nearly all topographic forms are due to destructive rather than constructive agencies, and that any given river system has been gradually developed by the erosive forces. Thus, in the region under discussion, the rivers and streams have incised their present valleys into what was, presumably, at one time, a nearly level surface. The thickness of material removed is to be measured in hundreds of feet, and in some cases in thousands. The amount of material removed, measured horizontally, varies, of course, with the size of the drainage basin. It is easy to see that in the carving out of a drainage system such as that of Anvil Creek, for instance, a very large amount of material has been removed, carried out, and redeposited outside of the basin itself. The gold contained in this mass of bed rock which has been gradually carried away by stream and frost action remains, since it is, comparatively speaking, indestructible; while the parent rock in which it was contained has been ground up, dissolved, and washed away. This gold is sorted by the water, accumulates, and forms placers.

The chief reason why more rich veins are not found in the region is because much of the gold was widely disseminated in small quartz stringers and in impregnated zones of the bed rock. It was not derived from a mother lode, but in the course of the destruction of the

A. AURIFEROUS FISSURE VEINS NEAR MOUTH OF OPHIR CREEK.



B. AURIFEROUS FISSURE VEINS ON SWEETCAKE CREEK.

bed rock the gold thus widely disseminated in small veins was concentrated in the sands and gravels. This does not by any means preclude the possibility of the presence of workable quartz veins in the region. In fact, some veins and impregnated zones carrying values have already been discovered. Compared with the amount of material which has been removed and destroyed, the amount of bed rock now exposed and accessible to the miner and prospector bears a relation of something like a thousand to one, if not a million to one. We have access to bed rock only along the stream channels and along valley walls. It is easy to see that the surface exposed, especially considering the thick coating of moss, which nearly everywhere hides the underlying rock, is but a small fraction of the amount which must have been removed during the formation of a stream valley.

Mineralized zones and veins.—Attention has been called elsewhere to the presence of quartz veins and stringers in the rocks of what have been termed the Kuzitrin and Nome series. These have been shown to be mineralized and to carry gold at a number of localities. Near the mouth of Ophir Creek an exposure of mica-schists shows a double system of veining, the older of which is parallel to the foliation, and the later intrusion, which cuts the first, is at right angles to the foliation (compare Pl. XV, *A*). A similar double system of veining was found in an exposure on Sweetcake Creek, a mile to the north. In both cases the veins and the adjacent schist carry some gold (Pl. XV, *B*). In the Anvil and Cripple basins gold-carrying veins are found. On some northern tributaries of the Upper Kruzgamepa assays of quartz veins show traces of gold. There can be no doubt that gold is widely disseminated in the veins found in the bed rock, though up to the present time but few have been found which carry values.

Distribution of mineralized zones and quartz veins.—It is evident that if the distribution of the mineralized veins could be determined it ought to determine the loci of undiscovered placer fields. Unfortunately, these gold fields have not been mapped in sufficient detail, either geologically or topographically, to fix the limits of the areas of mineralized rocks.

In the Anvil Creek region all the rocks of the vicinity are found to be much shattered and frequently impregnated with mineral-bearing solutions. Stringer veins are everywhere found in the bed rock, and some larger quartz veins have also been found, one of which has been shown, on assay, to carry values of gold and silver. In the York region the gold was traced to small veins and blebs filled with quartz and calcite; these always carry some pyrite, and in a number of instances were found to contain gold.

In the Ophir Creek region the gold-bearing rocks are those which have been much sheared. In fact, wherever work was done in detail it was apparent that the gold was derived from strata which had suffered dynamic metamorphism. In other words, where the rocks have been broken and sheared opportunities have been offered for the ore-bearing solutions to penetrate.

The conclusions in reference to the limits of the disturbances are of tentative character. In the discussion of the geology it was shown that much of the deformation and metamorphism, except in the neighborhood of the Kigluaik uplift, is of a local character. The earliest period of disturbances of which any definite knowledge has been obtained brought about a number of dome-like uplifts, which are of irregular form and distribution. It has been suggested that these may be due in part to the injection of igneous masses, and in part to subsequent movement, caused by vertical thrusts, along the same axis in which the intrusion took place. Along the margins of such domes the strata are deformed and sometimes faulted. Such dynamic disturbances were especially intense near the lines of contact of beds of different lithological and physical characters. It is along such lines of disturbance that the mineralized zones are most frequently met.

This may account for the irregular distribution of the deformed areas which are the mineralized zones from which the placers derived their gold. In a broad way the placer deposits are divided into two zones by the Kigluaik uplift. Considered locally, the placers have great variation in their distribution. A study of the individual deposits points toward the conclusion that there is a relation between the dome structure and the mineralized zones, and hence also a relation between the dome structure and the distribution of the placer deposits. The writer realizes that in drawing such far-reaching conclusions on limited evidence he is treading on dangerous ground, especially as they have great bearing on the economic resources of the region. The theory regarding the relation of the dome structure and the mineral zone is therefore advanced simply as a working hypothesis until more detailed investigations have been made.

CLASSIFICATION OF PLACER DEPOSITS.

INTRODUCTION.

Having considered the source of the gold in the parent rock, the next question is the mode of its occurrence and concentration in the placer deposits. In the descriptions of the various districts it has been shown that there are a number of different forms of placer deposits. From the standpoint of their genesis these naturally fall into three groups, two of which contain a number of different subgroups. The following classification of placers is introduced merely to elucidate some of the economic problems of the auriferous gravels of the Seward Peninsula. It is believed, however, that this classification is based on the principles which should govern a treatment of this form of deposits and that it may have a broader application than its present use.

I. Unconcentrated placers.[1]

II. Concentrated placers:
  1. Creek and gulch.
  2. River bar.
  3. Gravel plain.
  4. Bench.
  5. High bench.

III. Reconcentrated placers:
  1. Creek and gulch.
  2. Beach.
  3. Old beach placers.

Each one of these subgroups is exemplified by occurrences studied by the writer in the province under discussion. Usually the differentiations of the various types of deposits noted above is easily made, but when there has been but little development of the placers it is not always possible to assign them to any specific subdivision. As in most classifications, it also happens that there is a merging of one type into another. Thus river-bar placers and creek placers can not always be differentiated; and again, near the mouths of rivers the bar placers pass into the delta placers, which are here grouped with the gravel-plain placers. In spite of these discrepancies, it is believed that this classification has a practical utility in the discussion of the auriferous gravels of this province.

UNCONCENTRATED PLACERS.

The first group, called unconcentrated placers, needs but a brief mention. The only examples described in this report are on some of the creeks of the York region. Attempts have been there made to mine the slates, which contain weathered nodules of pyrite and other minerals, with some gold. These nodules are practically in place, and are readily separated during the mining and sluicing operations. Thus far the attempt has not met with success, and this form of placer may be considered to have little or no commercial importance in the region.

CONCENTRATED PLACERS.

The concentrated placers of the second group include the commonest occurrences of auriferous gravels, both in Seward Peninsula and in other regions. It embraces those deposits in which the gold has been

[1] Dr. G. F. Becker has suggested the name "saprolite" for the mantle of weathered material which is found covering the bed rock in regions of deep decay. The gold deposits found in this decayed rock, which are practically in place, he terms "auriferous saprolites." (Reconnaissance of the gold fields of the Southern Appalachians: Sixteenth Ann. Rept. U. S. Geol. Survey, Part III, 1896, p. 289.) It is suggested that the so-called "fossil placers" found in the consolidated gravels and sands would form subgroups under one of the three headings.

concentrated after it has left the bed rock. The atmospheric agencies set the gold free by the destruction of the bed rock, and the sorting action of the water and gravity assembles the gold in the placers. The concentrated placers are divided into a number of classes, according to their mode of occurrence.

Gulch and creek placers.—To the first subgroup belong the gulch and creek placers, which embrace most of the important diggings of the region. The pay streak in these deposits is usually on bed rock, though it sometimes is found on a clay which overlies the bed rock. Where no clay is present the gold is found not only on the bed rock, but also where the rock is broken the gold has worked its way down into the joints and crevices. Streams are often found to have a layer of clay on bed rock, which gradually thins out upstream and finally disappears entirely. The presence of the clay on bed rock usually indicates that no gold will be found in the weathered rock below, as the impervious layers prevent the gold from working its way down. On most of the creeks the gravel overlying the pay streak is shallow, and the creek placers usually afford what are known as "open" or "summer" diggings. Very little stripping is necessary, as a rule, after a foot or two of moss and muck have been removed. It is common to find the gravel containing sufficient gold from the surface down to warrant sluicing it all. The horizontal extension of the pay streak differs very much, and no general law in reference to it can be formulated. Sometimes it forms a narrow but uninterrupted layer, running parallel to the side of the valley, but more often the pay streaks are not continuous and are of irregular outline. They very frequently suggest the windings of old stream channels. The coarsest gold of the region is found in the creek and gulch placers, it being there nearest to its source in the parent rock.

To give examples of the gulch and creek placers would be to name a large percentage of the creeks of the region. The placers of Anvil Creek and its tributaries belong in part to this category, but, as will be shown, some of them are the result of reconcentrations. The gold mined in Ophir Creek, the Koksuktapaga, and other tributaries of the Niukluk has practically all been taken from this form of deposit. Some of the placers of York, and all of those that have so far been worked in the Bluestone, are of this description.

River-bar placers.—The auriferous deposits here classed as river-bar placers have not, up to the present time, proved to be of any great commercial importance. Most of the larger streams within the gold-bearing areas carry more or less gold in their bars. The other classes of placers in this province being so much richer, the river bars have not yet attracted the miners. It is probable that if these bars had been in other regions where there were no very rich deposits they would have already been extensively worked. The term "bar placer" implies that the gold is concentrated in bars and not on bed rock. It is finer than the creek gold, and the deposits do not compare in richness with the stream placers. The gold has been deposited in the rivers by the variations in the currents, a mode of deposition which is still going on. In the upper courses of the rivers their placers are comparable in every way to those of the creeks, but they are usually not so rich.

Examples of this form of deposit are the bars of Snake, Nome, and Solomon rivers. The Upper Niukluk also carries some gold in its bars. The placers of the Anakovik, in the York region, are more comparable to creek placers, as the stream is smaller and the gravels are probably shallow. Some enterprises have been inaugurated by which these river bars are to be worked by use of dredges and other machinery, but so far they have not gone beyond the initial stage.

Gravel-plain placers.—This subgroup includes the deposits laid down as littoral or lacustrine beds, the former often being formed in estuaries. In a previous report the writer applied the name "tundra placers" to this form of deposit, accepting the local usage. More careful consideration has led him to the conclusion that this is a misnomer, as the word "tundra" refers more especially to the character of the surface and to vegetation. The gravel-plain placers are characteristically delta deposits, which merge on one hand into the river gravels and on the other hand into marine or lacustrine sediments. The deltas were formed along the seacoast, in estuaries, and in lakes. As a rule the gravel shows cross bedding and gives evidence of having been deposited along the shifting channels of delta mouths. The gold of this form of placer is characteristically finer than the creek gold, and is comparable to that of the river bars. Probably it is generally more evenly distributed than in other forms of deposits. Where these placers lie close to the source of the gold, in bed rock, the gold may be quite coarse, and it is much finer when it occurs in lacustrine and marine offshore sediments. The size of the gravel-plain placer-gold grains, compared with other gold, is shown on Pl. XII. As stated elsewhere, some concentration of the gold of these placers has taken place along stream courses which cut the gravel plain.

The best examples of gravel-plain placers are those of the coastal plain in the vicinity of Nome. This coastal plain is made up of stratified sands and gravels with some clay beds. The gravels were deposited on an irregular rock surface and are of varying thickness. Throughout these gravels some gold is disseminated, the richest part being probably in the vicinity of the streams which flow from the creek placers. It is impracticable to make any statements in regard to the amount of gold per cubic yard in this coastal plain. Our knowledge of its presence is based chiefly on the placers which are reconcentrations of this gold, which will be described below. There has been only a little prospecting in the coastal plain away from the streams. The little development that has been done shows that colors are plentiful and that many of the gravels might yield returns if they could be mined on a sufficiently large scale. At a number of localities deposits have been found which could be profitably worked with rockers.

Another important example of the gravel plain type of placer was found in the Kugruk Basin. Kugruk River for about 15 miles above its mouth flows close to an escarpment which marks the eastern limit of a gravel terrace whose level top lies about 100 feet above the river. This gravel plain, as has been shown elsewhere, once filled a much larger portion of the broad valley lowland in which the Kugrok and the Kuzitrin flow. The terrace is built up of gravels and sands which are often cross bedded and contains some clay beds. This deposit is of interest because it is gold bearing. In the discussion of the Kugruk it has been shown that gold has been found in these terrace gravels proper, and that its presence is also proved by the fact that creeks whose drainage basins lie in its gravels are gold bearing.

Bench placers.—Under "bench placers" are included the stream benches which belong to the present drainage system. These deposits are in every way comparable to the placers of the present creek channels. They represent deposits made when the stream floors were above their present channels. The present channels have been incised in the old floors, and left them as benches along the valley walls. Such benches occur in many of the streams and river valleys of the region at elevations varying from 10 to 100 feet above the present stream beds. The higher benches are discussed in the succeeding paragraph. The gravels covering these benches, which are of varying thickness, have been found to be auriferous at a number of localities. In the case of the gold-bearing streams, the bench deposits have such close analogy in origin and occurrence to the stream gravels that there is every reason to believe that they will be found to carry workable placers. Up to the present time they have received but very little development. The difficulties of bringing water to these benches cause the miner to turn to the stream placers first, where immediate returns are to be had. With the rapid development of the region many of the stream placers are being exhausted, which will result in early attention to the bench placers.

High bench placers.[1]—The high bench placers include those which belong to an older drainage system than the one now in existence. As has been shown in the chapter on Physiography, a drainage system at one time existed at an elevation of 500 or 600 feet above the present valley bottoms. The streams of this drainage system carried gravels, and as these gravels were in some cases derived from auriferous rocks

[1] These deposits are termed "high bench placers" in preference to "ancient river channels" because the associated gravels are probably in part of littoral as well as of fluvial origin.

they probably formed placers in many instances. Up to the present time only a few such placers have been developed, and, in fact, in only a few cases have they been shown to exist. The most important deposit of this character is the one lying between the head of Dexter and the branches of Anvil Creek. These old drainage channels are well worthy of investigation by the prospector, and probably in the future will yield a great deal of gold. They can be traced usually by broad, flat depressions, breaking the continuity of the present valley walls, and by high gravel terraces.

RECONCENTRATED PLACERS.

Introduction.—The third of the larger subdivisions includes the reconcentrated placers. Under this heading belong those deposits that have derived their metallic contents from previously existing placers which have been destroyed by erosion. The gold of the older placers has been disturbed by the erosion of streams or along the sea-coast by the cutting of waves, and has been reconcentrated by the sorting action of water. These reconcentrated placers are easily differentiated from other placers when the source of material of which they are composed is studied. If this has been derived from beds of sand and gravel, and not directly from bed rock, there can be no question that they belong to this class. In some placers the gold is derived from two sources—directly from the bed rock, and also from previously existing surficial deposits. In such cases the classification of the placer is more difficult. The reconcentrated placers are similar in their mode of occurrence to those of single concentration. As a general rule they are richer because of the double sorting, but at the same time the gold, having been subjected to more attrition, is liable to be finer. The reconcentrated placers have been divided into three subgroups, which differ in their mode of occurrence. These have been called gulch and creek placers, beach placers, and old beach placers.

Creek and gulch placers.—These are similar in their mode of occurrence to those to which the same name is applied but which have been concentrated only once. They differ from these in that the channels of the streams in which they occur lie entirely within the gravel plains, and hence do not reach bed rock. The gold in such a stream, therefore, has been derived from the gravel plain placers. This reconcentrated gold is, as a rule, finer in character than that of single concentration. Such places have been worked to a considerable degree in the Nome region and have also received development in the Kugruk. The gold of Quartz Creek in the Kugruk (fig 2, p. 121) is for the most part, if not entirely, derived from the gravel-plain deposits.

In this connection attention should be called to the fact that the deposits of a creek may belong to both the primary and the secondary concentrations. Thus Anvil Creek has derived a great deal of its gold directly from the bed rock. It has, however, also reconcentrated the gold of the high bench placers. This high bench is formed by a drainage channel which must have crossed the present valley of Anvil Creek. When the gravels of this older drainage system were removed by the waters of Anvil Creek the gold which was contained in them was contributed to the Anvil Creek Basin. This was an important factor in the reconcentration of the rich Anvil placers. Another mode of secondary concentration which has probably taken place on Anvil Creek is that produced by the smaller tributary gulches. These gulches in many cases cut the older gravels, both the terraces of the present creek and the high benches of the former drainage channel. Wherever they tap these gravels they have access to the gold contained therein, and in course of time will contribute this gold to the main creek valley lying below their mouths. This action will probably account for the more or less spotted character of the deposits of such creeks as Anvil. If the gold had been entirely derived directly from the bed rock in the creek basin it would probably be more evenly distributed, but if these side streams contribute the gold they have robbed from the bench deposits they will enrich that portion of the main stream lying at or below their mouths. It seems to the writer that this is an important consideration and may account for the extreme richness and the irregularity of distribution of the gold of some of the creeks of the interior of Alaska and of the Klondike.

Beach placers.—The second division of the reconcentrated deposits comprises the beach placers, which have drawn so much attention at Nome. These have been discussed in some detail elsewhere in this report. It has been shown that the pay streak occurs on a clay layer 1 to 6 feet below the surface, and that it has an irregular horizontal extension and varying thickness. These placers were probably produced by the action of the surf on the coastal plain deposits, which are known to be auriferous. It has also been suggested that the movement of the beach sands caused by the piling up of ice floes may have been a factor in the concentration of the gold. Besides the Nome beach, along which these deposits extend for about 20 miles, a small stretch of the shore near Topkok has been found to be very rich. The beach gold at Nome is much finer than that from any other form of placer in the region. On Pl. XII the size of the colors is compared with the size of those of the gravel plain and creek placers. The Topkok beach gold, which is coarser, is also shown on the same plate.

Old beach placers.—The last group of secondary concentrations are the old beach deposits. As the entire region has been gradually elevated at least 600 or 700 feet, former shore lines must have existed which now stand at higher altitudes. As these shore lines are comparable to the present shore lines, there is every reason to believe that a concentration similar to that of the present beach took place at one time. Such old beach deposits should be sought in the gravel plain and in the higher benches. Until some development has gone on, it is not easy to differentiate these old sea beaches from other auriferous deposits which occur in the gravel plain. However, from the character of the gold and the gravel which has been obtained from a number of test pits, there is every reason to believe that some of the old sea beaches have been found during the investigations in the gravel plain near Nome.

CONCLUSION.

In the foregoing an attempt has been made to summarize the existing knowledge of the placer deposits of the southern part of Seward Peninsula. It has been shown that there are a number of different methods of occurrence of gold in the sands and gravels. Some of them, like the creek and beach placers, have been extensively developed; others, like the bench and high bench placers, have hardly been touched; and there are still other groups, like the old beach placers, of whose existence the prospector is hardly aware. It has been shown that the placers are rather widely distributed, the actual discoveries being scattered over an area of from 4,000 to 5,000 square miles. The occurrence of the gold in the bed rock is believed to be due to forces which have acted locally rather than regionally. While there is no affirmative evidence, there seems to be no reason why these conditions should not have occurred in places outside of the area under consideration. It is probable that careful prospecting will show that other creeks in the region carry workable gold deposits. While the very rich creeks, such as have already been developed, are probably exceptional, yet it can not be assumed that the limits of discovery have been reached within this area, which has been so extensively staked and so little prospected.

NOTES ON MINING METHODS.

The methods of mining and separation in use at Nome are but adaptations of the methods which have been used in other mining regions, and have been fully described by those that are familiar with their technical treatment. It will be the purpose of the writer here only to call attention to a few of the more important facts and, if possible, make some suggestion in the direction of improvement.

A new placer field is usually first developed by men having little or no capital. These naturally turn their attention only to the richest deposits, and use such methods as will give the greatest immediate returns at minimum expenditure of time and money. The result is that the manner of mining and separating the gold is usually crude and wasteful, and much of the finer gold is lost. It is only when mining enterprises, backed by capital, are inaugurated on a large scale that placer claims yield their full gold contents. It is often found that the tailings of the first primitive separating methods can be worked at a profit when handled in a large way. But few of the placer camps of Seward Peninsula have passed beyond the first stage. In the Nome region proper some improved methods have been introduced and enterprises have been inaugurated for working placer claims in a larger way on Ophir and on a few other creeks. In most of the regions, however, a large proportion of the gold is still taken out with short sluices and hand rockers.

While it is true that during the last season a very large amount of machinery was taken to Nome, most of this consisted of pumps and separating plants which were to be used in the beach mining. Under the mining laws as enforced at Nome the beach for 60 feet inland from high tide is public property, and everyone is privileged to mine the sands. The consequence has been that men with expensive plants could reserve only such portions of the beach as they were actually engaged in shoveling into their sluice boxes, and it was impossible for them to carry on mining on a large scale. The striking of a pay streak was a signal for a swarm of men with rockers to rush in and help the discoverer develop it. The men with rockers and small separators had the advantage, because their outfits could be moved from place to place as rich ground was found. Another drawback was that the richest parts of the beach had been gutted during the previous summer. Even during the winter the miners who remained at Nome thawed their way through the ice with driftwood and took out pay-streak sand which some of them washed out in their cabins. As the excavations made during these operations were filled up and smoothed over by the shore ice and by the surf, there was no way of determining where the sands had been mined. The heavy storms in the latter part of the summer interfered very much with mining operations, and the severe storm of September nearly put an end to them, for it destroyed a very large part of the more elaborate plants which had been erected on the beach. These plants had to be erected within the 60-foot limit, which was considered public property, and hence were subjected to the full fury of the waves. In view of the above facts, it is probably not an exaggeration to estimate that, considering the cost of equipments, the loss of time, and the number of men engaged in beach mining, every dollar taken out cost at least two dollars' worth of work and equipment. Some of the enterprises, nevertheless, paid large profits, for the loss was very unequally distributed. Dr. Whitehead estimates that some $350,000 was taken from the Nome beach placers, and about $600,000 from the Topkok beach.

Although the richest part of the beach has doubtless been gutted, it is probable that these placers will continue to yield gold. The experience of the last summer has shown what methods can be used to advantage, and much of the beach sand probably still contains a larger percentage of gold than that mined in other regions. Much of the Nome beach gold is phenomenally coarse, so that little attention has been paid to the fine gold, much of which is lost.

The matter of dredging in Bering Sea off the Nome beach was much agitated last winter, and some companies were organized for this purpose. As far as known to the writer, no practical test of dredges was made. While there can be no question that fine gold exists in the deposits beneath the shallow water, it is questionable whether they can be mined at a profit. The most serious difficulty in the dredging operations is in sheltering the dredgers during the severe southerly storms. These storms would entirely interrupt the operations and would be likely to wreck the machinery.

The placers that have been thus far developed in the creeks are for the most part shallow diggings. The gravels are from 2 to 6 feet in depth, and usually carry some pay throughout their entire thickness, while the pay streak proper is on bed rock or on a clay bed. The moss and soil are from a foot to 2 feet in thickness, and below this the gravel is usually all run through the sluice boxes. The mining methods are, therefore, of the utmost simplicity. One condition which is new to those that are accustomed to the placers of the temperate zones is the frozen ground. The ground, except under certain favorable conditions, as on the beach, never thaws, except where the thick coating of moss and grass is removed. After the removal of this mantle of nonconductive material the ground rapidly thaws out during the long days of the Arctic summer. Such thawing takes place, however, only to a certain depth, when another stripping is required. A difficulty which confronted the miners on many creeks is lack of water in early summer and the floods which are concomitant with the continued rainfall of the latter part of the season. Mr. Collier's summary of the meteorological conditions shows that last season was probably not abnormal, and the miners must therefore expect to meet similar conditions in future. In the creeks in the vicinity of Nome these conditions have been met by the establishment of pumping plants and by building the dams of stronger material. In the Bluestone and Kugruk, where operations had only just begun when the rains set in, much time was lost by the carrying away of dams. It will be necessary to provide means for building more durable dams and of carrying off the surplus water during floods.

Mining in the gravel-plain deposits has been confined to rich pay streaks, and no large plants have been established. As water was scarce and the streams had little fall, most of the gold was taken out with rockers. It has been shown elsewhere that the coastal-plain gravels probably contain much disseminated gold besides the rich pay streaks. These deposits would seem, therefore, worthy of investigation by men who would be able to obtain control of a number of claims and develop them in a large way.

No hydraulic mining has been attempted in Seward Peninsula, nor, so far as known to the writer, anywhere else in Alaska or the British Northwest Territory. There are, no doubt, gravel beds which, were they in more temperate climates, would pay richly as hydraulic properties. Attention has been drawn elsewhere to a high gravel terrace on the Kugruk, which undoubtedly carries considerable gold. Its situation in reference to water supply and disposal of tailings would permit of its being mined by hydraulic methods. Similar gravel deposits, though of less thickness, which carry gold, occur on the Nikluk and on the Koksuktapaga. Whether these deposits would yield profits in Seward Peninsula is for the mining engineer to decide. The chief factors to be considered, aside from those ordinarily affecting operations of this kind, are the cost of transportation and labor, the frozen condition of the ground, and the shortness of the season. The matter of transportation could be simplified by building railways; the price of labor will probably decrease, but the frozen condition of the soil and the shortness of the season will always have to be contended with.

The high gravel terraces that have been developed in the vicinity of Nome, offer some new phases of mining in the region. Some of these high gravels are very deep and the pay streak is near the bottom. These have to be worked by underground methods. The so-called "burning" methods of sinking shafts has already been introduced. The problems of handling the gravels cheaply and bringing them to water are still unsolved for the region, as this underground mining has received but little development.

CLIMATIC NOTES.

By Arthur J. Collier.

Cape Nome is in latitude 64° 30′, while the northern point of the peninsula touches the Arctic circle. To the north is the ice-bound Arctic Ocean, while the south shore is washed by Bering Sea, which has a southern connection with the Pacific Ocean. Cape Prince of Wales, its western extremity, approaches the great land mass of Siberia. During the greater part of the year[1] a cold current sweeps down from the north, along the Siberian coast, through Bering Strait, bringing the temperature of the Arctic Ocean into Bering Sea. In summer[2] a current during most of the day flows northwestward, along the southern coast of the peninsula, passes Cape Prince of Wales,

[1] Pacific Coast Pilot, Appendix I, 1879, p. 18.

[2] Lieutenant Jarvis, Bull. 40, United States Coast and Geodetic Survey, p. 8.

and drives back the pack ice from the northern entrance to Bering Strait. Situated thus between two oceans of widely differing temperatures, and containing no extensive mountain ranges, Seward Peninsula has an exceedingly variable climate that is to a large extent the result of these influences.

Meteorological data.—Before the discovery of gold the peninsula was little frequented by white men; the records available for the determination of its climate are therefore limited. The early explorers in these latitudes usually kept temperature records, which have been compiled by Baker and summarized by Dall.[1] Records of temperatures made for a few years by early explorers at St. Michael, Port Clarence, Choris Peninsula, in Kotzebue Sound, and Point Barrow are thus preserved. At St. Michael the United States Weather Bureau maintained an observation station from 1875 to 1886, keeping records of temperatures, rainfall, number of rainy days, etc., for ten consecutive years. These records afford suggestive information in regard to the climate of Seward Peninsula; but St. Michael being an island and nearly 100 miles farther south its climate naturally differs from that of the peninsula.

At Teller Reindeer Station, Port Clarence, a log-book record, giving directions of wind, number of rainy days, extreme temperatures, etc., was kept from 1895 to 1898. More complete observations were made at this place during one year, from October 15, 1894, to July 29, 1896, by J. C. Widstead. These records, published in the reports on the introduction of domestic reindeer into Alaska, 1895 to 1899, inclusive, afford valuable data in regard to climate at Port Clarence.

During last summer temperature records were kept by the several field parties of the United States Geological Survey in various parts of the peninsula. These records, made by camping parties constantly on the move and often by observers untrained in meteorological work,[2] are necessarily inaccurate. They are valuable, however, as the only data available in regard to the inland summer climate of the peninsula.

In the following tables are given the data in regard to St. Michael, Port Clarence, Kotzebue Sound, and Point Barrow, together with those gathered by the Geological Survey parties. The localities given for the field parties are as nearly as possible the centers of the areas covered by them.

The tables go to show that the highest temperatures in the peninsula are found near Golofnin Bay, and that the temperatures decrease to the west and northwest. The mean annual temperature at Port

[1] Pacific Coast Pilot Appendix I, 1879, pp. 7-162. Explorations in Alaska, 1898, U. S. Geol. Survey, pp. 133–135.

[2] For accurate determination of air temperatures, thermometers that have been carried about the person or among the baggage must hang out in the open air at least one-half hour before reading. When such observations are secondary to the work of geologists and topographers wearied by the long summer day this precaution is often neglected. The recorded temperatures are thus made somewhat too high.

Clarence is about 4° lower than at St. Michael, while the range of temperatures is somewhat greater at St. Michael.

Precipitation.—The continued observations made at St. Michael and Port Clarence show a rainy season extending from the 1st of June to the last of October, with maximum precipitation not exceeding 3 inches in September. During the winter months, from November to May, the precipitation is less than one-half inch per month.

Summer climate of 1900.—Miners and missionaries who have spent several seasons in Seward Peninsula report that May and June, 1900, were much drier than the corresponding months of the previous year, and that the rainfall during August was greater. Weather records[1] kept at St. Michael show that during the months of May and June of 1900 there was not a single rainy day, and that the rainfall was less than one one-hundredth of an inch, whereas the normal number of rainy days for each month is 9, and the average precipitation for the two months is 0.93 and 1.36 inches, respectively. It may safely be inferred that the Nome region was correspondingly dry during May and June.

In many localities water for working the placers was insufficient in the early part of July. The tundra was unusually dry, and large areas were burned. During July and August light southerly breezes prevailed, with occasional strong northeast or northwest winds, bringing low temperatures and cold rains.

In September there were a number of severe storms, usually with south winds and heavy precipitation of rain and snow, causing great discomfort to campers equipped only with light tents and depending on the scant fuel which the country affords.

From September 10 to 17 the rain was almost continuous, raising the water in creeks and rivers and in many places effectually putting a stop to the mining operations for the season. Along the beach a heavy surf overwhelmed the mining machinery, drove the campers back to the tundra, wrecked all the water front of Nome, destroyed all the lighters, drove many sailing vessels ashore, and drowned a number of miners caught out on Bering Sea in small craft. A weather record[2] kept by the North American Trading and Transportation Company during September, 1900, shows that the total precipitation during the month amounted to 7 inches. As the average precipitation at St. Michael for September is 2.9 inches, it is quite probable that September, 1900, was an exceptionally stormy month in the Nome region.

Winter climate.—During the winter months, from October to May, temperatures rarely rise above the freezing point. Bering Sea

[1] Fourth report of the agricultural investigations in Alaska, 1900, p. 81. Department of Agriculture.
[2] Fourth report on the agricultural investigations in Alaska, 1900, p. 80.

becomes frozen often for a distance of 5 or 6 miles from the land,[1] and is occupied by floe ice as far south as the Pribilof Islands. Bering Strait probably seldom contains a solid body of ice, though the Diomede Islands have been reached over the ice from Cape Prince of Wales. On land sufficient snow falls to make travel by dog team easy. The prevailing winds are from the north. There are only occasional south winds, bringing higher temperatures.

Winter is reported to be the most agreeable season of the year. The residents of Nome engage in various winter sports, such as skating, baseball, bicycle riding, sailing on the ice of Bering Sea, and sleigh riding with dogs, horses, and reindeer.

Much traveling and staking of claims is done during this season. There are as yet no winter diggings, but supplies can be easily transported to the inland mining camps to be stored for use during the summer. For this transportation dogs are usually used on the longer trips and horses frequently near the coast, where a supply of hay and grain has been provided. Reindeer have also been used in limited numbers for this purpose.

Severe blizzards, with strong north-northeast gales are frequent, and winter travel is, therefore, never without discomfort and danger. The following quotations from Lieutenant Jarvis[2] clearly set forth some of the difficulties of winter travel:

> The wind had increased during the night and by the time we awoke was blowing a gale, a howling blizzard from the north filling the air with quantities of fine hard snow that cut like a knife and hid everything from sight even a few feet away. It was all one could do to keep the tent from blowing down; so we cut blocks of snow and built a barricade around our camp that kept off some of the wind, but still it was anything but comfortable. During this blizzard Lopp was compelled to move his camp. How such things are done at such times none can tell but those who do them, and too often the experiences are so terrible that the desire is to forget about them when they have passed. All the party showed the effects of their work this day in the patches of black skin on their faces and noses where they had been frozen while shifting camp.
>
> A philosophical common sense is a great help in living in the arctic regions, as elsewhere. If you are subjected to miserable discomforts, or even if you suffer, it must be regarded as all right and simply a part of the life, and like sailors you must never dwell too much on the dangers and sufferings lest others question your courage.

Comparison with climate of interior of Alaska.—Those who have lived in the Klondike region or in adjacent portions of Alaska will be interested to know how the climate of the Nome region compares with that in the interior.

A study of the available data goes to show that the mean annual temperature of the Nome region is some 3 or 4 degrees higher than that of the Klondike and adjacent portions of the Yukon Basin. The

[1] Report of the cruise of the U. S. Revenue Cutter *Bear*, p. 73.
[2] Lieutenant Jarvis: Cruise of the *Bear*, p. 52.

maximum temperature during the summer months in the Yukon Basin is considerably higher than that of Seward Peninsula, while the minimum winter temperature is considerably lower. The summer months of the Klondike region are drier and there is probably less snowfall in the winter than in the region under discussion. The fall months in the Yukon Basin, while they are cold and wet, are usually not so trying as those of the coast regions; the blizzards of the winter are less frequent and less dangerous, because of the shelter and fuel to be obtained in the wooded region of the Yukon. In general, it may be said that the interior has rather the better climate.

Meteorological tables.—The tables on the following pages show the maximum, minimum, and mean temperatures and the state of the weather at various points in Alaska.

Mean temperatures in northwest Alaska.

Station.	Latitude.	Longitude.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Duration of observations.	Authority.
	° ′	° ′															
Point Barrow	71 23	156 30	−18.7	−23	−15	1	20	32	36	38	26	2	−9	−13	6	January, 1852, to December, 1853.	Pacific Coast Pilot.[1]
Kotzebue Sound	66 28	161 50	−13	− 7	− 2	5	29	41	49	48	40	24	3	1	......	August, 1849, to May, 1850; June, 1898, to July, 1900.	Pacific Coast Pilot; Report on Agriculture,[2] 1900.
Port Clarence	65 20	166 30	− 7	− 7	5	13	32	42	51	49	41	36	8	0	22	July, 1850, to June, 1852; November, 1894, to July, 1896.	Pacific Coast Pilot; Reports on Reindeer,[3] 1895 and 1896.
Cape Topkok	64 34	164	......	......	......	......	......	......	62	......	......	......	......	......	......	1 month, 1900	Reaburn, U. S. Geological Survey.
White Mountain	64 48	163 30	......	......	......	......	......	......	78	......	......	......	......	......	......	do	Hefty, U. S. Geological Survey.
Forks of Niukluk	65 3	164 20	......	......	......	......	......	......	56	......	......	......	......	......	......	do	Collier, U. S. Geological Survey.
Fish River	65	163 10	......	......	......	......	......	......	63	......	......	......	......	......	......	do	Peters, U. S. Geological Survey.
Nome	64 30	165	......	......	......	......	......	......	......	47	39	......	......	......	......	2 months, 1900	Reaburn, U. S. Geological Survey, and Report on Agriculture, 1900.
Council	64 52	163 40	......	......	......	......	......	......	......	51	......	......	......	......	......	1 month, 1900	Hefty, U. S. Geological Survey.
Kuzitrin River	65 15	164 40	......	......	......	......	......	......	......	46	......	......	......	......	......	do	Collier, U. S. Geological Survey.
Tubutulik River	65	162 10	......	......	......	......	......	......	......	46	......	......	......	......	......	do	Peters, U. S. Geological Survey.
Point Rodney	64 33	166	......	......	......	......	......	......	......	......	36	......	......	......	......	do	Reaburn, U. S. Geological Survey.
Koksuktapaga River	64 40	164 20	......	......	......	......	......	......	......	......	44	......	......	......	......	do	Hefty, U. S. Geological Survey.
Koyuk River	65 10	161 30	......	......	......	......	......	......	......	......	42	......	......	......	......	do	Peters, U. S. Geological Survey.
St. Michael	63 29	162 2	− 8	− 2	9	21	33	46	54	52	44	31	16	5	26	January, 1875, to June, 1886.	U. S. Weather Bureau.
Yukon River at international boundary	65	141	−17	−10	7	24	45	57	60	52	39	31	3	−16	23	September, 1889, to June, 1891.	Do.

[1] Pacific Coast Pilot, Alaska. Appendix 1, Meteorology and Bibliography, 1879. W. H. Dall.
[2] Fourth Report on the Agricultural Investigation in Alaska, 1900. C. C. Georgeson.
[3] Reports on Introduction of Domestic Reindeer into Alaska, 1895 to 1899, inclusive. Sheldon Jackson.

Extreme maximum temperature in northwest Alaska.

Station.	Latitude.	Longitude.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Duration of observations.	Authority.
	° ′	° ′															
Point Barrow	71 23	156 30	27	3	24	33	44	47	52	49	42	27	25	28	52	January, 1852, to December, 1853.	Pacific Coast Pilot.
Kotzebue Sound	....	....	21	29	39	40	59	72	81	67	63	43	22	27	81	August, 1849, to May, 1850; June, 1898, to July, 1900.	Pacific Coast Pilot; Report on Agriculture, 1900.
Port Clarence	65 20	166 30	35	27	36	42	72	71	72	77	57	44	42	49	77	July, 1850, to June, 1852; November, 1894, to July, 1896.	Pacific Coast Pilot; Reports on Reindeer, 1895 and 1896.
Cape Topkok	64 34	164	......	......	......	......	......	......	75	......	......	......	......	......	......	1 month, 1900	Reaburn, U. S. Geological Survey.
White Mountain	64 48	163 30	......	......	......	......	......	......	78	......	......	......	......	......	......	..do	Hefty, U. S. Geological Survey.
Forks of Niukluk	65 3	164 20	......	......	......	......	......	......	69	......	......	......	......	......	......	..do	Collier, U. S. Geological Survey.
Fish River	65	163 10	......	......	......	......	......	......	84	......	......	......	......	......	......	..do	Peters, U. S. Geological Survey.
Nome	64 30	165	......	......	......	......	......	......	......	65	54	......	......	......	......	2 months, 1900	Reaburn, U. S. Geological Survey and Report on Agriculture, 1900.
Council	64 52	163 40	......	......	......	......	......	......	......	68	......	......	......	......	......	1 month, 1900	Hefty, U. S. Geological Survey.
Kuzitrin River	65 15	164 40	......	......	......	......	......	......	......	55	......	......	......	......	......	..do	Collier, U. S. Geological Survey.
Tubutulik River	65	162 10	......	......	......	......	......	......	......	64	......	......	......	......	......	..do	Peters, U. S. Geological Survey.
Point Rodney	64 33	166	......	......	......	......	......	......	......	......	55	......	......	......	......	..do	Reaburn, U. S. Geological Survey.
Koksuktapaga River	64 40	164 20	......	......	......	......	......	......	......	......	55	......	......	......	......	..do	Hefty, U. S. Geological Survey.
Koyuk River	65 10	161 30	......	......	......	......	......	......	......	......	52	......	......	......	......	..do	Peters, U. S. Geological Survey.
St. Michael	63 29	162 2	44	41	43	46	57	75	75	69	69	54	42	45	75	January, 1875, to June, 1886.	U. S. Weather Bureau.
Yukon River at international boundary.	65	141	25	37	38	56	74	84	87	74	66	52	39	17	87	September, 1889, to June, 1891.	Do.

Extreme minimum temperatures in northwest Alaska.

Station.	Latitude.	Longitude.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Duration of observation.	Authority.
	° ′	° ′															
Point Barrow	71 23	156 30	—43	—45	—42	—40	—6	24	26	29	—3	—22	—37	—40	—45	January, 1852 to December, 1853.	Pacific Coast Pilot.
Kotzebue Sound			—43	—38	—36	—27	—4	27	32	34	18	—5	—23	—39	—43	August, 1849, to May, 1850; June, 1898, to July, 1900.	Pacific Coast Pilot; Report on Agriculture, 1900.
Port Clarence	65 20	166 30	—38	—34	—22	—16	—12	33	44	44	31	—2	—26	—26	—38	July, 1850, to June, 1852; November, 1894, to July, 1896.	Pacific Coast Pilot; Reports on Reindeer, 1895 and 1896.
Cape Topkok	64 34	164							40							1 month, 1900	Reaburn, U. S. Geological Survey.
White Mountain	64 48	163 30							42							do	Hefty, U. S. Geological Survey.
Forks of Niukluk	65 3	164 20							42							do	Collier, U. S. Geological Survey.
Fish River	65	163 10							47							do	Peters, U. S. Geological Survey.
Nome	64 30	165								28	22					2 months, 1900	Reaburn, U. S. Geological Survey and Report on Agriculture, 1900.
Council	64 52	163 40								32						1 month, 1900	Hefty, U. S. Geological Survey.
Kuzitrin River	65 15	169 40								31						do	Collier, U. S. Geological Survey.
Tubutulik River	65	162 10								37						do	Peters, U. S. Geological Survey.
Point Rodney	64 33	166									22					do	Reaburn, U. S. Geological Survey.
Koksuktapaga River	64 40	164 20									20					do	Hefty, U. S. Geological Survey.
Koyuk River	65 10	161 30									32					do	Peters, U. S. Geological Survey.
St. Michael	63 29	162 2	—47	—41	—39	—27	—2	22	33	32	18	3	—24	—43	—47	January, 1875, to June, 1886.	U. S. Weather Bureau.
Yukon River at international boundary.	65	141	—60	—55	—45	—26	8	30	35	31	14	4	—35	—49	—60	September, 1889, to June, 1891.	Do.

Mean number of rainy and snowy days in northwest Alaska.

Station.	Latitude.	Longitude.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.	Duration of observations.	Authority.
	° ′	° ′															
Port Clarence	65 20	166 30	5	6	7	5	3	5	8	11	10	7	5	4	76	July, 1894, to August, 1898.	Reports on Introduction of Reindeer, 1895 to 1899.
Cape Topkok	64 34	164							2							1 month, 1900	Reaburn, U. S. Geological Survey.
White Mountain	64 48	163 30							8							do	Hefty, U. S. Geological Survey.
Forks of Niukluk	65 3	164 20							7							do	Collier, U. S. Geological Survey.
Fish River	65	163 10							5							do	Peters, U. S. Geological Survey.
Nome	64 30	165								12	15					2 months, 1900	Reaburn, U. S. Geological Survey and North American Trading and Transportation Company observer.
Council	64 52	164 40								17						1 month, 1900	Hefty, U. S. Geological Survey.
Kuzitrin River	65 15	164 40								15						do	Collier, U. S. Geological Survey.
Tubutulik River	65	162 10								20						do	Peters, U. S. Geological Survey.
Point Rodney	64 33	166									20					do	Reaburn, U. S. Geological Survey.
Koksuktapaga River	64 40	164 20									14					do	Hefty, U. S. Geological Survey.
Koyuk River	65 10	161 30									17					do	Peters, U. S. Geological Survey.
St. Michael	63 29	162 2	7	4	6	8	9	9	12	14	14	11	9	5	108	January, 1875, to June, 1886.	U. S. Weather Bureau.

Measured precipitation in inches.

	Lat. °	Lat. ′	Long. °	Long. ′															
Port Clarence	65	20	166	30	0.83	0.01	0.17	0.18	0.02	1.33	0.5	1.3	1.1	0.08	0.04	0.02	5.58	Aug. 1, 1895, to Aug. 1, 1896.	Reports on Introduction of Reindeer, 1896.
St. Michael	63	29	162	2	.91	.17	.46	.54	.93	1.36	1.75	2.61	2.90	1.34	.79	.67	14.43	1875 to 1886	U. S. Weather Bureau.
Do	63	29	162	2	.21	1.00	1.00	.4	.0	.0								6 months, 1900	Rev. J. Post; Report on Agriculture in Alaska, 1900.
Nome												.6	7.00					2 months, 1900	North American Trading and Transportation Company; Report on Agriculture in Alaska, 1900.

NOTES ON THE VEGETATION.

By Arthur J. Collier.

The vegetation of Seward Peninsula is of arctic character. The plants are all of stunted stock, bearing witness to the rigor of the climate. During the short period when growth is possible, however, many species rapidly develop to maturity.

The most abundant forms of vegetation are the mosses and lichens. These lowly plants form a variegated carpet, its color ranging from the pure white and cream of the reindeer moss to the deep green and brown of the peat moss. During the brief summer this carpet is sprinkled over with many bright-colored flowering plants of higher orders, which heighten the gay effect of the whole.

Tundras.[1]—On level low grounds, where there is no drainage, the peat moss accumulates to a considerable thickness and the characteristic tundra is formed. In the western part of the peninsula about one-fourth of the surface is of this kind. The yielding nature of this moss makes travel across it very wearisome to men and sometimes impossible to horses. It is a hard day's work for a man to make 9 or 10 miles across the moss. For this reason the higher ridges and gravelly beds of streams are preferred for summer travel.

Timber.—In the eastern part of the peninsula spruce[2] timber occurs along the rivers. Trees 1 foot in diameter and 50 feet high were measured near Council on Niukluk River. The western limit of this spruce is approximately represented by a line extending from Golofnin Bay northwestward to the headwaters of the Niukluk River, and thence northeastward to the eastern end of Kotzebue Sound (Pl. XVI, *A*). Scattered trees were seen on the portage 20 miles west of Council (Pl. II, *B*). This is the westernmost limit of coniferous trees on the American Continent.

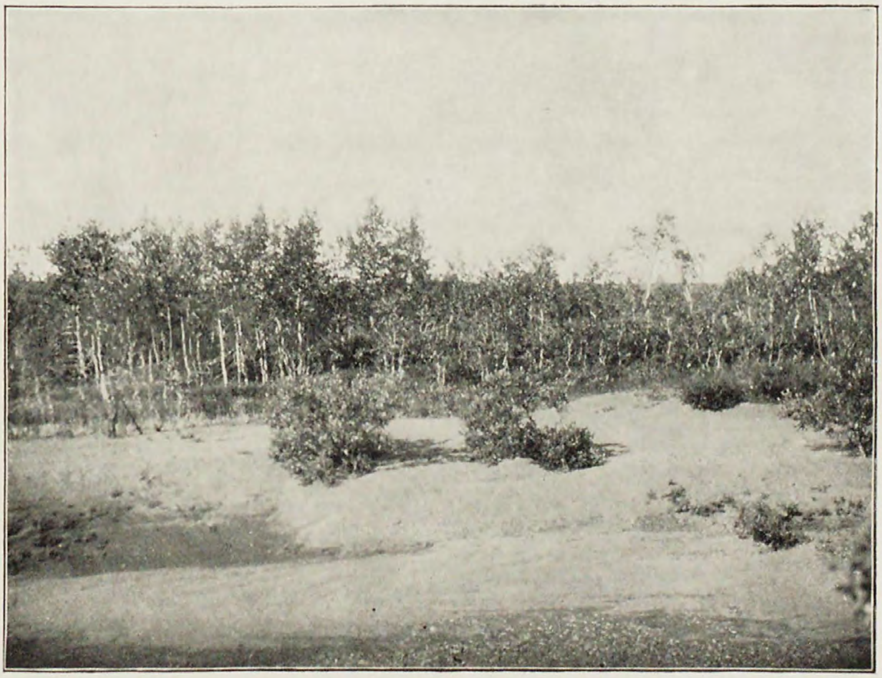
Within the spruce area fuel and sheltered camping places are abundant and comfortable log houses can be built for winter use. Beyond the limits of the spruce timber, cottonwood (*Populus basalmifera*) as large as 10 inches in diameter occurs at a few places along the rivers (Pl. XVI, *A*, *B*). Dwarf alders (*Alnus sinuata*) make occasional thickets on the hillsides. Along rivers and creeks generally there are dense thickets of willow, gnarled and tangled together, and often very troublesome to penetrate. In favorable localities the larger willow (*Salix alaxensis*) sometimes attains a thickness of 6 inches and a height of 20 feet. The smaller willows, to be found on nearly all the streams, are

[1] The Standard Dictionary gives the following definition of "tundra:" "A rolling plain of Russia and Siberia, covered with moss and at times very moist and marshy."

"The tundras of northern latituaes are frozen plains, of which the surface is covered with arctic mosses and other plants."—Archibald Geikie, Text-book of Geology.

[2] This spruce is probably *Picea canadensis* (Mill.) B. S. P. No specimen of it has yet been submitted to Mr. Coville for identification.

A. SPRUCE TREE NEAR GOLOFNIN BAY.



B. COTTONWOOD ON KRUZGAMEPA RIVER.

seldom over 2 inches in diameter and 5 feet in height. These willows are the main source of fuel in the mining camps of the western part of the peninsula. Stunted and small though they are they made possible all the exploration and development in the interior of Seward Peninsula last summer. They were found in sheltered nooks as far west as Cape Prince of Wales.

Grass.—Along the river and creek bottoms and wherever on low lands the growth of tundra moss has not prevailed, grasses are abundant and afford sufficient forage for pack animals. Some natural meadows were noted where hay might have been harvested in considerable quantities.

Six species of grass were collected, and there are probably many more. There was no attempt made to complete the collection. Waving above the moss of the tundras occur a number of grass-like plants of the sedge family. They are almost everywhere present on the tundras, giving them the appearance of verdure-clad pasture lands. The most abundant of these tundra grasses (*Eriophorum scheuchzeri*) produce tassels of white cotton, which in the distance appear to be white flowers, cotton-like in character.

In many places these tundra grasses grow in bunches, making hard lumps, known as "nigger heads," which turn under the feet in the more yielding moss and greatly increase the annoyance of tundra traveling.

These tundra sedges are readily eaten by horses when other forage can not be had. Their abundance permits the extensive use of pack horses and is a most important factor in the country's development. Pack horses were seen in all parts visited by us, and even wagons were taken over some parts of the peninsula last summer. Through July and August horses were invariably in good condition. Early in September, however, frost killed the grass and before the end of the month many horses had died.

Other forage plants.—Various kinds of lichens, known as reindeer moss, are very widely distributed over the peninsula. They constitute a considerable part of the tundra growth on the lowlands and extend over the hillsides. These lichens are the principal food of the reindeer, both in winter and summer. There are at the present time about 3,000 domestic reindeer on the peninsula, which number can probably be increased many times without overstocking the range. In comparatively recent times the wild reindeer or caribou have been abundant, although they already seem to be entirely extinct. Captain Cook reports having seen a band of these animals near Cape Rodney. Old antlers are often found partly embedded in the growth of tundra moss. Pl. II, *A*, showing a pair of these old antlers, is a characteristic view of the tundra. The mat of reindeer moss, sphagnum, cotton grass, and dwarf birch has accumulated to the depth of about a foot since these horns were shed.

Berries.—In the month of August berries of various kinds are fairly abundant. Several species of the cranberry and huckleberry family, and at least two species of the raspberry family, produce edible berries. Two of these berries are important: (1) The marsh blueberry (*Vaccinium uliginosum*), similar to the blueberry of the States, grows abundantly over the tundras and mossy hillsides and is an agreeable addition to the prospector's fare. (2) The salmon berry (*Rubus chamæmorus*), called also cloud berry and marooshka, is probably the most important food plant in the region. The berries are said to be gathered in large quantities by the Eskimo and preserved in seal oil for winter use. Mrs. Brevig, missionary at Port Clarence, puts these berries up for winter use in barrels, depending only on the cold weather to prevent fermentation. Some of these berries put up in this way and served on her table in September were delicious.

Flowers.—Summer in this region resembles the springtime of the States. Owing to the shortness of the season the greater profusion of flowers is in July. All the vegetative energy seems to be concentrated for the production of flowers at this time, and the large blossoms are disproportionate to the stunted stocks. Rugged prospectors and miners frequently find their latent sentiment stirred through unexpected familiarity with some of these flowers. The wild forget-me-not (*Myosotis sylvatica*), for example, is so like the forget-me-not in the gardens at home that it does not fail to call up tender memories, and many a rough prospector's notebook or folded map had sprays of forget-me-not pressed between the leaves.

Along the river bottoms and at the edges of the tundra generally *Polemonium*, *Mertensia*, and *Aconitum* are abundant, with vigorous stocks and showy blue flowers. On sand bars and steep banks along the rivers the fireweeds give brilliant patches of color. On the tundras are found, nestled in the green moss, the pure white flowers of the salmon berry, together with those of several heather-like plants, while standing up above the moss are frequently seen the large yellow Alaska poppies.

On the bleak hilltops hardy little plants crouch close to the rocky soil, but still produce their bright flowers. Phlox (*P. sibirica*) and bluebell (*Campanula lasiocarpa*) are among these. The most interesting, perhaps, is the little rhododendron (*R. kamtschaticum*). This plant, seldom over 2 inches long and usually hidden from sight among the mosses and rocks, has a flower that is large and showy, like the southern representatives of the family.

A small collection of the more common plants of the regions visited by the writer last summer was made, the purpose being merely to show the general character of the vegetation. The collection was submitted to Mr. Frederick V. Coville, of the United States Department of Agriculture, to whom we are indebted for the identifications.

LIST OF PLANTS COLLECTED IN SEWARD PENINSULA BY ARTHUR J. COLLIER; IDENTIFIED CHIEFLY BY FREDERICK V. COVILLE.

LICHENES. Lichen family.

The following species of lichens were collected near Salmon Lake and in the basin of Cripple River. No attempt was made to secure a complete collection of the lichens of the region, which are everywhere abundant. Some of them are of practical importance, as they afford food for reindeer.

The identifications were made by Miss Clara E. Cummings, of Wellesley College:

Cladonia alpestris (L.) Rabenh.
Cladonia turgida (Ehrh.) Hoffm.
Cladonia uncialis (L.) Fries.
With this is a mixture of *Cladonia sylvatica* (L.) Hoffm. and *Alectoria divergens* (Ach.) Nyl.
Cladonia coccifera pleurota (Floerk.) Schaer.
Cladonia elongata (Jacq.) Floerk.
Alectoria divergens (Ach.) Nyl.
Mixed with this is *Alectoria ochroleuca rigida* Fries.
Cetraria islandica (L.) Ach.
Pilophorus cereolus robustus (Fries) Tuck.
Nephroma arcticum (L.) Fries.
Umbilicaria hyperborea Hoffm.

POLYPODIACEÆ. Fern family.

Filix fragilis (L.) Underw.

East side of Krusgamepa River, August 1.

Filix montana (Lem.) Underw.

East of Krusgamepa River, at foot of mountain, August 1.

Dryopteris fragrans (L.) Schott.

South side of Niukluk River on rocky hillside at mouth of American Creek, July 16.

POACEÆ. Grass family.

Arctagrostis arundinacea (Trin.) Beal. Blue grass.

At Mud Lake on portage between Niukluk and Kruzgamepa rivers, July 30. Common in moist places, on river bottoms and old lake beds. Suitable for hay.

Arctagrostis latifolia (R. Br.) Griseb. Blue grass.

On Niukluk River at mouth of American Creek, July 15. Common on river bottoms. Suitable for hay.

Colpodium pendulinum (Laest.) Griseb.

Abundant at Mud Lake on the portage, July 30. Common in moist places, on river bottoms and old lake beds. Suitable for hay, and in sufficient abundance.

Festuca ovina L. Bunch grass.

On Niukluk River at mouth of American Creek, July 15. Common on river bottoms. Good forage plant. In sufficient abundance to make hay.

Festuca rubra L. Bunch grass.

On Niukluk River at mouth of American Creek, July 15. Common on river bottoms. Good forage plant. In sufficient abundance to make hay.

Elymus mollis Trin. Rye grass.

On Kruzgamepa River, August. Grows abundantly on high sand bars along rivers. The large heads have large grains which make good forage after other grasses are killed by frost.

CYPERACEÆ. Sedge family.

Eriophorum scheuchzeri Hoppe. Cotton grass.

At Mud Lake, August 20. A common tundra grass. There are a number of representatives of the sedge family growing over the tundras, which will afford inferior forage for pack animals. This species is the most abundant form.

LILIACEÆ. Lily family.

Zygadenus elegans Pursh.

On White Mountain, July 5. Growing in willow thickets along entire route of the party.

CONIFEREÆ. Spruce family.

Picea canadensis (Mill.) B. S. P. Spruce.

This specimen was lost before the collection was submitted to Mr. Coville, but the determination is probably correct. Is found from Golofnin Bay up Fish River to American Creek. Mr. Mendenhall reports the same tree abundant in the eastern part of peninsula. It is reported from south shore of Kotzebue Sound.

SALICACEÆ. Willow family.

Populus balsamifera L. Cottonwood.

On Kruzgamepa River, near Threefinger Mountain. Trees often 1 foot in diameter. An important fuel and timber tree, but not of wide distribution in the western part of the peninsula.

Salix alaxensis (Anders.) Coville. Willow.

The large tree willow of river bottoms. Trees sometimes 6 inches in diameter. The important fuel plant of Seward Peninsula.

Salix barclayi Anders. Willow.

Smaller scrub willow. Seldom over 2 inches in diameter.

Salix glauca L. Willow.

Scrubby. Seldom over 2 inches in diameter.

Salix reticulata L.

On White Mountain, July 5. A small creeping plant from underground rootstock, growing in wooded places inland; also on rocky soil on the tundra. Never more than a few inches high.

BETULACEÆ. Birch family.

Betula glandulosa rotundifolia (Spach) Regel.

Collected on the portage. A small shrub growing on the tundra. In general habit the plant resembles a small gooseberry or currant bush.

Alnus sinuata (Regel) Rydb. Alder.

On Niukluk River at mouth of American Creek, July 15. Seen on hillsides and in river bottoms throughout entire trip. Seldom over 4 inches diameter.

POLYGONACEÆ. Smartweed family.

Polygonum plumosum Small.

On west side of Golofnin Bay near Rocky Point, July 1. Seen also in wet places on the tundra at 500 feet elevation.

Polygonum viviparum L.

On White Mountain, July 6. Growing in wet places among willow thickets along entire route of the party.

PORTULACACEÆ. Portulaca family.

Claytonia sarmentosa C. A. Meyer.

On Krusgamepa River, July 30. Common along creek bottoms.

ALSINACEÆ. Chickweed family.

Arenaria arctica Stev.

On White Mountain, July 5. Growing on dry hillsides inland.

Arenaria hirta Worsmsk.

On White Mountain, July 5. Growing on dry wooded hillsides inland.

RANUNCULACEÆ. Buttercup family.

Delphinium Sp. Larkspur.

Near top of mountain, 1 mile south of Grantley Harbor at Coast Survey signal, August 29. This larkspur grows on high hills where the moss is not thick. Seen also on mountain south of Salmon Lake and on Larkspur Mountain at the Portage.

Aconitum delphinifolium DC. Monkshood.

Common among the willows on creek bottoms; the large, showy flowers resemble larkspur.

Anemone narcissiflora L.

PAPAVERACEÆ. Poppy family.

Papaver radicatum Rottb. Yellow poppy.

On gravelly soil of the spit at Cheenik on Golofnin Bay, July 1. Also from the tundra half a mile east of Cheenik, July 3. A large yellow flower, sometimes 2 inches in diameter.

Capnoides pauciflorum (Willd.) Kuntze.

Collected near Cheenik, July 3. Grows on the tundra.

BRASSICACEÆ. Mustard family.

Parrya nudicaulis Boiss. Wall flower.

About Golofnin Bay, July 1. Grows abundantly on tundras about Golofnin Bay and more sparingly inland. White to rose color. Fragrant.

SAXIFRAGACEÆ. Saxifrage family.

Saxifraga hirculus L.

On Krusgamepa River at the end of the Portage. Common in wet places in creek bottoms along Niukluk and Krusgamepa rivers.

Saxifraga neglecta Bray.

Collected by Alfred H. Brooks, in rocky soil of deep valley at east end of Kigluaik Mountains, August 1.

Parnassia palustris L.

A white flower one-half inch in diameter, common in moist places along creek bottoms.

ROSACEÆ. Rose family.

Spiræa betulæfolia Pall.

Collected on route along Fish and Niukluk rivers, from White Mountain inland. A small shrub 1 to 3 feet high.

Rubus chamæmorus L. Salmon berry.

Collected on the tundra west of Golofnin Bay, July 1. Very abundant on the tundras about Golofnin Bay, and inland up to Fish River. A large yellow berry, sometimes 1 inch in diameter. Differs from the salmon berry of the States in that it has a solid core like the blackberry, while the salmon berry of the States is a cap, like the raspberry. Plant is seldom over 3 inches high. It grows among the moss of the tundra. Flowers are pure white, about three-fourths inch in diameter. Probably the most important food plant of Seward Peninsula.

Rubus stellatus Smith.

Collected at camp on Golofnin Bay. Grows abundantly along the çoast at edge of the tundra and inland; never more than 6 inches high. First seen at Nome. It is said to have an edible berry, but no berries were seen. Flowers, rose colored, one-half inch in diameter.

Potentilla fruticosa L.

Collected at White Mountain, July 5. A small undershrub, 1 to 3 feet high, with a showy yellow flower. Grows inland along Niukluk River.

Dryas integrifolia Vahl.

Head of Sweetcake Creek, July. Also at Cheenik, July 2. A low creeping plant in moist places below melting snowdrifts on hillsides. The large white flower is nearly 1 inch in diameter.

Dryas octopetala L.

Collected on mountain at head of Sweetcake Creek, about 10 miles northwest of Council, July 13. Large white flowers similar to *D. integrifolia*.

Sanguisorba media L.

Collected at White Mountain, July 6. Along river bottoms inland as far as the party went.

VICIACEÆ. Vetch family.

Hedysarum americanum (Michx.) Britton.

On White Mountain, in rocky soil near the river, July 5 and 6.

Lathyrus maritimus (L.) Bigel. Beach pea.

Collected on gravelly spit at Cheenik, July 3. Grows at the edge of the beach all about Golofnin Bay. Large rose-colored flower.

VIOLACEÆ. Violet family.

Viola Sp. Yellow violet.

Collected on rocky hilltop between the head of Sweetcake and Ophir creeks, July 13. Much more slender and smaller than the *V. glabella* of the States.

Viola langsdorffii Fisch.

Collected on the tundra near Cheenik, July 3. Grows sparingly in moist places inland. Lavender colored.

ONAGRACEÆ. Evening primrose family.

Epilobium angustifolium L. Fire weed.

Collected at Salmon Lake, August 15. Grows all along the river bluffs to the coast; 1 to 3 feet high. This species is found all over North America.

Epilobium latifolium L. Willow herb.

Collected 5 miles below Council, July. Grows on bars along Niukluk River from White Mountain inland. Large rose-red flowers 1 inch in diameter.

CORNACEÆ. Dogwood family.

Cornus suecica L.

On bluff near water hole at Cheenik, July 3. Small herb 3 inches high.

VACCINIACEÆ. Huckleberry family.

Vaccinium uliginosum L. Marsh blueberry.

Abundant on the tundra and mossy hillsides during August.

Vaccinium vitisidæa L. Huckleberry.

A small, low plant among the tundra moss.

Oxycoccus oxycoccus (L.) MacM. Cranberry.

Collected on the portage between Niukluk and Krusgamepa rivers, July 25. This plant grows among moss on the tundra. Plant seldom over 1 inch high.

ERICACEÆ. Heather family.

Ledum palustre L.

Collected on tundra west of Golofnin Bay, July 1.

Rhododendron kamtschaticum Pall.

Collected on hilltop near Council, July 10. Grows on high, rocky hilltops; apparently more abundant westward. The whole plant not over 1 inch high. Flower deep rose color, about three-fourths to 1 inch in diameter.

Cassiope tetragona (L.) D. Don.

Collected 2 miles west of Camp 1, July 1. Grows on tundra about Golofnin Bay.

PRIMULACEÆ. Primrose family.

Primula eximia Greene. Primrose.

Collected near Cheenik, July 4. Grows abundantly on sandy river bars, inland.

Dodecatheon frigidum Cham. & Schlecht. Mosquito bill.

Collected on Golofnin Bay near Cheenik, July 4. Grows in moist grassy places inland as far as the party went.

GENTIANACEÆ. Gentian family.

Gentiana frigida Haenke.

In rocky soil on hillside near Camp 18, on Krusgamepa River, August 10. Large greenish flower with purple veins.

POLEMONIACEÆ. Polemonium family.

Phlox sibirica L.

Collected near Council, July 10. Grows on rocky hilltops. Ranges in color from white to deep rose.

Polemonium cæruleum L.

Collected on west shore of Golofnin Bay, last of June. Grows very abundantly inland wherever the soil is exposed and grass grows. One of the showiest flowers of Seward Peninsula.

BORAGINACEÆ. Borage family.

Myosotis sylvatica Hoffm. Forget-me-not.

Collected on hillside north of Council, July 10. Resembles very strongly the forget-me-not of cultivation.

Mertensia paniculata (Ait.) Don.

Collected near the coast on the west side of Golofnin Bay, July 1. Grows sparingly near the coast in alder thickets. Very abundant along Niukluk River in July. Grows in grassy places along the river from White Mountain inland, attaining a height of 1 to 1½ feet. One of the most common flowers.

SCROPHULARIACEÆ. Figwort family.

Pedicularis lanata Willd.

Collected on tundra at west side of Golofnin Bay, at 500 feet elevation, July 1. Grows rather abundantly in wet places on the tundra. Color varies from white to pink.

Pedicularis langsdorffii Fisch.

Collected on tundra on west side of Golofnin Bay, at 500 feet elevation, July 1. Grows somewhat abundantly in wet places on the tundra. Color varies from white to pink.

Pedicularis verticillata L.

Collected at White Mountain, July 5. Grows along Niukluk River, inland.

LENTIBULARIACEÆ. Butterwort family.

Pinguicula villosa L.

Collected near Cheenik, July 3. Grows on the tundra.

RUBIACEÆ. Madder family.

Galium boreale L.

Collected on the Portage between Niukluk and Krusgamepa rivers, July 30. Grows abundantly in grassy places along streams.

VALERIANACEÆ. Valerian family.

Valeriana capitata Pall.

Collected on the meadow at Cheenik, July 2. Very abundant inland.

CAMPANULACEÆ. Bluebell family.

Campanula lasiocarpa Cham.

Collected on mountain 2 miles north of the junction of Koksuktapaga and Niukluk rivers, July 15. Bright blue flowers.

Campanula sp.

Collected on White Mountain, July 6. Grows in rocky places inland. Corolla is deep blue, but fades with pressing.

CARDUACEÆ. Nettle family.

Chrysanthemum arcticum L.

Collected at Eskimo village at mouth of Agiapuk River on Imuruk Basin, August 28.

Arnica sp. Sunflower.

Collected on White Mountain, July 5. Grows on dry hillsides and river bottoms inland.

TOPOGRAPHIC SURVEY OF NOME REGION, ALASKA.

By E. C. Barnard.

In the spring of 1900 the writer was detailed to take charge of the topographic surveys in the Nome region, Alaska. The plan for work in the southern part of Seward Peninsula included the topographic survey of an area lying between Golofnin Bay and Port Clarence, bounded on the north by the Kigluaik Range, but including the gold district of Ophir Creek. The work was to be done with a view of publishing on a scale of $\frac{1}{250000}$ and with 200-foot contours. It was also proposed to extend the triangulation from the Coast and Geodetic Survey base on Golofnin Bay to the triangulation which was to be established during the summer by that organization at Port Clarence. The topographic survey of that part of Seward Peninsula which lies to the east of this area was placed in charge of Mr. W. J. Peters.

Mr. D. L. Reaburn, topographer, was detailed as a member of the party, and Messrs. J. G. Hefty and R. B. Robertson were employed as field assistants, while A. L. Quenean, G. W. Bowman, W. B. Reaburn, J. J. Connelly, W. W. Von Cannon, J. M. Heizer, John Dyer, John Boak, Arthur Roby, G. L. Stidham, and W. M. Moore were engaged as camp hands. According to instructions, the party embarked at Seattle on the United States Coast and Geodetic Survey S. S. *Patterson* on June 19, and reached Nome July 6. Here, through the courtesy of Captain Pratt, commanding the *Patterson*, supplies for the party were landed at Fort Davis, in spite of a heavy surf, and on July 9 the entire party, with supplies and equipment, disembarked at Golofnin Bay.

Three topographic parties and one triangulation party were then organized. The conditions proved very unfavorable for surveying, as during the month of July fires raged in every direction and the thick smoke almost prevented the use of telescopic instruments.

The triangulation was placed in the hands of R. B. Robertson, who, with two camp hands, began at once the development of the triangulation from the Coast and Geodetic Survey base, extending it up the Fish and Niukluk river valleys and westward along the coast. Mr. Robertson's party expected to travel by canoes, and, when not following streams, with packs. As their work was entirely away from water courses, the packing required was very laborious and occasioned great loss of time. Owing to this, and because of the continued smoky conditions, followed by rainy and cloudy weather, it was impossible to carry out the complete scheme of triangulation. A very creditable season's work was, however, accomplished, for, in spite of the adverse conditions, the triangulation was extended over 1,000 square miles and the positions of 14 points were established, 8 of which were occupied.

Mr. Reaburn, accompanied by three men, extended a plane-table triangulation westward along the coast and mapped the region between the coast and Klokerblok and Bonanza rivers. He also carried a similar survey westward, and started topographic mapping again at the Snake and Cripple river divide, and from there mapped a solid block of country extending around the westward end of the Kigluaik Range to Imuruk Basin and Port Clarence. During the first part of the season Mr. Reaburn used canoe transportation, but early in August he procured three pack horses, and was thus enabled to push his work ahead much more rapidly. He mapped in all about 1,500 square miles.

A second topographic party, in charge of Mr. Hefty, with three men, extended a plane-table triangulation to the northwest, mapping the Klokerblok and Fox river basins, and then, continuing up the Niukluk to Council, mapped the drainage basins of the Niukluk River. Mr. Hefty depended entirely on canoes and back-packing for transporting his supplies. In all, he completed the mapping of about 1,000 square miles.

In the early part of the season the writer's time was taken up in looking after these several topographic and triangulation parties. This necessitated a trip to Council to start the triangulation. On July 21 he reached Port Safety by steamer, with his party of three men. At this point a temporary base had been measured and more or less developed by the Coast Survey in 1899. From this base a plane-table triangulation was carried northward and westward. The drainage basins of Eldorado, Flambeau, Nome, and Snake rivers were mapped, and the work was extended northward to the summit of the Kigluaik Range, including the headwaters of the Kruzgamepa. On August 14 the party reached Nome, and through the courtesy of Major Van Arsdale, commandant of Fort Davis, an army pack train was secured, by the help of which the work was pushed forward much more rapidly. About 1,100 square miles of topographic work was completed by the writer during the season.

The treeless condition of nearly all of this country makes it almost ideal for plane-table work. The upland has somewhat the character of a dissected plateau above which rise numerous hills, affording summits admirably adapted for primary and secondary triangulation points. These summits are very frequently marked by curiously wrought rock pinnacles and knobs, which offer easily recognizable natural signals. The topographic work was all done by plane-table, supplemented by paced and stadia surveys of streams. In foggy and rainy weather, when signals were obscured, considerable work was accomplished by running plane-table stadia lines, using celluloid instead of paper on the board. Monuments were left along the lines of these stadia surveys and later, in clear weather, they were located from plane-table stations.

When lack of time at any one station prevented the drawing in of the continuous contours, their place was taken by sketch contours, which were corrected in camp during bad weather or later in the office. The elevations were determined by dip angles based on mean sea level.

The season was particularly unfavorable for topographic work. Out of eighty-five days spent in the field there were only twenty-eight clear days, and of the remainder it rained all day for twenty-seven. The spring months and the month of July, were it not for the smoke, would be the most favorable for surveying in this part of Alaska. During the late summer and fall months the field work not only involves exposure to very severe weather, but is often entirely interrupted by the storms that rage at that time.

The work of the four parties that were in charge of the writer resulted in a triangulation covering 1,000 square miles, with 14 points located, and a topographic survey of about 3,500 square miles. Three of the parties assembled at Nome on October 7 and were received on board the *Patterson* on the same day. Captain Pratt then very kindly steamed up the coast to look for Mr. Reaburn's party and picked it up on the following morning. The vessel turned southward on the same day and, after a very stormy voyage, reached Seattle on the 29th of October.

The writer wishes to express his great indebtedness to Captain Pratt and the other officers of the *Patterson* for the valuable assistance rendered to the parties in many ways.

He is indebted to the Coast and Geodetic Survey, for use in the construction of the map, for the shore line of Golofnin Bay and thence to Quartz Creek, and the shore line and topography adjacent to Port Clarence, Grantley, and Imuruk, as well as the geodetic positions along the coast and at Port Clarence. He is also indebted to Major Van Arsdale, Lieutenant Jameson, and other officers at Fort Davis, who did all in their power to aid the work and to make the party comfortable while at the post.

In closing, the writer wishes to express his appreciation of the untiring industry and perseverance shown by all three chiefs of parties in the prosecution of their work, and of the zeal and willingness of the others to do whatever fell to their lot.

TABLE OF APPROXIMATE DISTANCES.

	Miles.
Nome to—	
Port Safety, via steamer route	20
Solomon, via steamer route	30
Bluff, via steamer route	50
Cheenik, via steamer route	90
Nome to—	
Teller, Port Clarence, via steamer route	110
York, via steamer route	100
Cape Prince of Wales, via steamer route	110
Nome to—	
Council, via California and Willow creeks and Koksuktapaga River	80
Council, via Solomon River and Bear Creek	80
Port Safety, via beach	20
Solomon, via beach	33
Bluff, via beach	54
Nome to—	
Mouth of Cripple River, via beach	12
Mouth of Sinuk River, via beach	26
Shay's roadhouse, via beach	48
Teller, via beach	83
Alder Creek	83
Nome to—	
Salmon Lake, via Nome River	36
Mouth of Golden Gate Creek and Kruzgamepa Valley	55
Imuruk Basin, via Nome River and Kruzgamepa River	85
Checkers, mouth of Kugruk, via Nome River and Kruzgamepa River	85
Cheenik to—	
White Mountain, via river	18
Mouth of Niukluk, via river	32
Council, via river	44
Mouth of Ophir Creek, via river	48
Mouth of Koksuktapaga River, via river	63
Mouth of American Creek, via river	66
Kruzgamepa, via Niukluk River	75
Teller to—	
York, via steamer route	40
Cape Prince of Wales, via steamer route	55
Goldbottom Creek	18
Mouth of Bluestone River, via Grantley Harbor	15
Upper end of Tisuk Channel	20
Head of Imuruk Basin	33
Mouth of Kruzgamepa	50
Mary's Igloo, Kuzitrin River, via steamer route	60
Checkers, via steamer route and Kuzitrin River	110
Nome to—	
Imuruk Basin, via Nome and Kruzgamepa rivers	85
Checkers, mouth of Kugruk, via Nome and Kruzgamepa rivers	90
Cheenik to—	
White Mountain, via river	18
Mouth of Niukluk, via river	32
Council, via river	44

APPENDIX.

DESCRIPTION OF BOUNDARIES OF RECORDING DISTRICTS IN CAPE NOME GOLD FIELDS.

In accordance with the United States mining regulations, the various gold districts of Seward Peninsula were organized at so-called "miners' meetings" by the miners who discovered them. The organizers defined the limits of the districts and also specified the shape and size of the claim. Thus in the York region the length of the claims was limited to 500 feet, while in all the other districts the full allowance of 1,320 feet was taken. As the mining districts multiplied, the boundaries were often found to conflict, and this has led to many disputes. For the purpose of eradicating this evil, the United States district court at Nome decided to form new recording districts, and, in accordance with the new civil code of Alaska, appointed a commissioner for each district. Unfortunately, when these new boundaries were established there were no accurate maps of the region available, and consequently some of the descriptions of the boundaries are self-contradictory. With the publication of accurate maps, no doubt this matter will be rectified. The following description is taken almost verbatim from the official documents of the United States district court. The geographic nomenclature and the spelling of the geographic names have, however, been changed to bring them in accordance with those that were adopted by the United States Board on Geographic Names. The writer has also added some footnotes calling attention to certain discrepancies in the descriptions of these boundaries:

BOUNDARIES OF CAPE NOME RECORDING DISTRICT.

Commissioner "Cape Nome recording district" to reside at Nome, Alaska:

Commencing at a point on the shore of the Bering Sea, thence running northwesterly following the westerly line of the watershed of the Cripple River, including all the waters flowing into Cripple River; thence in a northeasterly direction following the watershed between the rivers flowing into the Bering Sea, including Snake, Nome, Flambeau, Eldorado, Bonanza, Solomon, and Topkok rivers, to the shore of Bering Sea; thence following the meanderings of the northerly shore of Bering Sea to the point of beginning.

BOUNDARIES OF KUGRUK RECORDING DISTRICT.

Commissioner "Kugruk recording district," to reside at Mary's Igloo, Alaska:

Commencing at a point at the headwaters of the Sinuk River; thence in a northwesterly direction to a point between Kruzgamepa and Port Clarence rivers at the head of Imuruk Basin; thence northerly, following the watershed between the Agiapuk and Kugrupaga rivers; thence northerly, crossing the main range of mountains to the southerly watershed of the Arctic River and following the same to the southerly shore of the Arctic Ocean at Shishmaref Inlet; thence following the meanderings of the southerly shore of the Arctic Ocean to the point where the watershed of the Goodhope River and Kugruk River reaches Goodhope Bay; thence southerly, following the watershed of the Goodhope and Kugruk rivers[1] to a point on the watershed between the River Tubutulik and the waters emptying into Imuruk Basin; thence westerly to Mount Gleaves;[2] thence westerly and southerly on the watershed between Port Clarence and Fish rivers headwaters to the point of beginning.

Boundaries of Council Recording District.

Commissioner of "Council recording district" to reside at Council, Alaska:

Starting on the northerly shore of the Bering Sea at a point on the easterly line of the watershed of the Topkok River; running thence northerly, following the easterly watershed of said river to the watershed dividing Topkok and Klokerblok rivers; thence northerly in a direct line to White Mountain;[3] thence northeasterly, following the watershed between Kwiniuk, Queruk, and Tubutulik rivers and the right fork of Fish River to a point on the watershed between the waters emptying into Imuruk Basin and Tubutulik rivers; thence westerly, following the watershed between the right fork of the Fish River and the waters emptying into Imuruk Basin, to Mount Gleaves; thence westerly, following the watershed between the Kuzitrin and the Kruzgamepa rivers;[4] thence southerly, following the watershed between the Koksuktapaga and Klokterblok rivers and Bonanza, Solomon, and Topkok rivers to the point of beginning.

Boundaries of Port Clarence Recording District.

Commissioner of "Port Clarence recording district" to reside at Cape York, Alaska:

Starting from the shore of Bering Sea on the watershed of the Cripple River, on the westerly side thereof; thence northwesterly to the east line of the watershed of the Sinuk River; thence following the easterly and southerly line of the watershed of the Sinuk River to the headwaters of said river; thence in a northwesterly direction to the point between Kruzgamepa and Kuzitrin rivers at the head of Imuruk Basin; thence northerly, following the watershed between the Agiapuk and Kugrapaga rivers; thence northerly, crossing the main range of mountains to the southerly watershed of the Arctic River, and following the same to the southerly shore of the Arctic Ocean at Shishmaref Inlet; thence southerly, following the shore of the Arctic Ocean to the Bering Straits; thence easterly, following the shore of Bering Sea to the point of beginning.

Boundaries of Cheenik Recording District.

Commissioner "Cheenik recording district" to reside at Cheenik, Alaska.

Starting on the northerly shore of Bering Sea at a point on the easterly line of the watershed of the Topkok River; running thence northerly, following the easterly watershed of said river to the watershed dividing Topkok and Klokerblok;[5] thence northeasterly in a direct line to White Mountain; thence northeasterly, following

[1] Tributary to the Arctic.

[2] Position not identified on any map.

[3] White Mountain is nearly due east from the point mentioned.

[4] This statement of the boundary can not be reconciled with the topography and drainage.

[5] This is impossible.

the watershed between Kwiniuk, Oweruk, and Tubutulik rivers and the right fork of the Fish River to a point on the watershed between the waters emptying into Imuruk and Tubutulik rivers; thence northerly, following the watershed between the rivers emptying into Imuruk Basin, Goodhope River and Tubutulik, Mukluktulik, Kanguksuk or Left Fork of Koyuk rivers and Kugruk River to the southerly shore of Goodhope Bay; thence easterly, following the southerly shore of Goodhope Bay to the watershed dividing the waters of Buckland and Mungoark rivers; thence southerly, following the easterly watershed of the Buckland River to the easterly watershed, and following it up Inglaliktalik River to the easterly shore of Norton Bay; thence westerly, following the northerly shore of Norton Bay to Cape Darby; thence westerly across Golofnin Bay to Point Ferguson; thence westerly, following the northerly shore of Bering Sea to the point of beginning.

Boundaries of St. Michael Recording District.

Commissioner "St. Michael recording district," to reside at St. Michael, Alaska:

Commencing at a point on the easterly shore of Norton Bay on the southerly watershed of the Inglaliktalik River; thence northeasterly following said watershed to a point on the watershed between the Buckland and Koyukuk rivers; thence northeasterly following the watershed of the Selawik and Koyukuk rivers; thence following the watershed of the Koyukuk and Kowak rivers to the boundary line between the second and third divisions of the district of Alaska; thence southerly following the boundary line between said divisions to a point south of the Yukon River on the watershed dividing the Yukon and Kuskokwim rivers; thence southeasterly following the watershed of the Yukon and Kuskokwim rivers to the Bering Sea; thence northerly following the shore of the Bering Sea to the point of beginning and including the island of St. Michael and Stuart Island therein.

A RECONNAISSANCE IN THE NORTON BAY REGION, ALASKA, IN 1900

BY

WALTER CURRAN MENDENHALL

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U. S. GEOLOGICAL SURVEY

CAPE NOME AND NORTON BAY REPORTS PL. XVIII

JULIUS BIEN & CO. LITH. N.Y.

SEWARD PENINSULA, ALASKA

Scales

10 5 0 10 20 30 40 50 MILES

10 5 0 10 20 30 40 50 60 70 80 90 100 KILOMETERS

A RECONNAISSANCE IN THE NORTON BAY REGION, ALASKA, IN 1900.

By Walter Curran Mendenhall.

INTRODUCTION.

During the summer of 1900 the United States Geological Survey undertook to study geographically and geologically the southern half of Seward Peninsula, a demand for such work having been created by the active economic development of the region adjacent to Cape Nome in consequence of the discovery of gold there in 1898. For this purpose the country was divided into two general provinces, extending west and east from Golofnin Bay and Fish River (see Pl. XVIII). In the western area, which included the known gold region tributary to Nome, York, and Council, Mr. E. C. Barnard was placed in charge of the topographic party and Mr. Alfred H. Brooks in charge of the geologic party. For reconnaissance work in the eastern area, which was much less known geographically and economically, a single party was organized, with Mr. W. J. Peters, topographer, in charge, and to this party the writer was assigned as geologist. The party included, besides the two already mentioned, J. H. Knowles, field assistant, and T. M. Hunt, G. B. Pitcher, and W. H. Dewar, camp hands. We embarked with provisions and equipment for the summer's work upon the United States Coast and Geodetic Survey steamer *Pathfinder*, at Seattle, June 13, and were landed on the 28th in Golofnin Bay, after a delay of four days in Dutch Harbor and a few hours at Nome.

From Dutch Harbor, Thomas Hunt, who had contracted the measles, was sent back to San Francisco in order to save the crew of the *Pathfinder* from infection, if possible, and the party thus lost a valuable man. He was replaced in Golofnin Bay, but his substitute proved incompetent and was discharged a month later. Thenceforth the party consisted of five men.

Our original plan of operations involved a division of the party at Golofnin Bay and the sending of the greater part of the outfit, in charge of two or more men, to the mouth of the Koyuk, there to await the other members, who intended to take a light outfit up Fish River, portage thence to the head of the Tubutulik, and join the Koyuk division four or five weeks from the date of landing. The party being thus crippled by the loss of one man, and Captain Gilbert, of the *Pathfinder*, being loath to undertake the landing of an outfit in Norton Bay on account of the shallowness of the waters about its head, some modification of plans was necessary. It was then decided to hold the party together and explore the Fish, Tubutulik, and Koyuk rivers successively from their mouths, caching extra provisions and outfit along the shores of the bay before ascending the streams.

ITINERARY.

FISH RIVER.

On the 2d of July we left the Eskimo village and trading post of Cheenik for the mouth of Fish River, on the opposite side of the shallow estuary known as Golofnin Sound. After grounding several times on the extensive shoals which run offshore from the delta of the river, we entered the well-defined eastern channel soon after noon, and spent the night on the banks of one of the many sloughs whose intricate mazes make up the delta.

Next morning we joined Brooks's party in camp at the foot of White Mountain and remained there until the 6th, Mr. Peters being busy during the interim in determining time, latitude, azimuth, and instrumental constants as a basis for his topographic work along the rest of the river.

Meanwhile another case of measles had developed, further interfering with the movements of the party, for while the disease is not serious, it unfits its victim for active service for a few days and, in an expedition like ours, absorbs the activity of other members of the party in transporting and caring for the sick man.

On the morning of the 6th we resumed our journey up the river toward the mouth of the Niukluk. This lower portion of the river was the highway followed at that time by the greater part of the prospectors whose destination was Council and the district tributary thereto, so that we were constantly encountering busy and hopeful gold seekers working upstream with any kind of craft that would carry supplies or was capable of being propelled by tracking or sailing or the use of dog teams. At the mouth of the Niukluk, which we passed on the 8th of July, we separated from the greater part of this throng, and thereafter saw but few prospectors. Eight or 10 miles farther up we passed out of the sand and gravel flats through which the lower portion of the river flows and entered a range of rounded limestone mountains of considerably greater elevation than the isolated prominences of which White Mountain, at the head of the delta, is a type. The course of the river through these hills is much

A. VIEW UP FISH RIVER FROM NORTHERN SLOPE OF WHITE MOUNTAIN.

Shows village of White Mountain at head of ordinary steamboat navigation, the character of topography, and the distribution of timber.

B. ESKIMO SOD HOUSE AT CHEENIK.

less tortuous than in the tundra area below. Timber is more plentiful, and we began to find fish abundant enough to make a pleasant variation in our bill of fare.

On July 9, when half way through the mountain range, we stopped for two days to do some mapping and geologic work, and on the 12th entered the Upper Fish River Basin, a broad, nearly level, lake and pond-filled tract surrounded on every side by higher ground, which to the north and east develops into quite rugged mountains. Crossing this area was both tedious and monotonous. The stream was so winding that we often found ourselves within a couple of hundred yards of our starting point after an advance of 1½ or 2 miles.

Two large tributaries join Fish River from the west in this basin and at least one of considerable size with others somewhat smaller from the east, so that the volume of water constantly diminished and the shoals became more extensive and troublesome as we advanced.

At the mouth of Omalik Creek we halted for a day or two, and Dewar and the writer took a light canoe and worked up this stream about 10 or 11 miles to the point where the company operating at Omalik Mountain had landed wagons and outfit for development and test work nearly twenty years ago. A few wagons and carts were still to be seen along the creek banks, with now and then the skull and bones of a horse, to testify to the abandoned enterprise. From the landing a track, in some places still quite plain, led over the tundra to the buildings used as the headquarters of the company on Mosquito Creek.

After spending a day at the mine we returned to the mouth of Omalik Creek on July 17 and overtook Mr. Peters and the main party several miles up the river about noon on the 18th. A severe rain and wind storm raged that afternoon and the next day; and since we were out of timber, with only brush for fuel and shelter, we suffered some discomfort, but the higher water which followed the rain enabled us to advance about 5 miles more with two boats and three or four days' provisions. During the next two days we occupied several points in the adjacent mountains, and in the clear atmosphere, the fires having been extinguished by the rain, were able to work to excellent advantage. On the morning of the 23d we started to return. Three weeks in all had been devoted to work on Fish River. We had traced the main stream to its source, had located closely the heads of other branches, and had gathered much information about the geology and the physical features of its drainage basin.

The trip back occupied only four days and a half, so that by noon of the 27th of July we were in camp on the shores of Golofnin Sound again. Here we negotiated with Mr. Dexter, the trader, at Cheenik, to take the party with its outfit around Cape Darby in his steam launch to the mouth of the Tubutulik, the next stream which we had planned to ascend. On the morning of the 29th everything was loaded into the launch and at 2 the next morning was unloaded on a sand spit opposite the mouth of the Tubutulik.

From our camp here observations for position were taken by Mr. Peters and a cache made of all provisions except the three weeks' supplies which we expected to take with us up the river.

TUBUTULIK RIVER.

On the 1st of August we entered the mouth of the stream and camped that night 5 miles above near one of the winter cabins of Mr. Alexander, recorder of the Chukajak mining district. Here, again, rains interrupted our work, and though not so continuous as during the latter part of August and throughout September, they interfered more or less seriously from this time until the close of the season.

The first 17 or 18 miles of Tubutulik River, like the lower course of Fish River, is a tortuous channel through alluvial flats built out doubtless by the river itself from detrital material that it has brought down from its upper course. On the 4th of August we left these flats and entered a more restricted valley with the high hills of the Cape Darby granite area to the west and the softer forms of the limestone and schist on the east. This relatively narrow portion of the valley of the Tubutulik extends to a point beyond that which we reached with our canoes, as the greater relief and abundance of rock exposures in it made frequent stops for observations necessary. On the 7th of August we passed the mouth of Chukajak Creek and met here several prospectors, some of whom had been at work on this stream since the previous autumn. Many locations had been made on Chukajak Creek itself, which is staked from source to mouth, and on Vulcan Creek and its tributaries, which enter the main river from the west. Our camp of August 8, a short distance above the mouth of the Vulcan, was maintained for three or four days, during which Vulcan Point was occupied and the surrounding district studied with some care. Here, again, rains were frequent and severe. On the 12th we resumed our work upstream and on the 14th reached the lower end of a narrow canyon, through which the canoes could have been taken only with considerable difficulty. Above the canyon the stream valley broadens out again into a basin of smaller area but otherwise similar to that of Fish River and connected with the latter by the low pass used in winter in making the overland trip from Golofnin Bay to Kotzebue Sound. The limits of this basin could be readily seen from the mountains within reach of the camp below the canyon. Much time would have been consumed and but little knowledge added by extending the trip through it; so after spending three days in the country within reach of this camp we started downstream and on the evening of the 19th camped on the sandspit opposite the mouth of the river where we had cached our extra supplies. The cache had been disturbed during our absence and some provisions stolen, but enough of the essentials were left to enable us to complete the work planned.

From this point it was necessary to cruise along the shores of Norton Sound for 30 or 35 miles to the mouth of the Koyuk, which enters the bay at its extreme northwestern extremity. Fortunately we encountered no storms during this portion of the journey, else we should have been seriously delayed, but the extensive mud flats at the head of the bay and the intricacy of the channels through them were a source of embarrassment. We reached the Koyuk, however, on the 22d, and camped that night some distance above its mouth. Here the first station was established and approximate determinations for position were made.

KOYUK RIVER.

The ascent of this stream was begun on the 24th of August. Its lower course is a broad estuary affected for many miles by the tide and having but little current. By using sails we made excellent progress along the lower course, and at the end of the first two days were nearly 40 miles above the mouth. Beyond this the current became constantly stronger and the number of shoals increased as we advanced day by day, until on the 5th of September, at a distance of 113½ miles from the mouth, we passed the first notable series of rapids on the river. The trip to this point had been a continuous progress practically uninterrupted by delays and diversified by no noteworthy incidents. The river valley is a region of rather low relief, the adjacent hills being nowhere comparable to those of the Tubutulik or the head of Fish River, and the flat mud- and sand-filled basins being relatively restricted in area. We saw but two parties of prospectors, whom we passed on the 28th of September. They had already satisfied themselves of the uselessness of further work on the river and started out soon after we left them.

We passed the rapids on the 5th of September without difficulty, but the next day, 7½ miles farther on, we came to the foot of a succession of more serious restrictions in the channel. For a few hundred feet the gradient of the river bed was very high and the channel filled with big blocks. The river banks were rocky and made up of horizontally bedded lava flows, from which the bowlders that filled the channel had been broken. At times it was feared that it would be necessary to portage around these obstacles, but eventually the canoes were all worked through with no more serious accident than the thorough wetting of all members of the party.

The waters rose rapidly on the night of the 6th because of the heavy rains a day or two before, and progress upstream was made increasingly difficult by the swiftness of the current even where there were no rapids. On the morning of the 7th we lightened our load by caching some of the impedimenta, intending to gather them up again on our return trip. The articles were placed several feet above the stage of the water at the time, and it was then very high. It did not seem possible that they would be reached by floods. With our loads thus lightened we made better progress, and on the 9th of September camped just below the outlet of a canyon more conspicuous than any we had thus far seen. The volume of the river had much decreased within the last day or two, for we had passed the mouths of two or three large tributaries which came in from the south and several smaller ones from the north. It was entirely impracticable to take the canoes farther, and besides snow was falling on the hills all around us, and the necessity of returning to Cheenik in time to catch the *Pathfinder* on the 1st of October made it unwise to continue the advance much longer; so we established a camp here on September 9, intending to map the headwaters of the stream from this point. Rain and snow fell constantly, there being but one clear day from the 9th to the 14th of September. This we utilized to the best possible advantage, although as snow covered the ground geological observations were difficult. The rain and snow previous to the 13th of September and the melting of the snow by the bright sun on that day raised the already high waters still higher, and at midnight on the 13th we were forced to crawl out of our cozy sleeping bags and load everything hurriedly into the canoes, the water having invaded our tents. We tied the canoes to trees, and during the remainder of the night made such shift as we could. On the morning of the 14th the water subsided somewhat. We found dry ground, built fires, warmed, and dried partially, and started on the return trip downstream. The work through the rapids was often exciting, and water was frequently shipped and had to be baled out. When we reached the cache made on the 6th of September we found that the river had risen 7 or 8 feet above what we had regarded as high-water mark, and those of our supplies that had not been placed in slings and drawn high up into the trees were washed away or water soaked and buried under the mud. We took such provisions as remained and continued down the river, reaching the base camp 5 miles above the mouth on the 18th. A cruise of five days along the coast, during which we were favored with good weather, carried us safely around Cape Darby and into Cheenik, where we arrived on the evening of the 23d.

On the morning of the 26th the *Pathfinder* steamed into Golofnin Bay, and that night the party with its collections and outfit were taken on board. The return journey was interrupted only by short stops at Nome and Dutch Harbor, and on the 15th of October we were landed at San Francisco, after a pleasant voyage through the North Pacific.

EQUIPMENT AND METHODS OF WORK.

In the topographic work Mr. Peters reports that latitudes and azimuths were obtained with a Saegmuller 4-inch theodolite especially constructed for this work. Distances were obtained by micrometer attachment to alidade. With these distances as bases a plane-table triangulation was carried on in the valleys of Fish and Tubutulik rivers. The rivers were meandered by prismatic compass and distances obtained by the stenometer, an instrument constructed for the purpose in 1898. Latitudes were determined at seven places, and magnetic declinations at places indicated on the map.

As an immediately available base for geological observations a rough compass traverse was maintained by the geologist along the streams, which were the usual routes of travel, and a paced line checked roughly by intersections, when leaving the streams for short overland trips. This work was made sufficiently accurate only for the identification for all points afterwards when the more exact topographic base prepared by Mr. Peters became available. Upon this rough traverse dips and strikes were recorded and collections located as upon the previously prepared bases in areas already mapped.

For transportation we used a nest of Peterboro canoes three in number, 16, 16½, and 17 feet in length, respectively, and made of bass wood. These are heavier than the cedar canoes, but much tougher and better able to stand rough usage. As our work did not involve portaging, the slight additional weight was not a disadvantage. With these canoes we were able to ascend the streams farther than would have been possible with heavier boats of deeper draft, and they proved sufficiently seaworthy to enable us to make the open water voyage from the mouth of the Koyuk to Cheenik in September without inconvenience. The canoes were equipped with oars, paddles, and light sails, and were provided with covers.

Besides the usual staples—flour, sugar, bacon, dried fruits, etc.—our provisions for the summer included beef-tea capsules, several varieties of evaporated vegetables, chocolate, compressed tea, dried soups, and lime-juice capsules, all light in weight and not bulky, but adding pleasant and healthful variety to our bill of fare.

GEOGRAPHY.[1]

SHORE LINE.

Seward Peninsula (see Pl. XVIII) is an irregular land mass midway between the northern and southern extremities of the western shore of Alaska, and separated from the continent by the indentations of Kotzebue Sound on the north and Norton Sound on the south. West-

[1] For a historical sketch of the region the reader is referred to Mr. Brooks's report, page 19.

ward it terminates in the bold promontory of Cape Prince of Wales, the westernmost point of North America, and eastward it is united with the mainland by an isthmus so broad as scarcely to come within the meaning of the term.

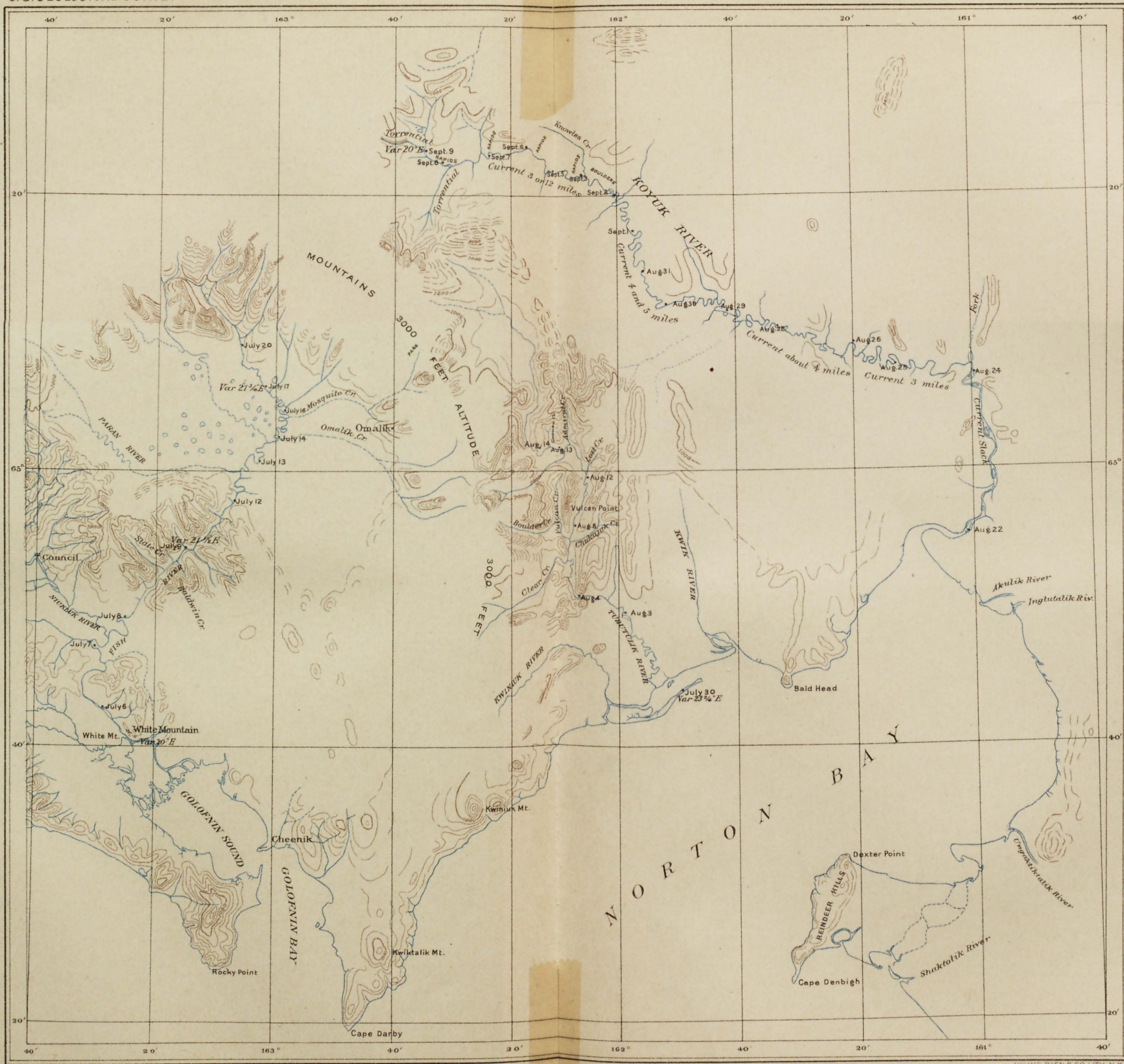
Other prominent headlands besides Cape Prince of Wales are Cape Espenberg, projecting into Kotzebue Sound upon the north, and Bald Head, Cape Darby, Rocky Point, Cape Nome, Cape Rodney, and Cape York, interrupting the regularity of the southern and southwestern shore. Golofnin Sound and Port Clarence are the best known indentations on the Bering Sea side, while Shishmaref Inlet, opening out into the Arctic, and Goodhope Bay, a broad lobe of Kotzebue Sound, are less known but very considerable interruptions to the regularity of the northern shore.

RELIEF.

The continuous east-west mountain range which has sometimes appeared on earlier maps of Seward Peninsula, usually under the name of the Rocky Mountains, seems to have no existence in fact. Indeed, it is probable that the north-central portion of the peninsula, while diversified and irregular in its topography, is generally a region of much milder relief than the southern half. North of the Upper Koyuk the hills generally are not more than 1,200 or 1,300 feet in height, although groups here and there rise to greater altitudes. Broad valleys traverse these hills in many directions and separate them into more or less isolated masses of different areas. Of the northern mountains probably the group south of Goodhope Bay is the highest.

The Cape Mountains at the western extremity of the peninsula and another large and higher group northeast of Cape York constitute, in the extreme western part of the peninsula, a mass of considerable elevation and indefinite limits.

South of Imuruk Basin the Kigluaik Mountains rise to 4,700 feet, an elevation without much question greater than is reached anywhere else in the peninsula. This group may be broadly considered as part of the range that extends northeastward around the Fish River drainage basin, thence southward to the coast at Cape Darby. Two well-marked depressions separate the range into three groups, the Kigluaik mass being the most conspicuous and the most completely isolated, the broad valley of the Kruzgamepa and the Upper Niukluk separating it clearly from the next mass east, of which Mounts Bendeleben and Chauik are the dominant peaks. At least one relatively high pass crosses this latter group from the head of the Fish to the upper course of the Kuzitrin, but without conspicuously interrupting the continuity of the chain. The depression connecting the head of a northeastern tributary of the Fish with the Tubutulik, however, is broader and separates the Bendeleben group from the more diverse and



RECONNAISSANCE MAP OF NORTON BAY REGION, ALASKA

Topography by W. J. Peters, E. C. Barnard and United States Coast and Geodetic Survey. 1900

Scale
2 0 2 4 6 8 10 12 14 16 18 20 MILES
Contour interval 200 feet
Datum is mean sea level

Dates refer to camps
Probable drainage, not surveyed

generally somewhat lower chain which passes southward with decreasing elevation to Cape Darby. There is probably more than one low pass across the southern end of this area.

In contrast to these mountainous tracts there exist in the peninsula well-defined flats many square miles in area. One of the most conspicuous of these is the Fish River Basin, which is drained by the upper course of Fish River and its tributaries. This basin is rudely oval in outline, 10 or 15 miles in its least diameter by 20 or more in its greatest, and inclosed on all sides by higher ground, through which at least two narrow gaps exist; one is the canyon of Fish River itself, the other, a low pass between the head of Ophir Creek and an upper tributary of the Parantulik. A similar smaller basin exists along the Upper Tubutulik, and others are to be found on the Koyuk, the Kuzitrin, and the Kruzgamepa. These latter, however, and the flats of the lower Kwik and Fish are not so completely inclosed as the Upper Fish River Basin.

DRAINAGE.

Imuruk Basin collects the waters of three considerable streams—the Agiapuk, the Kuzitrin, and the Kruzgamepa—which together drain the west-central part of the peninsula. Fish River has a drainage area of approximately 2,000 square miles, lying north of Golofnin Sound and within the curve of the mountain range which swings from Cape Darby north and west to the Kruzgamepa River. The Koyuk, entering the extreme northeastern end of Norton Bay, is the largest stream of the peninsula and drains the east-central part as the Imuruk Basin drainage does the west-central. Besides these three dominant systems a great number of small radial streams flow to the coast at various points about the borders of the peninsula. Of these the Kwik, Tubutulik, and Kwiniuk enter Norton Bay between Cape Darby and the Koyuk. Solomon, Bonanza, Eldorado, Nome, Snake, Cripple, and Sinuk enter Bering Sea betwen Golofnin Sound and Port Clarence. Most of them, though small, are known because of their placer gold deposits. The Anakovik drains into Bering Sea at York and the Goodhope, Kugruk, Kiwalik, and Buckland, the drainage basin of the latter lying for the most part east of the peninsula, enter Kotzebue Sound or one of its lobes.

FISH RIVER.

The various branches of this stream rise in the rocky northern rim of the great crescent-shaped lowland previously mentioned, whose center is a few miles north of the crossing of the parallel of 65° north and the meridian of 163° west. Several of these tributaries are of approximately equal size and discharge almost equal volumes of water, so that it is a matter of some doubt which should properly be called the source of the river.

Two of these large branches drain the northwest half of the basin and the hills, 3,000 feet or less in height, which limit it in this direction. Those portions of the streams which are confined to the mountains have high gradients and are torrential in character. Often these characteristics persist for some distance into the basin, but eventually disappear and the stream becomes comparatively sluggish with abundant shifting sand and gravel bars and intricate meanderings.

Before the river leaves the basin to enter the gorge which it has cut through the schist and limestone hills east of Council, the various tributaries are gathered into one river of considerable volume, all of them except the Parantulik, the westernmost fork, uniting near the north side of the flats. The latter stream flows east along the southern edge of the basin and joins the main river just before it enters the gorge.

After leaving the basin the river continues its southwest course for about 20 miles, air line, the first 10 of which lie within a restricted valley bounded on either side by hills which rise directly from the river banks. Here the course of the river is relatively direct, and in many places it is cutting in bed rock. After leaving these hills it enters a series of featureless flats and is soon joined by the Niukluk, and a few miles lower, after a series of loops, bends to the southeast and continues this course to the head of Golofnin Sound. At the head of the delta, which extends 5 or 6 miles from salt water, the river washes the foot of White Mountain, a limestone hill about 200 feet high, the southernmost of a group of low prominences which lie within the angle made by the stream as it bends from southwest to southeast.

Through the delta two principal channels run; the westernmost is the larger, and is usually followed by the river craft and small boats in ascending the river, but the eastern channel carries water enough for light craft at any stage. Between the two is a maze of sloughs, marshes, and ponds.

Table of distances on Fish River from Cheenik.

[Determined by W. J. Peters.]

	Miles.
Mouth of the river	10
White Mountain	18
Mouth of the Niukluk	31.8
Foot of hills and mouth of the gorge	38.8
Mouth of Slate Creek	42.3
Mouth of Omalik Creek	63.5
Head of loaded-canoe navigation and camp of July 17	76.5

TUBUTULIK RIVER.

Tubutulik River flows for the greater part of its course through the hilly region which separates the Koyuk and Fish river valleys. It rises in a group of granite mountains south of the source of the Koyuk, flows out into a small basin quite like that of Fish River, though much smaller in area, and enters the hills again at about latitude 65° 10′. From this point it continues, with many loops and bends and variations in the width of its valley, until it passes into its delta plain 10 or 12 miles above its mouth.

Its largest tributary, Clear Creek, flows in from the southwest about 30 miles from salt water. Other smaller branches are Vulcan, Chukajak, Admiral, Grouse, and Lost creeks. The first two of these are the only streams belonging to the Tubutulik drainage system, whose valleys had been extensively staked up to midsummer, 1900.

The lower course of the river lies in a fluvial plain consisting partly of fresh-water and partly of salt-water marshes, built up by the detrital material carried by the river itself and deposited beyond its mouth in the form of mud, sand, and gravel. The river discharges into a lagoon back of a long island sand spit. This lagoon also receives at its western end the waters of Kwiniuk River.

Table of distances up Tubutulik River from east end of sandspit opposite its mouth.

[Determined by W. J. Peters.]

	Miles.
Mouth of the river	3.25
Alexander's cabin	9.75
Red Bluff mine stakes	24
Mouth of Clear Creek	31.25
Mouth of Chukajak Creek	33
Mouth of Vulcan Creek	33⅓
Mouth of Admiral Creek	45.25
Camp of August 14 at foot of gorge and end of traverse	51

KWINIUK RIVER.

This stream has not been completely mapped, but it is known to rise in the high hills 15 or 20 miles north of Cape Darby, and to flow northeast parallel to the coast and but 6 or 8 miles distant from it until it leaves the hills and turns southeast in the marshes through which the Lower Tubutulik flows.

Its lower valley at least is a broad and conspicuous topographic feature, and through this valley lies the winter route followed by natives and traders in passing from Cheenik to the Tubutulik or Kwik river valleys.

KWIK RIVER.

A wide, flat valley opening out into Norton Bay between the mouth of the Tubutulik and Bald Head and connecting northward with the middle course of the Koyuk by a low pass, is occupied by the Kwik River, a sluggish and most tortuous stream, whose complicated meanderings, together with lakes and ponds representing abandoned channels, fill almost all of this broad valley.

Between the Kwik and Koyuk no large streams flow into Norton Bay, which gradually contracts beyond Bald Head into the broad estuary of the Koyuk.

This northeastern end of the bay is a region of very shallow water and extensive mud flats, bare at low tide or covered by but a few inches of water and traversed by intricate channels difficult to follow. Our light-draft Peterboros were frequently aground on these flats, and boats of greater draft have even more difficulty in finding channels with sufficient depth of water to float them. After once getting fairly into the mouth of the Koyuk, however, there is an abundance of water for a considerable distance, tides being felt throughout the lower 20 or 25 miles of the stream's course.

KOYUK RIVER.

The main branch of the Koyuk, heretofore called the West Fork, rises in a general divide north of the Bendeleben group of mountains, from which other streams flow west to Port Clarence and north to Goodhope Bay.

Its upper course, for perhaps 40 miles, is swift and is interrupted at varying intervals by rapids. Through the lower three of these light boats may be dragged, but it is not practicable to attempt to take craft of any sort more than 133 or 134 miles from the mouth.

The lower course of the river is sluggish, tides affecting it for probably 25 miles above its mouth. From the head of tide water the current gradually becomes stronger until at 113½ miles above the mouth the first rapid is encountered. Below this the channel for the greater part of the distance to the mouth of the East Fork is extremely crooked; from here to the head of the bay it is relatively direct.

The valley of the Koyuk is open and devoid of features of marked relief. Along its lower course hills 200 or 300 feet high rise immediately from the river. Along the middle third of the stream flats occur, resembling those of Fish River in miniature, and back of these are very irregular hills, usually low, but rising in a few instances to near 2,000 feet.

Near the head of the stream the swampy flats are absent, but the valley is open, a mile or more in width, and is flanked on the south by the mountains in which Fish and Tubutulik rivers rise. To the north the hills are lower and more regular and their outlines smoother.

Table of distances from Cheenik to the mouth of Koyuk River.

[Determined by W. J. Peters.]

	Miles.
To Cape Darby	17
To east end of the spit opposite mouth of Tubutulik River	60
To mouth of Kwik River	64
To Bald Head	67
To mouth of Koyuk River	87

Distances on Koyuk River from its mouth.

	Miles.
First house on right bank	1
Astronomical station marked by pole and flag	5
First forks	23.5
First riffle (barely perceptible)	39¼
Short stretch of swift water	49
Second forks	53
Indian cabin and fish dam with swift water	108
Mouth of Knowles Creek	112⅓
First rapids	113½
Second rapids	121½
Third rapids	125¼
End of traverse, an island at the mouth of a small stream	132½
Box canyon	136

GENERAL GEOLOGY.

METAMORPHIC SERIES.

GENERAL STATEMENT.

This is the oldest, most extensive, and most complex rock series in the Norton Bay region, comprising massive and thin-bedded limestones and marbles, micaceous, chloritic, feldspathic, and graphitic schists, schistose igneous rocks of uncertain relations, and occasional black and buff slates. It shows throughout evidence of metamorphism of varying amount.

This metamorphism, whose latest phase, at least, probably dates from the intrusive granitic masses, whose outcrops coincide roughly with the higher areas, is the common characteristic which, to a greater or less degree, affects the entire series, gives a basis for uniting under one head such diverse rocks, and distinguishes them from later masses of perhaps similar composition.

If the region is ever mapped in detail subdivisions will no doubt be made and age and structural relations within the series may be determined, but on the basis of our present knowledge it is deemed inadvisable to attempt to map separately rock masses whose relations are intricate, whose limits are imperfectly known, and whose correlation would depend solely upon lithologic resemblances.

The very slight mechanical deformation which many of these rocks seem to have suffered in spite of their general recrystallization, as evidenced by the nearly horizontal attitude in some localities and the absence of crinkling or minor flexures, even in the neighborhood of dikes, seems to show that the rocks were at a great depth at the time the schistosity was produced. These features also probably indicate the immediate proximity of some great magma, whose action was quiet and unaccompanied by serious physical disturbances.

DISTRIBUTION.

Golofnin Bay.—The western shore of Golofnin Bay and the low bluffs along the eastern shore of Golofnin Sound, from Cheenik northward, are made up of schistose rocks, generally garnetiferous, feldspathic, or calcareous, and usually almost horizontal in attitude. The bedding and schistosity generally coincide, and in an outcrop along the shore northeast of Cheenik coarser and finer grained beds with variations in color corresponding to the variations in texture probably represent original differences in the sediments.

Along the beach 2 or 3 miles north of Cheenik a greenstone phase of the schist becomes prominent. It is now chiefly chlorite, zoisite, and fresh feldspar, and its genesis is obscure. It may be a basic igneous sheet or pyroclastic.

Fish River.—Three miles below White Mountain micaceous and calcareous schists outcrop along the banks of the eastern channel of Fish River, but White Mountain itself and the greater part of the isolated mass near whose southern limit it lies are composed of a comparatively massive limestone, varying from gray to white in color and so uniform in texture and so fractured that its attitude is frequently indeterminable. These beds are somewhat crystalline and full of calcite veins, which have filled the cracks produced by the crushing forces to which the whole mass has been subjected.

Five or 6 miles above White Mountain, on the west bank of the river, the schists appear again in a low ridge which trends northwest, while 3 miles farther, in a bend of the river to the east, the foot of the White Mountain mass is again swept by the stream, which reveals massive limestone associated with more schistose and graphitic beds. This is the last outcrop to be observed along the river until the mouth of Niukluk is passed, the flats of sand and gravel left behind, and the gorge which exists through the hills south of the Fish River Basin is entered.

These hills are everywhere composed of calcareous rocks. In some places the rocks are rather massive limestone, in other outcrops they are merely very calcareous schists. Here, as in most occurrences in this series, where bedding can be determined at all, the bedding coincides with the schistosity, only occasional divergences being noted. The veins that affect the system are of quartz and calcite throughout this gorge, sometimes one of the gangue minerals occurring alone, sometimes both in association in the same vein.

About the head of Fish River the mountains are chiefly granitic, but along their flanks and sometimes extending through them in belts of varying breadth, which mark the passes, are areas of schistose sediments.

About 1 mile above the camp of July 20, along the creek bed, is an outcrop of rusty and very graphitic schist associated with more cal-

GENERALIZED SECTIONS ON THE LINES A–B AND C–D VERTICAL SCALE EXAGGERATED TWICE THE HORIZONTAL

GEOLOGICAL RECONNAISSANCE MAP AND SECTIONS OF NORTON BAY REGION, ALASKA

BY W. C. MENDENHALL

Topography by W. J. Peters, E. C. Barnard and United States Coast and Geodetic Survey, 1900

Scale
2 0 2 4 6 8 10 12 14 16 18 20 MILES
Contour interval 200 feet
Datum is mean sea level

Dates refer to camps
Probable drainage, not surveyed

LEGEND

PLEISTOCENE — Unconsolidated muds, sands, and gravels

PLIOCENE OR PLEISTOCENE — Basalts

TERTIARY (?) — Unaltered sediments. Consolidated and folded shales, sandstones, grits, and calcareous beds, sometimes coal bearing

LATE MESOZOIC (?) — Massive intrusives, usually granites

MESOZOIC AND OLDER — Metamorphic series including a great variety of rocks chiefly schistose sediments, in places gold bearing careous phases. Five miles farther along the right bank of this same branch of Fish River is an outcrop of buff slates with very little calcareous matter, while 2 miles farther northwest, in a gap between two branches of Fish River, the series is represented by a white, coarsely crystalline marble. This narrow belt of the crystalline series, between two great intrusive granitic masses, expands to the northwest and forms a series of hills somewhat lower than the more resistant masses on either side, separating the Fish River drainage basin from a low area to the north, which is probably a part of the Kuzitrin Valley. East and west from the camp of July 20 these sediments appear as remnants on the flanks of many of the spurs running from the high mountains out toward the Fish River Basin. Whether or not these outcrops form a continuous belt westward from the camp of July 20 could not be determined during the hasty reconnaissance, but eastward they seem to extend uninterruptedly to the broad belt which runs northeastward toward the basin of Tubutulik River.

At the Omalik mine a prominent, crescent-shaped outcrop of clear, white marble, visible for a distance of many miles across the flats of the Fish River Basin, forms a prominent landmark, and is a good geological signboard to guide seekers to the mine itself. Omalik Mountain, just back of the mine, is probably a mass of much-altered igneous rock of dioritic nature; numerous dikes of the same character cut the marbles and calcareous schists in the neighborhood of the mine. All, however, sediments and intrusives alike, are highly altered.

East of the Omalik mine the white hills that mark the limestone areas extend for many miles across the intervening higher region toward the middle course of Tubutulik River.

Tubutulik River.—The lower course of Tubutulik River above the alluvial flats near its mouth lies for the greater part in limestones and calcareous schist and schistose greenstones, comparable in most respects with the rocks already described from Fish River Valley and showing almost as great variety in origin and lithologic character.

Halfway between the camps of August 3 and 4, near the point where the river flows out from the hills into the flats, some very carbonaceous schists, nearly horizontal, outcrop at the foot of a gravel bluff. In the immediate neighborhood of the camp of August 4 the schists are green, are composed chiefly of chlorite with occasional kernels of augite, and seem to be much changed basic igneous rocks. West and northwest from this bend limestone predominates until the granite boundary is reached, while east and north across the lower course of Chukajak Creek the greenstones continue.

Vulcan Point (Pl. XXII, *A*), an acute prominence between Vulcan Creek and the river, is a conspicuous mass of thin-bedded limestone, which continues north from this point, crossing the river and making up the greater part of the group of hills which separate the Upper

Tubutulik from the Koyuk Valley. Near the western part of this area, but on the east side of the Tubutulik and covering the boundary between the granite and schist, is a small patch of compact basalt. East of the boundary, but near it, an apophysis of granite has indurated the dark slates into a compact hornfels containing microscopic quartz veins.

Just west of the granite tongue at camp of August 14, the schistose limestones again appear and continue westward to the neighborhood of Omalik Mountain, or beyond, and southwestward as far as can be seen from the peaks in the neighborhood. Northward about 12 miles, a low gap between the Tubutulik and Koyuk basins, just east of the pass leading to Fish River, is apparently cut in them.

North shore of Norton Bay.—About 15 miles northeast of Cape Darby the eastern limit of the granitic body which makes up the mass of the cape is passed, and the bluffs along the shore, eastward to the head of the bay, prove, wherever examined, to be composed of some one of the various phases of the schistose series.

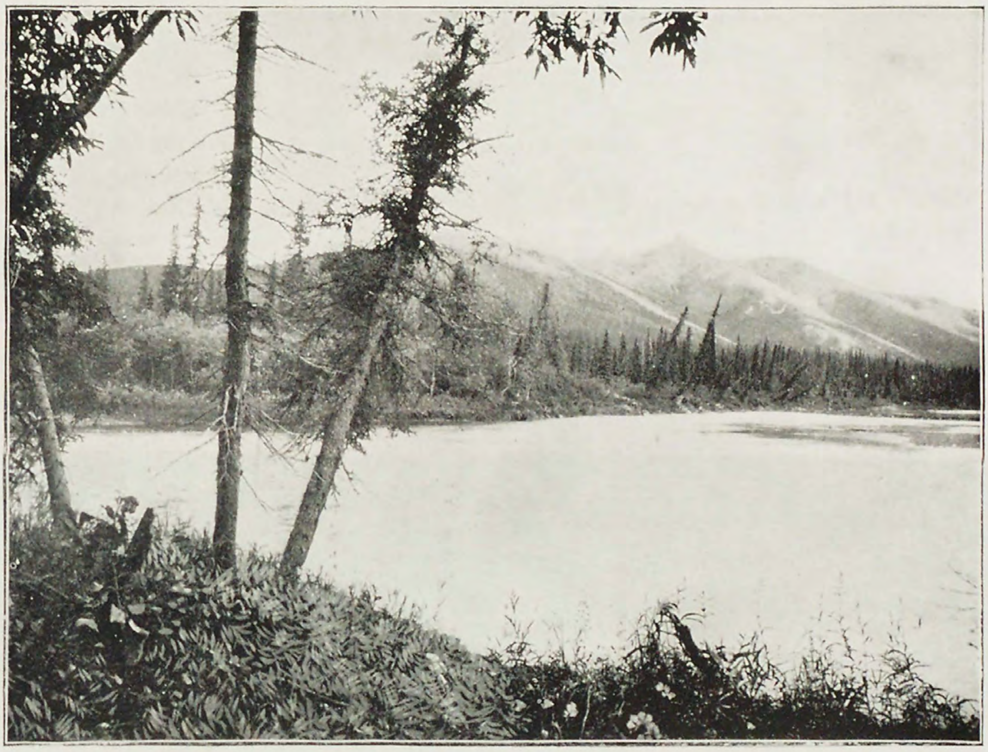
At Kuiuktalik, near the base of Kwiniuk Mountain, the calcareous schists are nearly vertical, and a divergence between the bedding and schistosity, sometimes reaching almost 90°, is noted. Just east of this point white coarsely crystalline marble outcrops along the beach. The schistose phase of the rocks prevails, however, eastward to the extensive flats that mark the outlets of Kwiniuk, Tubutulik, and Kwik rivers.

Along the west side of Bald Head gray and white marbles occur infolded with thin-bedded limestones and schists, and blocks of these rocks cover the beach. The point of the promontory is a mass of heavy black graphitic beds, and the eastern face exhibits a slaty and schistose phase, the rocks being generally dark. Dips and strikes are variable and the relations are obscure but evidently complex. Eastward to the head of the bay the bluffs, which gradually recede from the shore as the mud flats off the Koyuk are approached, are of brown, gray, and black schists and phyllites in various attitudes.

Koyuk River.—On Koyuk River comparatively small areas of the rocks exposed belong to the schists. They are first seen when ascending the stream, in an exposure crossed about 6 miles above the mouth of the East Fork. The sharp ridge north of this outcrop is made up of calcareous beds.

Another belt a few miles in width appears above the camp of August 26. Within this belt a tributary carrying a considerable volume of water, and evidently draining a large area to the north, enters the main stream, but only a very inconsiderable proportion of the pebbles carried by it are of schist, the greater part being basalt, with which are mingled a few granitic fragments.

In the neighborhood of the camps of September 2 and 5 the river



A. VIEW ALONG THE MIDDLE TUBUTULIK, VULCAN POINT IN THE BACKGROUND.

Shows type of topography derived from schistose limestone

B. VIEW FROM CAMP OF SEPTEMBER 9, AT HEAD OF CANOE NAVIGATION ON KOYUK RIVER.

Mountains in background are 8 or 9 miles distant and 3,000 feet high.

again cuts into the schists at several points, although generally along this upper course the basalts form the immediate stream banks. The higher country for 15 to 20 miles north of the river from the camp of September 9 is made up of schistose limestone, and the same rocks probably extend for as many miles east and west from this line. In the Upper Koyuk Valley the same diversity that characterized the series at other localities was not observed.

STRUCTURE.

The haphazard observations which result from following waterways and confining the measurement of dips and strikes practically to outcrops that occur along them do not give the best data for determining structure, even in regions where it is comparatively simple.

The flexures which affect the schists are probably very complex in places. So long as definite horizons within the series are not recognized, it can only be conjectured whether the flexures include faulting; but the minor flexures in certain districts are abundant and involved, and dips and strikes correspondingly variable. This condition is well illustrated about Bald Head. In other parts of the region the schists lie flat and apparently but little disturbed. This is true in the neighborhood of Golofnin Sound, where dips are often 20° or less, and throughout the Fish River gorge, where, although there are many variations, the dips are prevailingly eastward and less than 35°.

Steeper dips are general along the Tubutulik and Upper Koyuk, and a large proportion of them are toward the west. Usually along the immediate borders of the intrusive granitic bodies the schists dip away from the intrusives, a condition probably dependent upon and not preceding the intrusions. Such structural relations as were suggested by the summer's study appear, much generalized, in the sections accompanying the geologic map (Pl. XXI).

AGE OF THE SCHISTS.

No very definite statement can be made concerning the age of these beds. Owing to their heterogeneous character and to the fact that members with such varied lithologic features are grouped as one formation on the basis of the common characteristic of metamorphism, rocks of any age previous to the period of metamorphism may be represented in this series.

The alteration has generally destroyed such organic remains as may have existed in the rocks. A few vague forms of very doubtful value were collected at the base of White Mountain and submitted to Mr. T. W. Stanton, who makes the following statement concerning them:

The collection includes fragments and imperfect specimens of 3 or 4 individuals of a large compressed, thick-shelled bivalve mollusk, with smooth or nearly smooth surfaces, and of a form that is met with in the Unionidæ, the Cardiniidæ, and more rarely in the Trigoniidæ, though it can not be said positively that the species belongs to either of these three families. While the species can not be named nor definitely classified from the material at hand, its general characteristics are such as are not to be expected in Paleozoic shells and the formation that yielded it is probably of either Mesozoic or Tertiary age.

A series of unaltered rocks to be described later are believed to be of Tertiary age; hence the schists are presumably not later than Mesozoic, and probably include members of greater age.

GRANITIC ROCKS.

DISTRIBUTION.

Cape Darby and a broad belt of country extending 55 miles northward from it with a maximum width of about 12 miles is occupied by a great intrusive body of granite and granitoid rock which exhibits considerable variation in texture and mineralogical composition, but is regarded as belonging to one geological body.

A few miles below Cheenik, along the east shore of Golofnin Bay, the rock is a diorite-porphyry with large tabular phenocrysts of andesine or andesine-oligoclase, some colorless pyroxene and abundant hornblende, in part, at least, secondary. Quartz is present, but often in very inconsiderable amounts, and titanite is a conspicuous accessory. This phase or a slightly more acid one is rather largely represented in this portion of the mass, extending at least 5 or 6 miles east from its western border.

Near the eastern edge of the northern part of the area, in the Tubutulik Valley, the rock appears as a coarsely crystalline aggregate of pale brownish orthoclase and smoky quartz with a little biotite. A gneissoid phase of the same rock appears along the western side of its northern limit.

Northwest of the Darby mass, but separated from it by a broad belt of schistose rocks and alluvium, is another big granitic area lying south of the Upper Koyuk Valley. Only the borders of this mass were touched at one or two points, but here it does not exhibit the dioritic phase which marked the Darby mass, but appears as a simple biotite-granite. It is separated from a similar area west of the head of Fish River by a belt of limestone and associated rocks already described.

OCCURRENCE.

Wherever evidence was collected bearing upon the relations of these plutonic rocks to the schistose series, with which they are usually found in contact, it points to the intrusive nature of the granitic masses.

In the first place the sediments are always metamorphosed, more or less extensively, while the granites, although occasionally exhibiting gneissoid phases near their borders, are usually coarsely granular or porphyritic, without a trace of the mechanical deformation which is so conspicuous a feature in the schists. Again, near the contact, dikes from the granitic masses are found cutting the schists, often so intricately that it is a matter of difficulty to tell where the boundary between the two should be drawn, and dikes and bosses of the intrusive rock are sometimes encountered at considerable distances from the main areas.

Along the beach below Cheenik two small areas of limestone 400 or 500 feet broad have been caught up in the intruding magma and now appear as isolated bodies intensely foliated and marmorized, and cut in all directions by tongues and dikes of the diorite and by later and more basic dikes which have intruded both masses.

Distinct contact phenomena in the schists and slates, while sometimes present, are not so abundant as one would expect. The inference is that the intrusion was slow and deep-seated and affected the intruded rock generally rather than locally. This inference finds support in the coarse texture and porphyritic character of the diorite, even at its borders.

AGE.

The period of intrusion, is of course, later than the rocks affected and seems older than the Tertiary sediments, to be described below. It may be assigned tentatively to the late Mesozoic.

UNALTERED SEDIMENTS.

Eleven or 12 miles above the mouth of the Tubutulik some bluish and shaly sandstones and fine quartz conglomerates entirely unaltered, but dipping NE. 50° or 60°, outcrop along the river bank. Two or three miles above this exposure is another of soft, brown sandstone and fine conglomerate with blue clay shales. The beds are very soft and do not resist weathering and erosive agencies, so that the exposures are poor, but sufficient to determine the presence of a small area of sediments more recent than the schistose rocks and deposited apparently in a basin in them.

On Koyuk River, about 26 miles above its mouth, a similar series is exposed, but is here much better shown. Shales, coarse loose sandstones, fine quartz conglomerates, and impure limestones alternate in thin strata that strike N. 15° W. and dip S. 70° W.

Fragments of coal are found with the sandstone débris in the Tubutulik exposure and imperfect casts of plant stems appear in the same beds. No organic remains of any kind were observed in the Koyuk River exposure.

These beds are evidently more recent than the schists upon which they lie, yet are well indurated and folded, and the coal they carry is bright, hard, and apparently of good quality. No direct evidence of their age is available, but on the basis of these general considerations and of their resemblance to similar sediments in other parts of the Territory they are assigned to the Tertiary.

BASALTS.

At one point near the Upper Tubutulik, as already mentioned, a patch of basalt, probably not more than 2 miles across in any direction, lies over the contact between the granites and schists and extends down toward the river at the point where it leaves its upper basin to enter the hills, but it is on the Koyuk that these rocks have their greatest development.

Along the lower course of this stream they make the low rounded hills on either side of the valley, and are the only hard rocks outcropping along it until the small area of Tertiary sediments above the mouth of the East Fork is reached. Beyond these and beyond the schists which immediately succeed them upstream and below the flat through which the river flows, about midway in its course, is another small effusive area.

Beyond these flats, the bed of the stream, as far as our explorations went, lies in these volcanics except for a few miles in the vicinity of the camp of September 5, where the river flows alternately in schist and basalt, and an excellent opportunity to study the relations of these two rocks is afforded.

The lava is a green, gray, or black rock, the color depending in part upon its freshness. It is compact or vesicular, and usually porphyritic, olivine being the most conspicuous of the phenocrysts, although plagioclase is recognizable megascopically in some instances. Sometimes the vesicles are filled with opal; more frequently they are without filling.

The rock varies in texture, having sometimes a very glassy groundmass, and in other cases showing a coarse, well-defined interstitial arrangement with almost no glass.

The basalt beds have not been disturbed since they were poured out. They are horizontal wherever their attitude is determinable and overlie all the other rocks with which they are found in contact, and where actual contacts can not be seen the general relations and attitudes leave no doubt as to which is the most recent.

The topographic forms to which they give rise are usually not sufficiently pronounced to distinguish the basalts at any great distance from the Tertiary sediments or in some cases from the schists.

AGE.

Just above the camp of September 5 a section in the river bank exposes clearly the relations between the schists and the basalts. Over the truncated edges of the former lie about 5 feet of waterworn gravels made up of pebbles of schist, vein quartz, and granite. These gravels, superficially at least, are slightly cemented with iron oxide, and over them lies the horizontal undisturbed sheet of basalt. The pebbles afford direct proof that the basalt is younger than the granite as well as the schist, and the relatively unindurated condition of the underlying gravels as compared with the Tertiary sediments, described above, supports the evidence of relative attitude for the greater youth of the basalt.

The rapids of the Koyuk are in each instance due to obstructions to the stream caused by the basalts. Usually the stream has cut only from 20 to 40 feet in these, but the blocks falling from the walls of the shallow canyon obstruct the channel and give locally very high gradients to the stream bed. This slight cutting represents but a very short time interval, geologically speaking, yet it began presumably with the outflow and cooling of the lava, which, from its general distribution, seems to have followed previously existing lowlands cut in the schists, granite, and Tertiary sediments. The trend of this evidence is toward the conclusion that the basalt is Pleistocene or late Pliocene.

GRAVELS AND SANDS.

Within the Norton Bay region these superficial deposits are rather extensive and widely distributed. They are fluvial, littoral, or both, and in many instances their areas are being extended by constant additions.

Between Golofnin Sound and Golofnin Bay the spit on which Cheenik is built and the one across the strait south from the village are examples of recent beach deposits still growing.

At the head of the sound the delta deposits of Fish River, merging with the sands and gravels of the broad lower valley, extend up Fish and Niukluk rivers to the gorges along the middle courses of the streams. The White Mountain group forms a bed-rock island rising from these flats. Fish River Basin above the gorge, already described among the topographic features as the gathering point for the upper tributaries of the river, is filled with similar deposits, coarse near the borders and finer near the center of the basin. The depth of this filling is purely conjectural, but presumably is not great. No islands of bed rock exist within it as far as known, but sand and gravel prominences, rising in some instances 30 or 40 feet above the general level, are abundant over it, and are interpreted as remnants of a slightly higher level generally destroyed by the meanderings of the stream.

Along the coast east from Point Darby only meager beaches between rocky promontories exist until the big flat west of Bald Head through which the Kwiniuk, Tubutulik, and Kwik rivers discharge into the bay is reached. These combined deltas have a frontage along the bay of approximately 18 miles, and extend inland almost as far. The lower courses of the Kwiniuk and Tubutulik, and practically the whole course of the Kwik, lie within this plain.

Near the head of the Tubutulik is a gravel-filled and lake-covered basin similar to that on Fish River, but smaller. The head of Norton Bay, like the head of Golofnin Sound, merges into an expanse of tundra, the Akulik, Koyuk, and Inglutalik having aided in its formation. The immediate mouth of the Koyuk is estuarine rather than deltoid, and the alluvial deposits about its lower course are not so extensive as those along Tubutulik and Fish rivers. Like both the other rivers described, the Koyuk has one or two small basins, expansions of its rather restricted valley near the middle of its course. These basins are floored with sand, gravel, and clay.

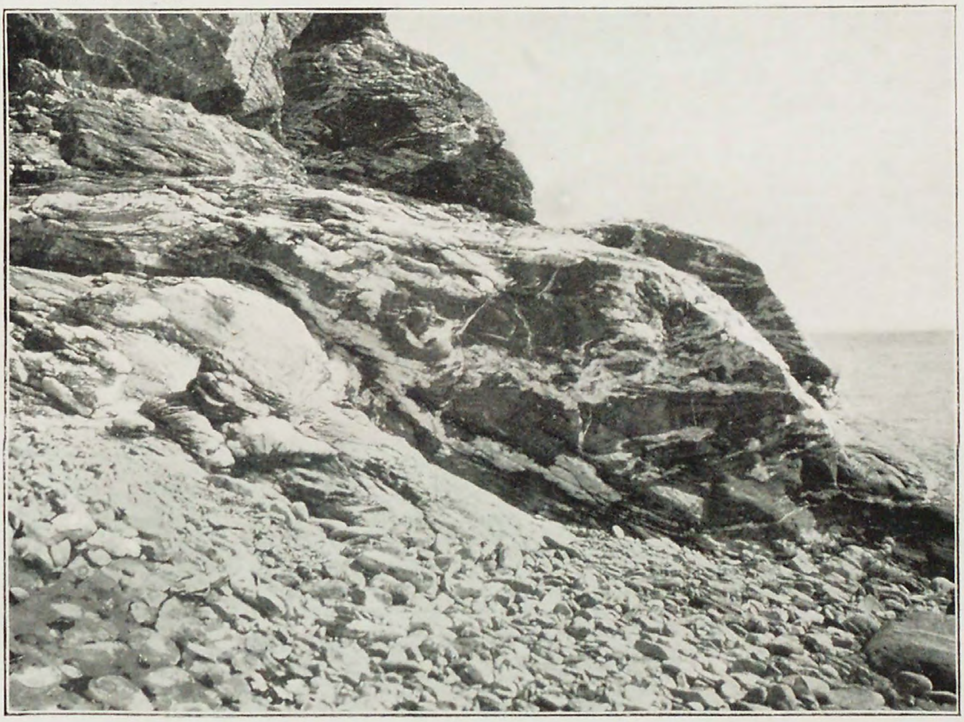
GLACIATION.

The district has suffered no general glaciation, as is proved by the existence, over much of the area in which bed-rock outcrops are encountered, of balanced bowlders of disintegration and needles projecting through the usual covering of rock detritus and moss (Pl. XXIII, *B*). The absence everywhere of those features which always accompany glacial action, like moutonnée forms, glacial grooves, moraines, U-shaped valleys, till, and bowlder clay, constitutes further proof that a general ice sheet has not at any recent time eovered the region.

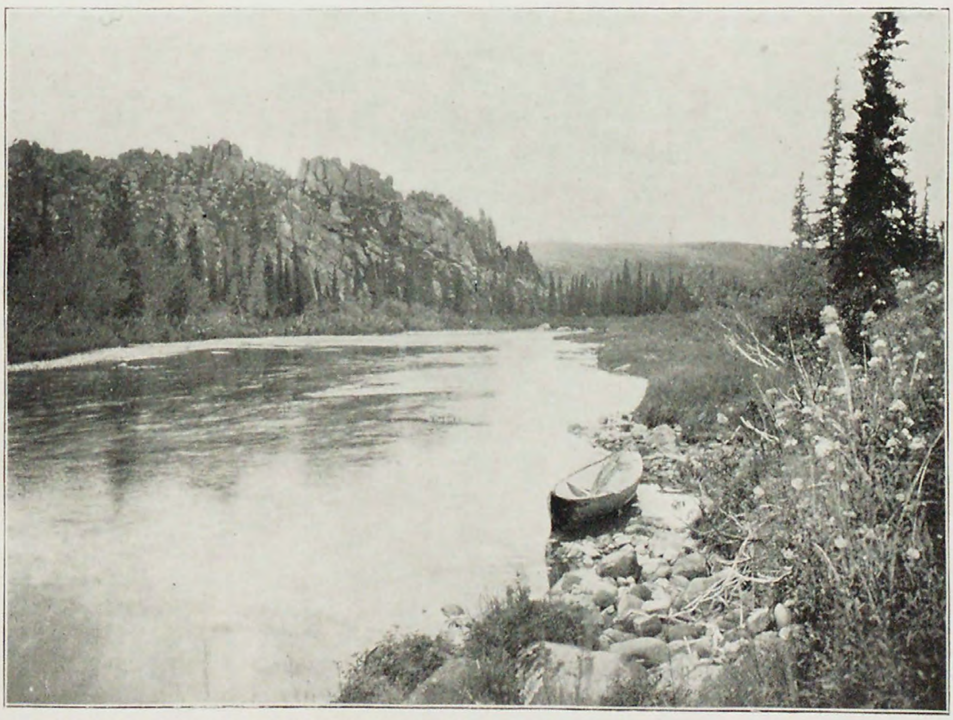
Many of the higher areas have not been examined in detail, and it is possible that small local glaciers may have existed in the heads of some of the valleys, but no evidence of their existence was gathered during the summer, and views into the mountains from levels but little below their highest points revealed no forms suggestive of ice work. The very local character of the most active glaciation in the Kigluaik Mountains (see Brooks's report, p. 43), which reach elevations 1,500 feet higher than the hills farther east, to which the writer's studies were confined and which are probably on this account favored with a much more abundant precipitation, supports the view that glaciers would not form at all under the less favorable conditions that prevailed within the district under consideration.

COASTAL DEVELOPMENT.

Norton Bay itself appears to be in its upper part an extensive erosional feature transformed into a bay by an invasion of the sea accompanying relative depression of the land mass. Since this depression, the original outlines of the land have been much modified by the combined action of waves and rivers, the former cutting back headlands and distributing material along shore, and the latter building deltas



A. VIEW ILLUSTRATING IRREGULARITY OF CALCITE VEINING IN SCHISTS, EAST SIDE OF BALD HEAD.



B. GRANITE SPIRES ON UPPER TUBUTULIK RIVER, PROVING ABSENCE OF GENERAL GLACIATION.

which fill out the lower drowned portions of their valleys, and supplying material which, together with that derived by wave action from the headlands, builds beaches along the reentrants of the shore line.

Cape Darby, separating Golofnin Bay from Norton Bay, is the most conspicuous promontory of the region, and consisting, as it does, of resistant rock, has not receded notably under the influence of wave attack to which its situation makes it most liable. Bald Head, though less exposed, is also less resistant, and has probably suffered as much as Cape Darby. Cape Denbigh and Dexter Point, on the southeast side of the bay, are the points of a resistant island which has been attacked on the seaward side and tied to the land by a broad wave- and current-built bar on the shore side. The combined lower valleys of the Kwiniuk, Tubutulik, and Kwik rivers seem to occupy an indentation in the initial shore line which has been filled out nearly to the general coastal curve by river and wave waste. The long island spit opposite the mouth of the Tubutulik points to the northeast and indicates that the effective winds and waves and the shore currents to which they give rise come from the southwest. The lower course of Kwik River bends in the same way—toward the northeast.

Koyuk River, entering at the head of the bay, has filled a limited area with fine alluvial material, but the converging shores of the bay toward the mouth of the river produce strong tidal currents there, which are felt 25 miles up the stream and convert its lower course into an estuary. These tidal currents carry the river's load of detrital material much farther out to open water than the river current in a tideless sea would be competent to do, and are checked much less suddenly than the river current would be under tideless conditions. The result is a general distribution of river waste over the head of the bay, which is in consequence very shallow, with tidal channels shoaling outward through it.

The winds and waves at the extreme northeast end of the bay, which have sufficient sweep to control shore currents and littoral drift, come from the south, and have resulted in forcing the mouths of Inglutalik and Koyuk rivers to the north. The prevailing winds west of Bald Head and Dexter Point are from the southwest, and the most marked evidence of their direction and effect is seen in the cases already mentioned—the spits off the mouths of Tubutulik and Kwik rivers.

The indentation of Golofnin Sound and Golofnin Bay can not be conceived of as formed by sea action. It is but the lower sea-invaded portion of a valley which continues inland along the courses of Fish and Niukluk rivers to the gorges along the middle parts of these streams. The upper portion of this degradational trough is filled by river gravels and alluvium. The middle portion is occupied by the delta of Fish River and the shallow brackish water of Golofnin Sound, and the lower portion by the deeper sea water of Golofnin

Bay. These three tracts represent the three stages in the reclamation of a drowned valley from the sea by river work—the completely reclaimed tract, the area in process of reclamation, and the area as yet unaffected by reclamation processes.

The controlling recorded movement, then, of the land in its relation to the sea in the Norton Bay region has been downward. The evidence lies in the irregular character of the shore line, the drowned stream valleys, and the tied islands. The character of the downward movement, whether uniform and continuous, spasmodic, or interrupted by brief periods of elevation, can not be determined, as the evidence is beneath the sea.

The time which has elapsed since this depression is at least considerable. It has permitted extensive delta growth and a marked advance toward the smoothly curving shore lines of maturity from the excessively irregular lines which immediately followed submergence. The greater part of the work has been accomplished in the initially shoaler parts of the bay about its head, where building is more rapid. For some distance northeast of Cape Darby beaches are meager and sea cliffs are numerous. Offshore depths here were greater and but little building has been done, the chief shore work being cliff cutting, but at the head of the bay wave-built constructional features become more prominent.

On the west shore of Golofnin Bay raised gravels were observed capping the schistose bluffs of Rocky Point. From this point west evidence of uplift is increasingly abundant and consists of terraces, high gravels, and superposed streams (see Mr. Brooks's descriptions). That is, west of Golofnin Bay the paramount movement has been elevation, with perhaps minor episodes of depression; east of Golofnin Bay the paramount movement has been subsidence, with perhaps minor episodes of elevation.

A line from Cape Espenberg to Cape Darby appears to be the axis about which these movements have played, the narrow eastern part of the peninsula owing its limited width to its situation near the area of maximum submergence with the accompanying invasion of the land area by advancing oceanic waters, while the broader western part has risen relatively to the sea, or at least maintained its own.

VEINS.

The schistose beds are everywhere filled with stringers, veinlets, or gashes of calcite and quartz, with occasional larger veins, chiefly of the latter mineral.

The filling belongs to two generations, and perhaps to more. The older veins seem to be much the more abundant, and are now interrupted by faults and compression zones and are stretched into large irregular belts of fractured material or expanded into blebs and lenses of irregular form and size. In the softer slaty aspects of the schists it is not always easy to distinguish between different generations of vein filling because of the very irregular original cavities giving resulting forms to the latter generation which resemble those of the earlier, due to dynamical stresses.

Along the west shore of Golofnin Sound, 4 or 5 miles from Rocky Point, in the micaceous and garnetiferous schists, a rusty, compact quartz vein 6 feet thick, striking about north and south and dipping 20° W., is displayed in the upper portion of a sea cliff. No mineralization appears on the surface, but the rusty color is probably due to the weathering out of sulphides. The quartz in this outcrop is very dense.

North of Cheenik, along the beach, quartz as well as calcite appears in the veins. A couple of miles from the village a big lens 30 by 15 by 10 feet is conspicuous at a distance of a mile or more. It is compact and barren and exhibits a brilliant fracture.

The prevailing filling of the veins in the limestone in the gorge of Fish River is calcite, but some quartz is apt to be associated with it, and a few of the veins are almost exclusively quartz. This mineral is concentrated by weathering and erosive agencies because of its resistance, and so forms a larger proportion of the stream gravels than of the rock mass.

The details of the association of the quartz and calcite were not usually determined, but in an exposure along the middle course of the Tubutulik rhombs of gray calcite were found inclosed in white vein quartz. Here, however, the schists were not so calcareous as in many localities, and the vein filling was usually of the harder mineral. In the patch of greenstone which forms a part of the schistose series just north of the camp of August 4 a train of quartz blocks along the slope of the ridge indicates the presence of a quartz vein not less than a foot thick and persisting for several hundred yards at least. The exposures are not fresh, and the presence or absence of other minerals could not be determined.

The photograph (Pl. XXIII, *A*) of an exposure at Bald Head illustrates well the intricate character of the calcite filling in a slaty phase of the schist. The harder beds, particularly the greenstones, are not so abundantly veined, usually exhibit much more regularity, and are likely to carry more quartz. Free gold was not noted at any point, and evidence of mineralization of any character was but rarely encountered.

In general, it may be said that the massive limestones carry only calcite veins. The more calcareous and the softer carbonaceous phases of the schist carry but little else, while the vein fillings in the quartz-mica-schists and in the greenstones are chiefly quartz.

ECONOMIC GEOLOGY.

GOLD.

Fish River.—Fish River carries colors from its mouth to the northern end of the gorge, the beginning of the flats. Throughout the sands and gravels of the lower river these are very light, but become heavier in the constricted portion of the valley. Opposite the mouth of Anaconda Creek, at the surface of the broken rim rock, pans yielded from half a cent to 1 cent each. Rumors were current that coarse gold had been found during the preceding winter on this stream, which heads near Melsing Creek, one of the branches of the Niukluk, in the Council district. Slate Creek, just below Anaconda, has also been reported to carry coarse gold.

Prospectors found nothing in the upper flats of Fish River, and, as far as reported, the streams flowing out of the mountains to the north do not yield colors. The greater part of these tributaries, it is true, flow through granitic rocks, the schistose series usually forming only a narrow belt along the flanks of the granite mountains, and even here exhibiting generally the very calcareous phase which seems not to be auriferous, so that the area is not a promising one for prospectors. Parantulik River, which drains the southern side of Fish River Basin and the slopes immediately adjacent to it, is more favorably situated, but has not as yet been reported to yield gold in commercially valuable quantities.

Tubutulik River.—This stream, while farther from the known productive districts than the Fish, was the object of considerable attention during the summer of 1900. The surface gravels of the river bars gave colors quite as heavy as those on Fish River wherever a pan was washed out—at least as far up as the granite area. We had no reports from the head of this stream and did not have an opportunity to examine it ourselves, but the area drained by it is not particularly promising.

Mr. C. C. Alexander and members of his party, who had been prospecting on Chukajak and Vulcan creeks during the fall of 1899 and the summer of 1900, report the finding of coarse gold early in their work on the former stream, but more thorough development did not fulfill the promise of this first find. Reports of favorable prospects here, however, had reached Golofnin Bay and Nome, and a small stampede toward the Tubutulik resulted. When we left the river, late in August, many outfits were reaching the field. Reports toward the end of September did not tend to confirm the earlier accounts of rich strikes there.

Koyuk River.—This stream, entering Norton Bay at its northeastern extremity, is well off the routes usually pursued by prospectors, and has as yet received comparatively little attention. A great part of its valley is cut in fresh basalts, which are not gold bearing, so that the portions of the main stream and its tributaries that flow over the schists and may carry gold are limited.

Knowles Creek, which enters the Koyuk just below the camp of September 3, has been prospected and a mining district established there. The greater part of the course of this stream lies in the schists, which seem here to carry considerable quantities of quartz. We did not see the men who worked on the stream and do not know what results they secured.

Just above the camp of September 5 another tributary enters from the south, carrying only schistose pebbles. These, however, are very calcareous. Most of the streams which enter the upper course of the river from the north also lie without the lava belt, but the schists here have not the aspect of the gold-bearing members. At Cheenik, in the fall, we met prospectors who had been up the river and reported finding colors all along its course.

Ungalik River.—Ungalik River flows into the southeastern side of Norton Bay, 13 miles east of Dexter Point. Three or four paying claims were worked last season on a branch of this stream 5 or 6 miles from the coast. They were all reported as being in the valley of one small tributary and including all the workable ground on it. No other paying properties had been located in the neighborhood up to the time of our departure.

Beaches.—Colors are reported along the shore of Norton Bay from Koyuk River to Cheenik, but no paying diggings are known.

SILVER.

The Omalik mine, in the northern edge of Fish River Basin, is one of the oldest mining properties in northern Alaska. Development work was begun and abandoned on it long before the rich placers on Klondike River and at Nome were dreamed of. Petrof, in the census report of 1880, mentions the reputed occurrence of silver ore in Golofnin Bay.

Fish River mining district was organized in 1881, and work on the galena deposits at Omalik began soon afterwards. In 1884 the steamer *Corwin* took to San Francisco 30 or 40 sacks of ore which are reported to have yielded high values in silver. In 1885, 125 tons were shipped out. Previous to this two small schooners loaded with ore had been lost, with one of the owners of the property. In 1886, 30 tons more of the ore were shipped south, and this lot was reported by the owners to have assayed from 70 to 85 per cent of lead and from 100 to 250 ounces of silver per ton. In 1890 operations at the mine were suspended because experts reported that "no continuous vein of ore existed, the same being found only in irregular and disconnected pockets." In 1891 operations were resumed, but have since been discontinued.

The Russian American Mining and Exploration Company put up buildings at the mine years ago for winter quarters for men and stock and established a road 6 miles long leading from the mine to a landing on Omalik Creek, where the ores have been loaded on light-draft boats and floated down to Golofnin Sound.

At the mine coarsely crystalline white marble and schistose gray limestones alternate in bands of varying width with a dark schist, which in places seems to be an altered dioritic intrusive. The ore apparently occurs along the contact between these two rocks or in the limestone near the contact. At the time of our visit last summer the cuts had fallen in to such an extent that entrance to the mine was precluded, and the only mineralization visible near the surface was a scattering of pyrite. Stibnite is said to occur also with the galena. An assay of a sample of the latter picked up on the ground yielded 88.57 ounces of silver and 0.03 of an ounce of gold per ton, and two samples of carbonate ores received later from the owners of the property yielded the following results upon assay:

Assays of two samples of carbonate ore.

Material.	Gold.	Silver.	Lead.
	Oz. per ton.	*Oz. per ton.*	*Per cent.*
Yellow carbonate ore	0.05	94.30	55.9
Red carbonate ore	.05	60.7	10.27

COAL.

The only rocks encountered in the reconnaissance likely to carry coal are the sediments supposed to be of Tertiary age outcropping on the Tubutulik and Koyuk rivers in narrow belts. No direct evidence of the presence of this mineral was secured on the Koyuk, but along the river bank associated with the sandstone outcrops on the Tubutulik are numbers of small pieces of bright, compact coal, seemingly of good quality. Some time would have to be spent in careful prospecting to determine the extent and value of the deposit.

DESCRIPTION OF THE GEOLOGIC MAP.

The formations which have been described and their areal relations, so far as determined, are expressed on the geologic map which appears opposite page 200. All of the gold and other precious metals known in the region have been derived from some one of the group of rocks classed together as the metamorphic series. This series is probably about equivalent in its position in the stratigraphic column to the beds mapped by Mr. Brooks in the southwestern part of the peninsula under the names Nome and Kuzitrin series. It may also include small areas of the Kigluaik series.

Coal is not to be expected except in the unaltered sediments. Outcrops of these beds were noted in but two localities, and although but little is known of their distribution, it can not be extensive.

NATIVES.

The natives were found along or near the sea coast, the largest settlement in the spring being at Cheenik, on Golofnin Bay. At the time of our arrival there, in late June, they had not yet dispersed to their fishing stations along the various rivers. Later, sickness broke out among them, measles proving fatal in many cases, according to report 28 of the 75 or 80 in the neighborhood of Cheenik dying within five days. They dispersed from this neighborhood early in July to escape the sickness and to begin their summer fishing, and late in July a number were encamped at the mouth of the Niukluk engaged in catching and drying salmon.

In the neighborhood of the mouths of the Kwiniuk, Tubutulik, and Kwik rivers is another large settlement of from 50 to 100 Eskimo, who fish along these streams and trap in their valleys. In middle September a large party had assembled along the shore near the mouth of the Kwiniuk. Earlier a fishing station had been established a few miles above the mouth of the Tubutulik, and fish dams were passed on this stream and the Koyuk. Near the mouth of the latter stream two or three tents, occupied by as many families, were passed in the fall, and villages were noticed along the shore of the bay farther south.

These Eskimo everywhere bear an excellent reputation for honesty and reliability, and through their long intercourse with the white traders and travelers have become acquainted with a few English words and are supplied in part with American clothing and food. At Cheenik many were employed as laborers at the same wages that white men received, and seemed to be giving excellent service. We heard no complaints of them at any time.

FISH AND GAME.

Seward Peninsula is easily accessible throughout, and situated as it is, so near to St. Michael, one of the oldest trading posts north of the Alaskan Peninsula, has been a native hunting ground from time immemorial. Caribou, formerly quite abundant and occasionally seen within a few years, have now been entirely driven out. Beaver, although present, are scarce, and other food and fur-bearing animals are becoming rarer each year. A few bear, both brown and black, are still found, and foxes, land otter, and mink are occasionally to be seen. The ever-present ptarmigan and a few grouse in the sparse spruce forests, and water-fowl in abundance and variety, together with several varieties of snipe and plover, and many sand-hill cranes, may be counted upon to add to the food supply of those armed with shotguns. Fish are strikingly abundant in all the streams and are easily caught. Many varieties of salmon run during the summer, grayling are found wherever the water is clear and swift, and pike lurk in the mouths of quiet sloughs and among the aquatic plants of still stretches along the rivers. We found an assortment of trout flies and a couple of light lines very useful for catching the grayling. Pike may be snared, shot, or caught with a fish or meat bait. A light gill net is recommended for catching the salmon, and, while adding very little to the weight of an outfit, may increase the available food supply very materially.

ROUTES AND MEANS OF TRANSPORTATION.

From Cheenik travelers reach Topkok and adjacent portions of the coast by crossing Golofnin Sound to its west shore not far from the mouth of Fish River, and then crossing the low ridge which separates the delta of the river from the shore of Norton Sound to the west. This route is followed in summer as well as in winter.

The old telegraph route between Port Clarence and Golofnin Sound is an easy and oft-followed winter trail. It lies along the valleys of Fish and Niukluk rivers to near the head of the latter, whence by a low divide the upper Kruzgamepa is reached. After crossing the divide travelers follow the latter stream to Imuruk Basin and Port Clarence. The all-water summer route which appeared so long on maps of the region does not exist, and the portage of 9 miles is such a barrier to summer travel that during this season the trip is much more easily made by boat through Norton Sound and Bering Sea.

Kotzebue Sound is frequently and easily reached by prospectors with sleds in winter by following Fish River to the northeast side of the big basin in its upper course, crossing the low divide north of the Omalik mines to the head of the Tubutulik, and traveling thence to the Upper Koyuk by another low pass which separates the two river valleys. From this point on the Koyuk the country northward toward Kotzebue Sound is not high and the winter traveler may choose from a number of possible routes. That by way of the Kiwalik River seems to be the one usually followed.

Occasional trips are made across here in summer with a light pack, but this is a rather difficult undertaking, requiring a week or ten days, the walking across the tundra being trying in the extreme. For such a trip it will probably be advisable to keep nearly due north from Cheenik well up on the high ground between the Fish and the Tubutulik drainage systems, cross the latter stream and the Koyuk near their sources, and then strike Goodhope Bay farther west than by the winter route. By keeping thus on high ground the traveler secures better footing, and avoids the worst of the mosquitoes and much of the oppressive heat which is so disagreeable in the flats in summer.

Natives and traders desiring to reach the head of Norton Bay or the lower valley of the Tubutulik by winter from Cheenik travel northeast from the latter point to the head of the Kwiniuk, which is reached in fourteen or fifteen hours. The valley of this stream is then followed to the coast; or if the Tubutulik Valley is the region to be visited the Kwiniuk is left at the point where it flows out from the hills and turns southward through the flats on its lower course. Five or 6 miles northeast of this point the Tubutulik is reached.

From any of the native villages between the Kwiniuk and Bald Head the middle course of the Koyuk can be reached easily in winter by way of the valley of the Kwik and the low divide at its head. In summer this route is too marshy to be available.

One of the oldest and least known winter routes of the district is that from the head of Norton Bay to Kotzebue Sound by way of the Lower Koyuk, its East Fork, and the valley of Buckland River. This route was followed by Lieutenant Bertholf, of the Overland Relief Expedition, who occupied six traveling days with his mixed dog and deer train to make the distance from the mouth of the Koyuk to the mouth of the Buckland in February, 1898. Before and since that time the route has been constantly used by traders and prospectors as well as by natives. Although passing through hilly country along the divide between the two streams the heavy grades are avoided by winding about among the hills.

DEVELOPMENT.

The lower course of Fish River was one of the highways into the interior during the past summer, and as far as the mouth of the Niukluk prospecting parties were met daily. The greater number of these followed the Niukluk to the district tributary to Council. A few of them investigated Fox Creek and the other southern branches of the Fish, while others continued up the main stream itself and prospected along its upper tributaries. These devoted the greater part of their energies and work to Baldwin, Slate, Anaconda, and other creeks which are tributary to the Fish within the gorge. Most of these gulches had been staked during the previous winter by prospectors who during the summer were working in other parts of the peninsula or who had left the country entirely. Comparatively little development work was done on the flanks of the mountains in which Fish River rises, the great basin south of these hills turning most of the prospectors back, and the few who did cross the flats seem to have found no encouragement in the granitic masses lying to the northward.

Work was begun on the Tubutulik in the fall of 1899 by Mr. Alexander and others associated with him, and was continued throughout the summer of 1900. They devoted their energies chiefly to work in the valleys of Chukajak and Vulcan creeks, although several smaller streams a little farther north were staked. They seem to have found rather encouraging prospects at first, but later work did not justify the high hopes which had been raised earlier in the season. Reports, however, of a rich strike in this valley reached Golofnin Bay and the Nome district early in the season, and by midsummer several outfits were at work on the Tubutulik. The latest advices we received from there in September were to the effect that nothing had been found to justify the stampede of midsummer.

Comparatively little attention was paid during the season to Koyuk River Valley. One district, known as the Rocky Mountain district, was organized in the upper part of the valley, and Mr. Knowles was chosen recorder. A few parties, of three or four men each, were met on the stream in August and September, but so far as known none of these spent any considerable time on the river. In the latter part of September, however, one small party ascended the river with the declared intention of wintering in the valley and doing some systematic work there.

The shore of Norton Bay from Bald Head to Cape Darby was prospected more or less thoroughly during the summer by many men who came down the Yukon from the Koyukuk, Klondike, or other tributaries of the master stream. No one, however, seems to have found sufficiently promising prospects to induce him to spend any time on this part of the beach.

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