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RECONNAISSANCE

FROM

FORT HAMLIN TO KOTZEBUE SOUND, ALASKA

BY WAY OF

DALL, KANUTI, ALLEN, AND KOWAK RIVERS

BY

WALTER C. MENDENHALL

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RECONNAISSANCE FROM FORT HAMLIN TO KOTZEBUE SOUND, BY WAY OF DALL, KANUTI, ALLEN, AND KOWAK[a] RIVERS.

By Walter C. Mendenhall.

INTRODUCTION.

The reconnaissance described in the following pages was carried out in pursuance of a plan which has been followed for some years by the United States Geological Survey in the topographic and geologic exploration of the little-known parts of Alaska and in the collection of such information as will be of value not only to the scientific world, but to the prospector, the miner, and the trader. Capital disappears and years are wasted by prospectors who push out beyond the shifting frontier and pursue their search for gold where gold is not to be expected, and lives are being continually lost because the location and character of trails, drainage ways, and mountain ranges and passes are unknown, or because the knowledge which a few possess is not in a form available for the use of others.

Gradually the great waterways and mountain systems are being mapped, and reliable information is being gathered concerning the distribution of timber, the number and character of the native inhabitants, and the presence or absence of game—all matters of vital interest to the traveler who, whatever his object, ventures away from the great central waterway of the Yukon or from the trading stations on other streams.

An important object of the work in the region under consideration is to contribute to the increasing but as yet inadequate knowledge of the interior of the great Territory, and to present such conclusions concerning the known and probable distribution of mineral wealth as are justified by a hasty reconnaissance.

Those immediately responsible for the work, Mr. D. L. Reaburn and the writer, desire to express their appreciation of the cheerful service rendered at all times, and often under trying circumstances, by the other members of the party, Messrs. R. C. Applegate, W. B. Reaburn, W. W. Von Canon, George Revine, and W. L. Poto, without whose individual and collective cooperation the results

[a] This river is known as the "Kobuk" or "Kovuk" by the natives, prospectors, and traders. In this report the name Kowak is used, in accordance with the decision of the U. S. Board on Geographic Names. See Geographic Dictionary of Alaska: Bull. U. S. Geol. Survey No. 187, p. 250.

secured would not have been possible. Many others have also given information or aid and extended courtesies, but from among these many friends it is not possible to select names for especial mention, for the friendly hand is always extended by the Alaskan pioneer.

ITINERARY.

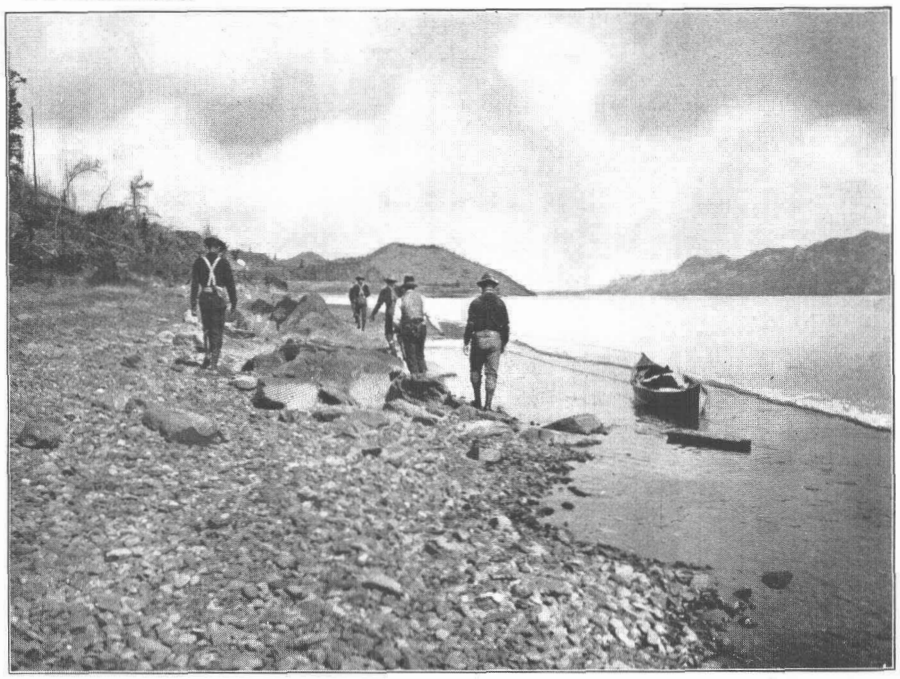
The party assembled in Seattle about the middle of May, 1901, and on May 19 took passage on the steamer *City of Seattle*, arriving at Skagway on the 23d. It was learned that Lake Laberge was still covered with ice and that steamers would not be able to get through until about the 10th of June. The Yukon River from Lower Laberge to Dawson, however, had been open since May 23. Being extremely loath to lose the ten days which remained before Lake Laberge would be navigable, canoes were purchased at White Horse, and with these the trip through Lake Laberge was made during the last of May and the early part of June. Open water was found between the ice and the shore for much of the distance, and where these channels had been closed by the crushing of the floe against exposed points the boats were placed upon rude runners and hauled over the ice until open water again appeared.

Finding the steamer *Bailey* waiting for outside mail at Lower Laberge, the party embarked on the 2d of June and reached Dawson early on the 4th. Here the party was divided, and Mr. Reaburn, with three men, was equipped with provisions and boats for running a stadia line from Fort Yukon to Fort Hamlin. This portion of the party left Dawson on the 5th of June on the steamer *Louise*, and began its work at Fort Yukon on the 8th.

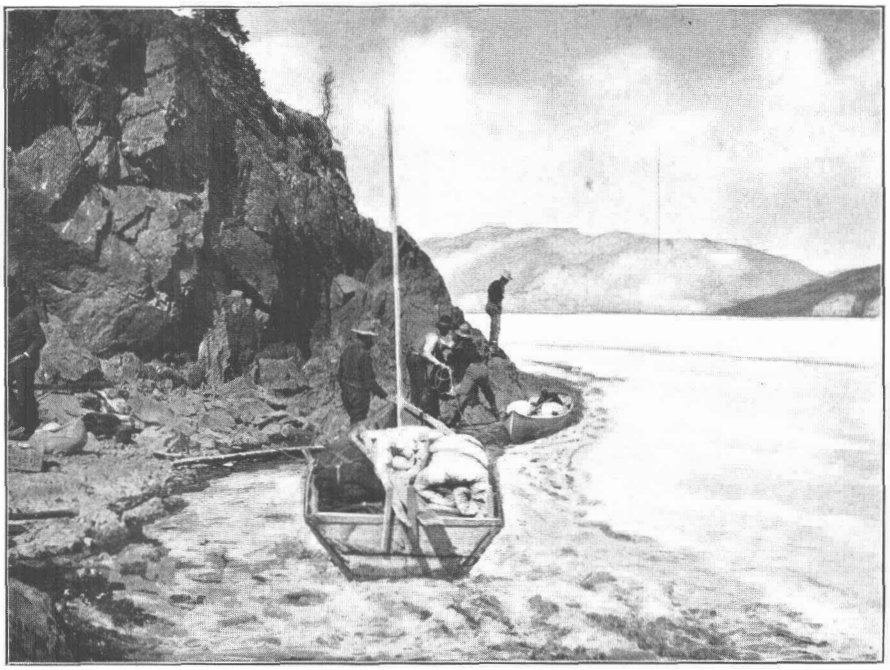
The remaining members of the party stayed at Dawson until June 10, buying supplies and securing information concerning the country between the mouth of Dall River and the Koyukuk, which was to be traversed later. A brief visit was made to the producing creeks near Dawson. On the evening of the 10th the party left Dawson and arrived at Fort Hamlin on the morning of June 13. Three weeks' supplies were purchased here for the trip to Bergman, and on the 17th the party was reunited by the arrival of Mr. Reaburn and his assistants.

June 18 to June 27 were spent in carrying the traverse line up the Dall River to the collection of cabins on its upper course known as Dall City. Here the overland pack trail from Fort Hamlin to the Koyukuk diggings crosses the river, and prospectors were found, bound for the Koyukuk diggings, but entirely ignorant of the route to be followed in reaching them.

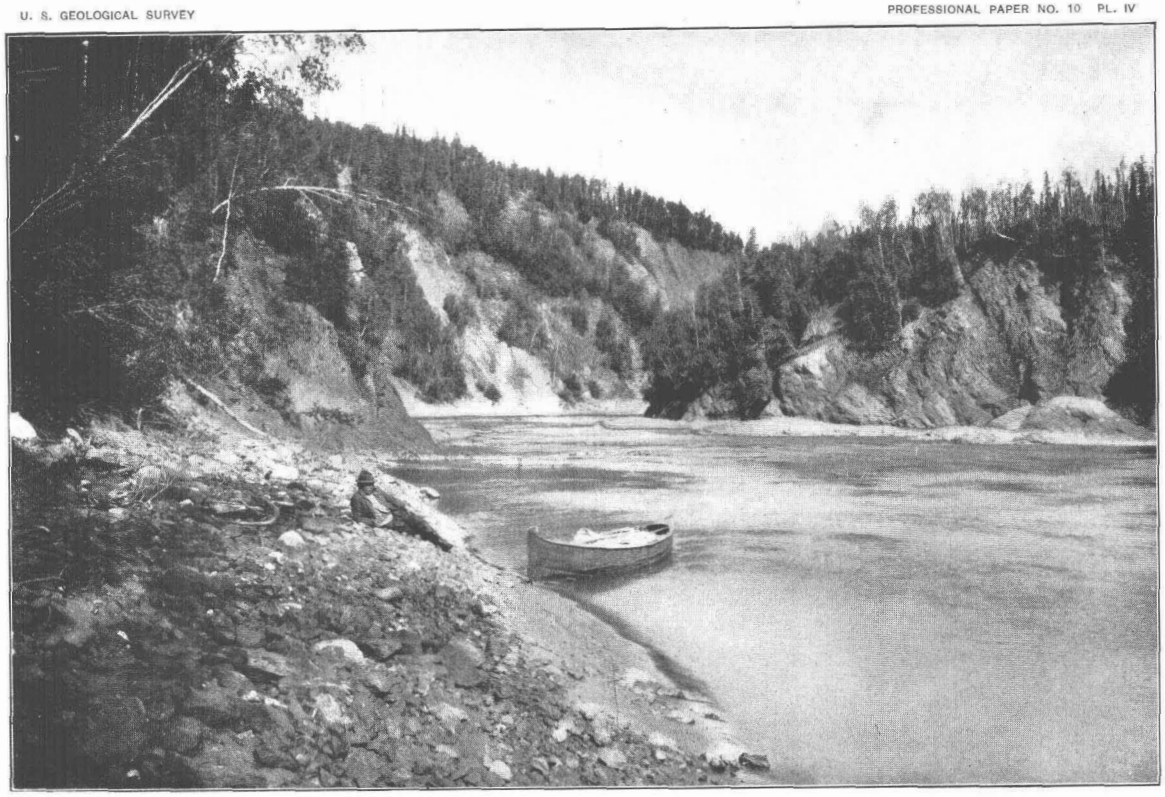
By the evening of July 3 the entire outfit had been transported over the 18 miles of portage to a point on the Kanuti River where boats with their loads would float. The stream here, however, was swift, shallow, and full of bowlders, so that boats could be taken through it only with the greatest care, and even then



A. TRACKING ALONG THE EDGE OF THE ICE, LAKE LABERGE.



B. ROUNDING A BAD POINT, LAKE LABERGE.



A. LOWER END OF KOWAK RIVER GORGE.

B. LOOKING TOWARD HEAD OF WALKER LAKE FROM 2 MILES BELOW ITS WESTERN END.

In the background are mountains of schist and limestone.

undertook the exploration of the Kowak River with a steam cutter and a native skin boat of 6 tons' capacity. After ascending about 275 miles, the current became too strong for the cutter, and it was left behind. The journey was continued, however, in the skin boat, until the Soolookpowuktoark River (outlet of Lake Selby) was reached. Stoney visited the lake drained by this stream and then returned down the Kowak to Hotham Inlet. He sent Ensign Purcell to explore Selawik Lake and another east of it, which was called the Inland lake. This done, the party returned to San Francisco. During the next summer, 1886, Lieutenant Stoney went again to the Kowak, established winter quarters about 250 miles up that stream, at Fort Cosmos, and during the following winter parties conducted either by himself personally or by his officers carried out extensive explorations in the surrounding country. The principal of these explorations were by way of the Ambler River to Nimyuk on the Noatak, up the Kowak through a pass near its head to the Allen, which belongs to the Koyukuk system, and northward from its source to Chandlar Lake, and southward to the middle course of the Selawik. These three trips were conducted by Lieutenant Stoney in person. Besides these, Ensign Howard, under Lieutenant Stoney's direction, made a trip to Point Barrow in the spring by way of the Upper Colville and Chipp rivers, which he mapped en route; and Assistant Engineer Zane journeyed to St. Michael by way of the Pah, Koyukuk, and Yukon rivers. These combined expeditions resulted in the acquisition of definite geographic knowledge of this territory, which before this had been practically unknown.

Lieut. John C. Cantwell,[a] of the Revenue-Marine Service, entered one of the mouths of the Kowak July 10, 1884, and explored the river to a point some distance beyond the mouth of the Black. A small steam launch and a skin boat were used. The launch became disabled, and the party returned without reaching the large lakes in which the river was reported to rise.

The second expedition in command of Lieutenant Cantwell, for the exploration of the Kowak, left the *Corwin* on July 2, 1885.[b] Lieutenant Cantwell used, as in the previous year, a steam launch and a skin boat, the launch having been specially prepared for the work. On the 16th of July he reached the lower rapids of the Kowak, which he passed after an accident which nearly proved fatal to one of the natives who accompanied him, and on the 21st reached the outlet of Walker Lake. This he ascended as far as the rapids. A couple of days were spent in the neighborhood of the lower end of the lake, which was mapped from the top of one of the neighboring peaks; then a short portage was made to the Kowak above the mouth of the Kichaiakaka. He reported the

[a] Report of the cruise of the Revenue-Marine steamer *Corwin* in the Arctic Ocean in the year 1884.

[b] Exploration of the Kowak River, Alaska, by Lieut. J. C. Cantwell: Report of cruise of the revenue steamer *Corwin* in the Arctic Ocean in 1885, pp. 21–52.

Kowak to be here a small stream 50 yards wide and 1 foot deep. Having completed his explorations on the upper river, he returned to his launch, which had been left below the mouth of the Pah, and on the 27th rejoined the steamer. An expedition under Engineer McLenegan, of the *Corwin*, had been carried out at the same time on the Noatak River. Maps accompany the reports, which give the results of the geographic work in the valleys of the two streams.

The work of Lieutenants Stoney and Cantwell, who were pioneers in this region, north of the Arctic circle, is most valuable, and to the workers themselves a maximum of credit is due, since they were penetrating territory about which nothing was known except from inaccurate native accounts, so that no adequate provision could be made for meeting conditions encountered.

An historical sketch of the Kotzebue Sound region would not be complete without mention of the remarkable journey of Lieutenants Jarvis and Bertholf, Dr. Call, of the revenue cutter *Bear*, and W. T. Lopp, missionary at Cape Prince of Wales, in connection with the expedition for the relief of the whalers imprisoned at Point Barrow in the winter of 1897–98.[a] A midwinter journey of about 1,500 miles was made from the coast north of Bristol Bay to Point Barrow, and several hundred reindeer intended for food for the imprisoned whalers were driven from the region about Port Clarence.

In 1898 the Kowak River Valley was the scene of a stampede, brought about by reports to the effect that gold in paying amounts existed in the valley of the river. Mr. McIlwaine[b] reports that about 1,200 people took part in that stampede, and gives in popular form a brief account of the movement, its hardships and disappointments. Of the 1,200 people who reached Kotzebue Sound, about 800 spent the winter of 1898–99 on the Kowak, but few indications of the presence of gold were found. In the spring practically all the prospectors departed, the majority went down the stream and out of the region by way of Kotzebue Sound, but a few went up the river to the passes at its source and then down the Koyukuk River. Since that time a very few white men have been on the stream each summer, and the river steamer *John Riley*, commanded by Captain Coogan, has spent two winters there, and again wintered in the neighborhood of Black River during the season of 1901–2.

The Yukon is now, and within historical times has been, the highway followed by the trader and the explorer in the interior; hence its geography became known early in the history of interior work. Lieutenant Zagoskin's map of the lower river, prepared about 1843, extends up to a short distance above Nulato. The Western Union Telegraph Company's map of 1869 is based in part upon it. Mr. Whymper's, Dr. Dall's, and Captain Raymond's maps of

[a] Report of the cruise of the revenue cutter *Bear* and the overland expedition, 1897–98.
[b] The Truth about Alaska, by Eugene McIlwaine.

the Yukon below Fort Yukon followed in rapid succession, each map being a distinct improvement upon its predecessor. The astronomic positions as determined by Captain Raymond are still accepted as the basis for the charts of this part of the Territory. In addition to their contributions to geography Dr. Dall and Robert Kennicott also added notably to our knowledge of the natural history and ethnology of the Yukon Basin. Among later geographers, Lieutenant Schwatka and Mr. Homan are to be mentioned, Homan's survey of the Yukon, made in 1883, being the basis of the present maps of the river. Lieut. H. T. Allen,[a] in 1885, after ascending the Copper River and descending the Tanana, made the overland trip from a point 6 miles below Nuklukayet on the Yukon to the junction of the Mentanontli and Kanuti rivers. He was accompanied by one soldier, Fickett, and 7 natives, and the journey was made in a little more than six days. From the mouth of the Mentanontli he descended the Kanuti River and continued his work up the Koyukuk to the mouth of the Totsenbet River. At this point he turned back, drifted down the Koyukuk, and reached Nulato on the 21st of August, 1885, having contributed to the world, as a result of his remarkable work this summer, the first definite knowledge of the basin of the Koyukuk as well as of the Tanana and Copper.

In 1889 Professor Russell[b] accompanied the Coast and Geodetic Survey parties under McGrath and Turner, whose object was to establish on the Porcupine and Yukon rivers the crossing of the one hundred and forty-first meridian, the international boundary line. The trip involved the ascent of the Yukon from St. Michael to Lake Lindeman, and while opportunities for detailed geologic study were limited, a number of interesting and suggestive notes of a general nature resulted.

In 1896 Messrs. Spurr, Goodrich, and Schrader, of the United States Geological Survey, descended the Yukon, and in the report[c] which followed is found the first comprehensive study of the geology and of the physiographic history of the American Yukon Basin.

In 1899 F. C. Schrader[d] and T. G. Gerdine ascended the Chandlar River, portaged from near its head to Robert Creek, one of the upper tributaries of the Koyukuk, and descended the latter stream to its mouth. Previous to this the Chandlar was practically unknown, and but little accurate information was available concerning the Koyukuk beyond the point reached by Lieutenant

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[a] Report of a military reconnaissance in Alaska, made in 1885 by Lieut. Henry T. Allen, U. S. Cavalry.

[b] Notes on the surface geology of Alaska, by Israel C. Russell: Bull. Geol. Soc. America, Vol. I, pp. 99–162.

[c] Geology of the Yukon gold district, Alaska, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, pp. 87–392.

[d] Preliminary report on a reconnaissance along the Chandlar and Koyukuk rivers, Alaska, in 1899, by F. C. Schrader: Twenty-first Ann. Rept. U. S. Geol. Survey, Pt. II, pp. 441–486.

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Allen in 1885. The result of this reconnaissance appears in a complete topographic map of the field traversed, with comprehensive data on the geology, economy, and mining developments in the drainage basins of both the Chandlar and Koyukuk.

Although the route from the Yukon to the Koyukuk by way of the Dall River has been known and used for a number of years by prospectors, and the headwaters at least of the Kanuti River have been visited by them, no maps of either stream were available, and no accurate information concerning them was obtainable previous to the year 1901.

The valley of the Allen has always been one of the lines of travel followed by the Kowak Indians when journeying to the Koyukuk in winter for purposes of trade, and several of the prospectors who wintered in 1898–99 on the Kowak came out to the Yukon by this route, but no maps had been prepared of it previous to our work there.

CONDITIONS AND METHODS OF WORK.

Exploring expeditions in high latitudes, which are carried on only in the summer, with no provision for wintering, are limited in time, and hence, where the extent of territory covered is considerable, in the present case between 1,100 and 1,200 miles, certain sacrifices must be made to the paramount necessity of gaining ground. Through difficult regions all the energies of the scientific, as well as of the other members of the party, are of necessity often devoted to overcoming the physical obstacles encountered.

Work under these conditions can not be uniform in quality. Observations made while the observer is struggling ahead at the end of a tracking line, or bending all his energies to the prevention of disaster in the wild waters of a gorge, or perhaps zigzagging up a 1,000-foot climb with 90 pounds on his back, are not always as complete as is desirable. It is hoped, however, that such conditions have not resulted in other inaccuracy than that due to incompleteness.

Geologic observations were for long stretches confined to the line of traverse, but wherever it was possible these were supplemented by side trips. Generally a rough compass traverse was maintained upon which observations were recorded directly; but at times when the geologist and topographer were together, references were placed upon the topographer's traverse and the geologic observations recorded with corresponding references. Collections were of course made for comparative study later, and information was gleaned from all possible sources.

For transportation Peterboro canoes were used, since the route lay along waterways or over portages where these light boats could be carried. Two were used from Fort Yukon to Bergman, and four from Bergman to Kotzebue Sound.

The canoes were propelled by oars, sails, or paddles, or by tracking or poling, as conditions varied.

Some photographic records were secured, although these are not as numerous nor complete as was desired because of the damage to instruments by water.

For temperature observations two standard thermometers were depended upon chiefly. A minimum thermometer was used during the early part of the season, but later was broken. The maximum was of little use because camp was moved practically every day, and no records could be secured from the instrument while it was packed in a moving canoe.

Plants were collected when conditions permitted and dried with such care as was possible, and brief notes on their distribution were recorded at the same time.

Distances were determined in all cases by micrometer and stadia measurements and by plane-table triangulation. A continuous line was maintained from Fort Yukon on the Yukon River to the mining village of Deering on the south shore of Kotzebue Sound. The total distance thus traversed, including two side trips, one to the head of Walker Lake and the other for a short distance up the Ambler River, was 1,169 miles. This involved two portages, one from the head of the Dall River to the head of the Kanuti River, a distance of 18 miles over a divide 2,500 feet high, and the other from the head of Helpmejack Creek to the upper course of the Kichaiakaka, a distance of 5½ miles, over an elevation of 300 feet.

Elevations were determined by vertical angles, and the results of these determinations are shown on the maps by contours. Sights in some instances were long, making exact work impossible, but the error can not in any case be great. The elevation of Fort Yukon was assumed as a starting point to be 500 feet above mean sea level. This assumption was based in part upon data furnished by ex-Governor Ogilvie, of the Yukon Territory, and in part on the slope of the river from Fort Yukon to Fort Hamlin, a distance of 190 miles. Mr. Ogilvie, after a series of synchronous barometric readings, carried on at the point where the Canadian and United States boundary line crosses the Yukon River and at Lake Laberge, deduced the slope of the Upper Yukon as 2.44 feet per mile, and the elevation of Dawson as 1,040 feet. The slope of the Yukon between Fort Yukon and Fort Hamlin is approximately .9 feet per mile. Assuming the mean of these two results as the slope between Dawson and Fort Yukon, the elevation of Fort Yukon becomes 480 feet. Vertical angles carried from this assumed elevation as a starting point check approximately with sea level at the mouth of the Kowak River.

Thirty-six azimuth observations were made at points distributed all along the route, and the magnetic declination was determined at each azimuth station.

The plane-table and stadia work was checked by 19 latitude observations, 14 of which are solar and the remaining 5 made on Polaris.

The longitude of Fort Yukon, as determined by Captain Raymond, was accepted as a starting point. The closure on Captain Beechey's position for Chamisso Island, as corrected by T. G. Gerdine, was 3½ miles long. This was distributed between extremes in proportion to the longitudinal distance.

GENERAL GEOGRAPHY.

The most important physical feature of that portion of Alaska lying north of the Yukon is a great mountain range extending from the Arctic coast just north of Kotzebue Sound east and northeast to the international boundary in the region between the Porcupine River and the Arctic Ocean. To this range, whose central portion he could see from Lookout Mountain on the middle Koyukuk, Lieutenant Allen, in 1885, applied the name Endicott Mountains. These mountains extend from the vicinity of the Mulgrave Hills east and northeast to Demarcation Point and the British Mountains in the vicinity of the international boundary.

The mountains have a north-south width of 30 or 40 miles. At their western end they are narrow and comparatively low, reaching heights of 3,000 or 4,000 feet, but near the head of the Kowak, peaks reach altitudes of 6,000 feet, and in the vicinity of the Totsenbet River portage and eastward to the boundary 7,000 feet is not unusual. The mountain belt is broader, too, toward the east, where it may have a maximum north-south extension of 100 miles. In Canadian territory it bends to the south near the Mackenzie River, and is considered a continuation of the Canadian Rockies.

Between this mountain belt and the Arctic Ocean there is a triangular area of relatively low country, with Point Barrow forming its northern angle. On its coastward side this region is a true coastal plain, and adjacent to the mountains it is a low, rolling plateau with an elevation of between 1,000 and 2,000 feet above sea level.

As might be expected, the mountain range forms a barrier between regions of strong contrast, both in meteorologic conditions and in floral and faunal life. North of it the cold Arctic storms, with snowfall and freezing temperatures, may be expected at any time throughout the year; south of it the summers are hot and bright, although short, and from two to three months of midsummer are free from snows and low temperatures. North of the range the country is timberless; south of it trees are more or less abundant in the river valleys.

Physically, the belt of country lying between the Endicott Mountains and the Yukon is much more diverse, as well as more extensive, than that to the north of the mountains. More or less isolated groups and ranges reach in exceptional cases altitudes of over 5,000 feet. Generally, however, the ridges have altitudes between 1,000 and 3,000 feet and are separated by river valleys which here and there open out into broad flats, comparable, except in extent, to the well-known basin of the Yukon, whose center is in the vicinity of the mouth of the Porcupine River.

The most important streams rise, as is to be expected, in the Endicott Mountains, which form a general divide between the Arctic drainage proper and that of Bering Sea and Kotzebue Sound. The largest of these rivers is the Koyukuk. This is about 700 miles in length and, by its numerous important northern tributaries, among which may be mentioned the Dietrich, Totsenbet, and Allen rivers, drains the southern slopes of the Endicott Mountains, between the meridians of 149° and 154° west longitude. East of the one hundred and fifty-fourth meridian the southern slopes are drained by the Chandlar and Porcupine rivers, and west of the one hundredth and forty-ninth meridian by the Kowak and its branches. The Noatak River, rising near the one hundredth and fifty-fifth meridian, in a high mountain group, whose drainage is shared by the Kowak, Alashuk, Colville, and Noatak, flows west along the sixty-eighth parallel to within 40 or 50 miles of the Arctic coast, then turns south through the range and empties into Kotzebue Sound near the entrance to Hotham Inlet. The position of the Colville on the north slope of the Endicott Range corresponds to that of the Koyukuk, opposite it, on the south slope, and its drainage basin is almost as extensive. It enters the Arctic about midway between Point Barrow and the international boundary.

East of the Colville the streams which reach the Arctic coast within United States territory are small, Turner River, perhaps 150 miles in length, being the largest known. West of the Colville, however, several streams flow northward, the Chipp, the Meade, the Otukah, and the Pitmegea being the most important.

LOCAL GEOGRAPHY AND ROUTES.

DALL RIVER.

The Dall River joins the Yukon 9 miles above Fort Hamlin, near the western edge of the great Yukon Flats, the lower 50 or 60 miles, about half the length, of Dall River lying within these, although near their western limit. The country is utterly devoid of relief and contains a great number of sloughs and ponds, many of them old and abandoned courses of the Dall and its tributaries, so that

during periods of high water the entire area is flooded and the course of the river is marked only as a lane through the spruces and willows. At such times it may be difficult to find land areas of sufficient size for camping purposes, and transportation by other means than boats is out of the question.

For about 25 miles below Dall City the river, although not in the Yukon Flats proper, wanders back and forth across a rather broad valley, bounded at some distance on either side by hills which approach the river and increase in height toward its source. Near the upper end of this stretch a branch almost equal in volume to the main stream joins the latter from the north. Dall City, so called, consists of two or three abandoned prospectors' cabins, and lies at the point where Dall River is crossed by the overland trail, at the entrance to the canyon-like upper portion of the valley. Our party did not traverse this canyon, since it is impassable for small boats, as it has a fall of nearly 1,000 feet in an air-line distance of less than 10 miles.

The general divide between the Dall River and the Koyukuk stands at between 3,000 and 3,500 feet above tide, the gap at the head of the Dall River being cut 1,500 feet below this level. The hills immediately to the north of the Dall River are broad, smooth, rounded ridges, standing above timber line, and very generally devoid of all vegetable growth except hardy lichens. An area of much more rugged forms, but standing at approximately the same elevation, lies north and west of the portage in the direction of Fish Creek and Jim River.

A conspicuous valley leads northeastward from a point north of Dall City and is probably drained by the Hosiana or Swift River, which empties into the Yukon between the Dall and the Chandlar.

KANUTI RIVER.

The Kanuti River is approximately 200 miles long, and within that distance its valley presents great physical diversity. It heads in the same mountains whose northern slopes are drained by Fish Creek and Jim River, but within a few miles of its source it enters a relatively flat basin, 9 or 10 miles long and half as wide, which contains a number of small lakes and ponds, although standing at an elevation of between 1,200 and 1,400 feet. This basin, like all similar topographic features in the north, whatever their relation to sea level, is a marsh, covered with the usual tundra growth. At its lower end, in longitude 150° 45′ west, the river enters a restricted valley, so steep walled in places as to deserve to be called a canyon and having a maximum depth of 2,000 feet. The gorge-like character prevails for about 30 miles, and through much of this portion the river can scarcely be called navigable, since it is a succession of rapids, and the channel throughout is obstructed by bowlders of all sizes. Below this stretch the valley gradually broadens, and

near the camp of July 12 is an extensive flat, which is perhaps a part of the broad basin in which the lower portion of the South Fork of the Koyukuk flows.

Within this lower basin the Kanuti River receives a large tributary from the south in the direction of the sources of the Tozi and Melozi.

About 25 miles above its mouth the river plunges into a second canyon about 10 miles long and 500 feet in depth. This is the most beautiful section of the river; the stream is swift, but free from dangerous rapids, and the bluffs of slate and sandstone rise sheer from the water to a height of several hundred feet. Ten miles above the mouth it receives the waters of the Mentanontli, descended by Lieutenant Allen in 1885 after his overland journey from the Yukon.

The hills which border this lower section of the Kanuti River and adjacent parts of the Koyukuk are seldom more than 1,500 feet in height, are not excessively steep, and are well timbered.

ROUTES VIA DALL AND KANUTI RIVERS.

The route followed by the Geological Survey party during the summer of 1901—i. e., up the Dall to Dall City, across the portage to the head of the Kanuti River, and down the latter stream to the Koyukuk—is not a practicable one for parties traveling in boats, because the portage from the Dall to the Kanuti is long (18 miles) and arduous, involving a climb of 2,500 feet, and the canyon of the Kanuti River, nearly 30 miles in length, is a succession of rapids through which boats must be lined with constant risk of loss.

A trail often followed by packers in summer leaves the Dall at its mouth, crosses the flats westward to the hills, and follows these to Dall City, whence the route coincides with the Kanuti River portage route as far as the divide at the head of the latter stream. At this point those bound for the Koyukuk turn to the north along a ridge separating the Swift River from the Kanuti River, but the trail above timber line is not recognizable. That portion of the route lying between the mouth of the Dall River and the hills is often impassable on account of high water, and pack trains may be delayed for two or three weeks waiting for the water to subside, as was the case in June, 1901. This difficulty may be avoided by landing opposite Fort Hamlin, 8 or 9 miles below the Dall River, whence high land, rising from the banks of the Yukon, can be followed directly to Dall City.

A winter route to the Koyukuk lies directly up the Dall to its source; then by a low gap at its head, which can not be reached by boats in summer because of rough water, to the upper basin of the Kanuti River. From the lower end of this basin Fish Creek is reached by another low pass and can be descended to the South Fork of the Koyukuk. The traveler over this route always is within reach of timber and the shelter and fuel which it affords.

ALLEN RIVER.

The type of topography which prevails along the lower Kanuti River and adjacent parts of the Koyukuk Valley continues north of the Koyukuk for many miles along the valley of the Allen. The lower valley of this stream, above the more extensive flats immediately adjacent to its mouth, is 5 to 10 miles wide and bordered by rounded hills, usually low, but reaching elevations of 2,000 to 2,500 feet in a group north and east of Siruk Creek.

Below the mouth of Helpmejack Creek the Allen receives no important branches. The Siruk, a small stream entering from the south, and the Sevenuka, of about equal volume, from the north, are the only tributaries worthy of mention.

Halfway between Siruk and Helpmejack creeks a low belt of country extends through from the Allen to the Kowak by way of the upper Hogatza and Norutak Lake, and is followed as a winter route by natives traveling from one stream to the other.

A short distance above Helpmejack Creek Malemut Creek enters the Allen from the east, and its valley is likewise followed by natives in their journeys from the head of the Kowak or the middle course of the Allen to the Totsenbet River, on their hunting excursions. This stream flows west along the southern base of the Endicott Mountains, and the pass at its head to the east is reported to be low.

Near the head of the Allen the natives report a pass leading to the upper Noatak, but used only in winter. It seems to be too high and too long for summer use.

Helpmejack Creek enters the Allen Valley through a canyon-like north-south valley, conspicuous for many miles below its outlet on the Allen. Farther up the valley of Helpmejack Creek joins a wider east-west valley, which extends through from the Kowak to the Allen and is occupied by the Kichaiakaka, Helpmejack Creek, and the pass between these two. This pass was crossed by Lieutenant Stoney in the winter of 1886 in his trip from Fort Cosmos to Chandlar Lake.

These passes and the valley in which they lie are, like Malemut Creek, situated along the southern edge of the Endicott Mountains, which here form a rugged tract of country 30 or 40 miles broad. One high, rough group, similar to but less elevated than the main range, lies to the south of this line and is bisected by the valley of lower Helpmejack Creek, but in general the mountains to the south are conspicuously smoother and lower than those on the north.

KOWAK RIVER.

The Kowak heads north of the sixty-seventh parallel and west of the one hundred and fifty-fourth meridian in a high group, which is reported to be the source of branches of the Allen, the Colville, and the Noatak. At the mouth of the Kichaiakaka it is 125 feet wide, with a depth of 6 or 8 feet; but a short distance above, Lieutenant Cantwell reports that it becomes very shallow, and, according to the natives, it breaks up into several branches, all of which rise within a short distance. Near the head of the river the valley is 3 miles or more in width, with comparatively level floor. It broadens somewhat below Walker Lake, but contracts again in the vicinity of the lower gorge, where its general course changes from south to west. Several lakes of importance are drained by its upper waters. Chief of these is Walker Lake, 14 miles long, but only about 2 miles broad at its lower and wider end. At its northern end it is but 1 mile in breadth, so that the lake is to be regarded as a water-filled portion of a stream valley scoured out and deepened by ice action.

The lake is bordered on both sides by precipitous mountains, which rise to heights of 3,000 or 4,000 feet. Southeast of it toward the mouth of the Reed River the country becomes broken, the hills, which are from 1,000 to 4,000 feet in height, being separated by broad passes which are often not much above the general level of the streams. Such a pass exists from Nutavukti Lake to the Reed River, and others, probably somewhat higher, are reported to exist between the latter and Walker Lake.

Nutavukti Lake is less than half as extensive as Walker Lake, and is rudely crescent shaped. Its north and south shores are formed by relatively high hills, but the valley in which it is situated extends northwest and southeast far beyond the limits of the lake. A third lake, named Norutak, somewhat less extensive than either of the two described, lies between the lower gorge of the Kowak and the head of the Hogatza. It was seen from a distance only, and it could not be measured accurately.

West of the lower gorge the Kowak Valley broadens to a width of 10 or 20 miles, and this width is maintained to about the one hundred and sixtieth meridian, where the valley suddenly contracts until it is only about 2 miles wide. From this point it gradually broadens again to the head of the delta, where it enters a great flat, extending from near the mouth of the Noatak to south of Selawik Lake.

All along its middle course the Kowak receives abundant tributaries, the most important ones flowing out of the mountain ranges to the north of the stream. Among them may be mentioned the Reed River, at whose head are the hot springs, first visited by Ensign Reed, of Lieutenant Stoney's expedition. A number of cabins

were built here by white men during the winter of 1898–99. The upper Noatak is reported to be easily reached from this point in winter, and to be navigable by small boats where first seen, although natives report that falls exist below. About 2 miles west of the Reed River, Beaver Creek, a somewhat smaller stream, enters from the north, but no other important tributaries are received until the Indian village near the camp of August 17 is reached. This village is near the mouth of the outlet of Lake Selby, a body of water probably 6 or 8 miles in length and situated 5 or 6 miles north of the Kowak. The northern end of the lake lies within the high mountains which form the valley wall. A very short portage from its head is reported by the natives to lead to Avaterat Lake, drained by Mauneluk River.

Eight or 10 miles below the outlet of Lake Selby, Pah River, the most important of the southern tributaries of the Kowak, flows in from the south. The valley of this stream is a favorite highway for the Kowak natives in their winter visits to the Koyukuk. A summer portage between the head of the Pah and a Koyukuk tributary is reported to be about 35 miles long and to lie for the greater part through marshy flats, across which travel is exceedingly difficult. Western tributaries of the Pah drain the slopes of the Sheklukshuk Range, the highest group of mountains south of the Kowak.

The Kogoluktuk River enters the Kowak from the north a few miles east of the one hundred and fifty-seventh meridian. It is one of the most important of the northern tributaries, and the pass at its head to the Noatak is reported by the natives to be one of the shortest and easiest leading to that river. Many rapids, however, make its navigation difficult. In the vicinity of Riley camp and below the Pick River, the Black River and Shingnek Creek join the main stream. They are unimportant tributaries, however, and add little to the volume of the river.

The Ambler is the most important of the branches of the Kowak. It joins the latter near the one hundred and fifty-eighth meridian, after flowing from near the Noatak Valley southward through the Schwatka Mountains to a broad east-west valley, which it crosses diagonally about 25 miles above its mouth. The principal tributary of the Ambler has been called by Lieutenant Stoney the Redstone, because of the color of the rock débris which it brings.

The Hunt, Salmon, Reed, and Squirrel rivers all flow into the lower course of the Kowak from the north, and by way of the valleys of most of these streams lie routes followed by the natives to the Noatak or its tributaries.

Below the Squirrel River the Kowak begins to separate into a number of channels which finally expand into the maze of intricate sloughs which make up the delta of the stream. The principal of the delta channels, and the one usually

followed by steamboats, is the southeastern branch, which enters Hotham Inlet at its head and near the outlet of Selawik Lake. There is, however, a shorter course, which, leads to the inlet opposite Nimiuk Point. This channel also has been followed by the steamboat *John Riley*, and has in consequence been called the Riley Channel.

KOTZEBUE SOUND.

The long, slender peninsula separating Hotham Inlet from the main waters of Kotzebue Sound has but little relief; in the northern part, where it is broadest, heights of but 300 to 400 feet are reached. Long stretches of shore stand at about the level of extreme high tide, and the occasionally recurring shore bluffs of sand, clay, and frozen muds do not run generally more than 100 feet above mean tide level. Choris Peninsula, the highest point of this long spit, has its summit 360 feet above the water. Along the southern shores of Kotzebue Sound low sea cliffs and flats alternate, the latter marking the outlets of streams. Rounded ridges and hills, sometimes reaching heights of 1,200 to 1,300 feet, but usually lower, extend inland and separate the wide, flat river valleys. The Kiwalik, Swan (Kugruk), Ipnechuck, and Goodhope rivers are the principal streams entering the sound from the south. The Buckland River, larger than any of these, flows into Eschscholtz Bay from the southeast.

TABLES OF DISTANCES.

The following tables give the distances between the principal points along the route, as determined by Mr. Reaburn:

Distances between Fort Yukon and Fort Hamlin.

Locality.	Distance from Fort Yukon.	Distance from Fort Hamlin.
	Miles.	*Miles.*
Mouth of Porcupine River	9	184
Mouth of Chandlar River	24	169
Cabin on left bank of river	73	120
Mouth of Beaver Creek	108	85
Alaska Exploration Company's wood camp, No. 35, at foot of Beaver Slough	118	75
Cabin on right bank of river	163	30
Alaska Exploration Company's wood camp on left bank of river	167	26
Indian village on right bank of river	179½	13½
Mouth of Dall River	184	9
Fort Hamlin	193	.....

Distances along Dall River.

Locality.	Distance from mouth of river.	Distance from summit.
	Miles.	*Miles.*
Mouth of creek from north	55	46½
Mouth of Coal Creek	85	16½
Junction of North and West forks of Dall River	86	15½
Dall City, on West Fork of Dall River, head of canoe navigation	90	11½
Summit of portage between Dall and Kanuti rivers	101½	.....

Distances along Kanuti River.

Locality.	Distance from summit.	Distance from mouth of river.
	Miles.	*Miles.*
Head of canoe navigation	7	197
Mouth of creek from southeast, which heads in a low divide against a branch of Dall River	12	192
Lower end of big flat, where the river bends south and enters the canyons	27	177
Camp of July 6, in a prominent bend at mouth of a small creek from the west	37	167
Mouth of a good-sized creek from the east, at the head of a large flat	46	158
Mouth of a large stream from the south, in canyon south side of mountain	60	144
Mouth of a creek from the south	120	84
Indian cabins on right bank	130	74
Mouth of *Mentanontli* River	190	14
Mouth of Kanuti River, on the Koyukuk	204	.....

Distances along the Koyukuk.

Locality.	Distance from mouth of Kanuti River.	Distance from mouth of Allen.
	Miles.	*Miles.*
Arctic City	½	13½
Bergman	4	10
Mouth of Allen River	14	.....

Distances along Allen River and Helpmejack Creek.

Locality.	Distance from mouth of river.	Distance from summit.
	Miles.	*Miles.*
Mouth of Siruk Creek	44	59
Mouth of Helpmejack Creek	80	23
Mouth of Lake Creek, on Helpmejack Creek	90	13
Beginning of portage, at head of canoe navigation	101	2
Summit of portage	103	.....

Distances along Kichaiakaka Creek and Kowak River.

Locality.	Distance from mouth of river.	Distance from summit of portage.
	Miles.	*Miles.*
West end of portage, at head of canoe navigation on Kichaiakaka	373	3
Mouth of Kichaiakaka, on Kowak River	366	10
First rapids below mouth of Kichaiakaka	365	11
Second rapids below mouth of Kichaiakaka	362	14
Mouth of river draining Walker Lake	357	19
Head of gorge, one-half mile long	349	27
Mouth of Nutavukti River	342	34
Head of gorge, 1 mile long (rapids)	331	45
Mouth of Norutak River	329	47
Cabins on right bank of river	319	57
Mouth of Reed River	318	58
Mouth of outlet of Lake Selby	285.5	90.5
Indian village, on left bank of river	285	91
Mouth of Pah River	279	97
Mouth of Mauneluk River	265	111
Head of Big Island	255	121
Mouth of Kogoluktuk River	246	130
Foot of Big Island	242	134
Mouth of Kuiksherk River	227	149
Riley Camp	225	151
Pick River	223	153
Site of Fort Cosmos, at mouth of Cosmos Creek	217	159
Mouth of Salmon Creek	211	165
Mouth of Shingnek Creek	204.5	171.5
Mouth of Black River	201.5	174.5
Mouth of Ambler River	173	203
Mouth of Jade Creek	158	218
Mouth of Tunutuk Creek	151	225
Mouth of Hunt River	139	237

Distances along Kichaiakaka Creek and Kowak River—Continued.

Locality.	Distance from mouth of river.	Distance from summit of portage.
	Miles.	*Miles.*
Mouth of Kauvet Creek	125	251
Mouth of Kaligurichearк River	114	262
Mouth of Toolooksook River	111.5	264.5
Mouth of Salmon River	109	267
Mouth of Reed River	97	279
Mouth of Squirrel River	68	308
Mouth of Kowak River, at Hotham Inlet, directly opposite Nimiuk Point	.....	376

Distances on Hotham Inlet from mouth of Kowak River to Quaker mission.

Locality.	Distance from mouth of Kowak.	Distance from Quaker mission.
	Miles.	*Miles.*
Nimiuk Point	4.5	23.5
Pipe Spit	19	9
Cape	23	5
Mission	28	

Distances along the shore of Kotzebue Sound from Quaker mission to Deering.

Locality.	Distance from mission.	Distance from Deering.
	Miles.	*Miles.*
Cape Blossom	11.5	93.5
South end of Choris Peninsula	55	50
Chamisso Island	58	47
Main shore (6 miles southeast from Chamisso Island)	64	41
Spafarief Bay, east shore of entrance	75	30
Spafarief Bay, west shore of entrance	79	26
Cape	86	19
Alder Creek	87	18
Hunter Creek	89	16
Camp Creek	93	12
Cape	98	7
Swan River	101	4
Mouth of Ipnichuk River	104.5	.5
Deering	105	

GENERAL GEOLOGY.[a]

METAMORPHIC COMPLEX.

GENERAL STATEMENT.

The geologists who have carried out studies in the interior of Alaska have almost without exception encountered and described near the base of the column a complex of more or less schistose sediments, sometimes associated with igneous rocks of various types and relations. These schists they have subdivided in their map work according as they were able to carry out subdivisions in the area studied. Different phases of the schists have in all cases been recognized, and where these have not been represented on the map, it has been because the exigencies of reconnaissance work are such that only those relations and characters which are exhibited immediately adjacent to the line of traverse are determinable, and these may not give the evidence necessary for definite subdivision, or, if subdivisions are made at one point, for correlation of these with others elsewhere. The great distances usually covered in such work increase the uncertainty of correlations because of the changing character of most rock formations from place to place. In a series of highly altered rocks, where fossil evidence is not obtainable, a reconnaissance map in which fine subdivisions are attempted is necessarily only lithologic.

A general classification along broad lines which can be followed with approximate correctness, also lends itself better to the work of the future, which will necessarily be closer and more exact, and in which many formations now not recognized will be distinguished and their relations determined. Logically, the earlier work should be done so that with future developments the first great groups may be subdivided rather than entirely replaced, hence it is deemed better now to draw only general boundaries and to omit such subdivisions as would inevitably be discarded.

Considerations of this sort have influenced the writer in grouping together a diverse complex of older rocks which probably include partial equivalents of Spurr's Birch Creek and Fortymile series,[b] and of Brooks's Nome, Kuzitrin and perhaps of his Kigluaik rocks.[c] Schrader's Rapids schist and Lake quartzite-schist[d] may also be represented. The rocks described here are regarded as in a general way equivalent to those described by the writer in a previous paper as the Metamorphic series.[e] They present many of the same characteristics and general features,

[a] See footnote regarding geologic map, p. 49.

[b] Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, Part III, pp. 140–155.

[c] A Reconnaissance of Cape Nome and Adjacent Gold Fields of Seward Peninsula, Alaska, in 1900, pp. 27–31.

[d] Reconnaissance along Chandlar and Koyukuk rivers in 1899: Twenty-first Ann. Rept. U. S. Geol. Survey, Part II, pp. 473–475.

[e] Reconnaissance in the Norton Bay Region, Alaska, in 1900, pp. 199–204.

although exhibiting somewhat greater diversity lithologically. This is to be expected as a much more extended area has been studied this season than in 1900.

The grouping of these rocks in the present report is determined by the same conditions observed in the Seward Peninsula in 1900; namely, a general and considerable, although varying, metamorphism, which affects all the rock types, however diverse, and gives a clear basis for the separation of the group from younger unaltered or but little altered sediments and lavas which are found at widely separated points in the field.

AGE.

Overlying portions of the Metamorphic complex are recent unaltered beds with basal conglomerates derived in some cases directly from the schists, and containing no other material than that furnished by them. Some of these beds are of Tertiary age, as determined by plant remains collected in them, and others are regarded on somewhat less definite grounds as Cretaceous or at least Mesozoic. The members of the Metamorphic complex are, of course, older than these.

In his section across the Arctic Rockies, Mr. Schrader[a] found quartzites and phyllites of Carboniferous and limestones of Devonian and Silurian age. These exhibit the effects of metamorphic action, and probably are represented among the diverse beds included here.

Messrs. Brooks[b] and Collier[c] found fossils of Devonian and Silurian age in the rocks of the Nome series of Seward Peninsula. In 1900 the writer found on Seward Peninsula fossils which are Lower Mesozoic or Carboniferous. These Seward Peninsula rocks, as has been stated, are regarded as the general equivalents of those under consideration, because of their similarity in metamorphism and in relations to later sediments and lavas. Thus the evidence at hand tends to the conclusion that the rocks here considered are chiefly Paleozoic, probably ranging generally through this era; they may in some localities include Lower Mesozoic beds.

LOCALITIES AND DESCRIPTIONS.

DALL RIVER AREA.

The old rocks were first encountered along the upper Dall River, where the hills in which it heads rise from beneath the silts of the Yukon Basin. It is out of these rocks and the granitic intrusives which cut them that the broad ridges and spurs were carved from which the waters of the Dall, Swift, and Kanuti rivers, and many Koyukuk tributaries flow. The phase most commonly displayed

a Geological section of the Rocky Mountains in northern Alaska: Bull. Geol. Soc. America, Vol. XIII, pp. 233-252.
b A reconnaisance of the Cape Nome and Adjacent Gold Fields of Seward Peninsula, Alaska in 1901, p. 31.
c A reconnaisance of the northwest portion of Seward Peninsula: Prof. Paper U. S. Geol. Survey No. 2, pp. 21-22.

here is a fine, even-grained quartz-biotite-schist, with very fine and straight lamination—a true metamorphic rock of uncertain origin. This type makes up the great mass of the schistose rocks of this area. With the intrusives which cut it, it forms the crest of the divide between the Yukon and the Koyukuk and the higher parts of the branching spurs where these were examined. Farther down their flanks and away from the intrusive centers, the rock is oftener coarser, less quartzose, and less finely and evenly laminated. Other micas than biotite sometimes appear and by gradations schists are encountered which are clearly sediments carrying graphite and calcite. Interbedded with schists like these, 2 miles north of Dall City, are three or four bands of gray, often very coarsely crystalline limestone, standing at high angles and striking nearly east and west.

South of the flats at the head of the Kanuti River a series of dark, fine-grained slates and dark quartzites form the lower slopes of the wall of the valley.

Intrusives.—The schists are extensively cut by uniform bodies of granite-porphyry, which in some parts of the region occupy greater areas than the rocks into which they have been forced. These masses are particularly abundant north of the upper course of the Kanuti River and among the hills northwest of the eastern branch of the Dall. An area near the head of Fish Creek, although not visited, exhibits rough topographic forms which are presumably to be ascribed to these resistant intrusive masses.

Near the camp of June 24 on the Dall River, granites which are not porphyritic and not schistose, though deeply weathered, outcrop along the stream section, and are regarded as intrusive in the schists, although the contact is not shown. On the hill slopes to the north occasional narrow and compact acid dikes are exhibited. These are regarded as offshoots from the main intrusive mass.

In addition to these unaltered intrusives, gneissoid porphyritic rocks of granitic and dioritic composition occur in the schists. Sometimes the crushing has gone so far as to suggest that some of the biotite-schists may themselves be derived from igneous rocks of like character, but as no instance was observed in which the distinction could not be clearly made, this suggestion remains unproved. It is true, however, that the intrusion began before the metamorphic action had ceased, so that the earlier intrusives were greatly affected by it.

KOWAK AREA.

The second group of metamorphic rocks was first seen a few miles above the mouth of Helpmejack Creek, and they were encountered at intervals all along the Kowak Valley and Kotzebue Sound.

The hills in which the lower course of Helpmejack Creek is cut are made up of a gray or green compact, schistose quartzite, with occasional calcite grains,

cut by intrusive greenstone masses which are themselves much altered and have been rendered schistose. Sufficient of their original structure, however, remains to determine them as diabases.

The quartzites overlie interbedded graphitic and chloritic schists, likewise containing basic intrusive masses, greatly altered. The east-west valley in which Kowak Pass lies seems to be cut along the strike of these softer beds, whose presence may have been a determining element in locating this wide depression.

North of the portage, the immediately adjacent mountain group is made up of interbedded crystalline limestones and gray schists, the latter often very graphitic and siliceous. One bed of limestone, 200 feet in thickness, is conspicuous, and the schists for several hundred feet above it contain narrower interbedded calcareous bands.

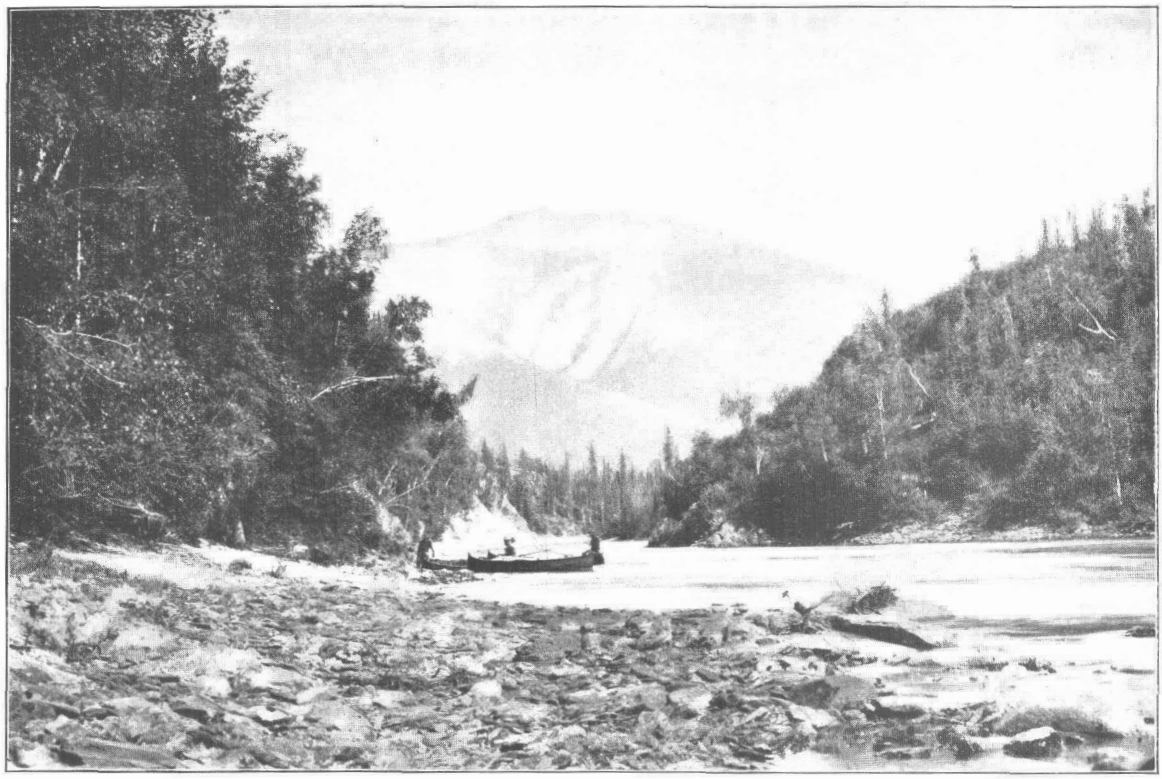
Along the southwest shore and the islands of Walker Lake, west of the last-described area, and having the same general strike, are lustrous muscovite-schists, quartz-calcite-schists, and massive crystalline limestones. On the shore opposite, 2,000 feet above the level of the lake, narrow belts of limestone interbedded with the schists form conspicuous white bands encircling the mountain.

Below and for a short distance above the outlet of Walker Lake the Kowak crosses a belt of black slates, usually clean, smooth, and easily cleaved, but also exhibiting pencil-slate aspects due to the development of two approximately equal cleavages at right angles to each other. These slates, like the schists to the north, more usually exhibit east-west strikes and southern dips, although local cross folds and fractures occur, with resulting confused attitudes.

Among the beds outcropping along the shores of Lake Selby, and assigned to this series, are a number of greenstones of various types. More generally they are highly schistose and appear in one instance at least to be derived from the alteration of a fragmental volcanic rock. The alteration usually has gone so far that very little can be said about the original character of the rock. One specimen examined was found to be composed almost exclusively of finely granular epidote.

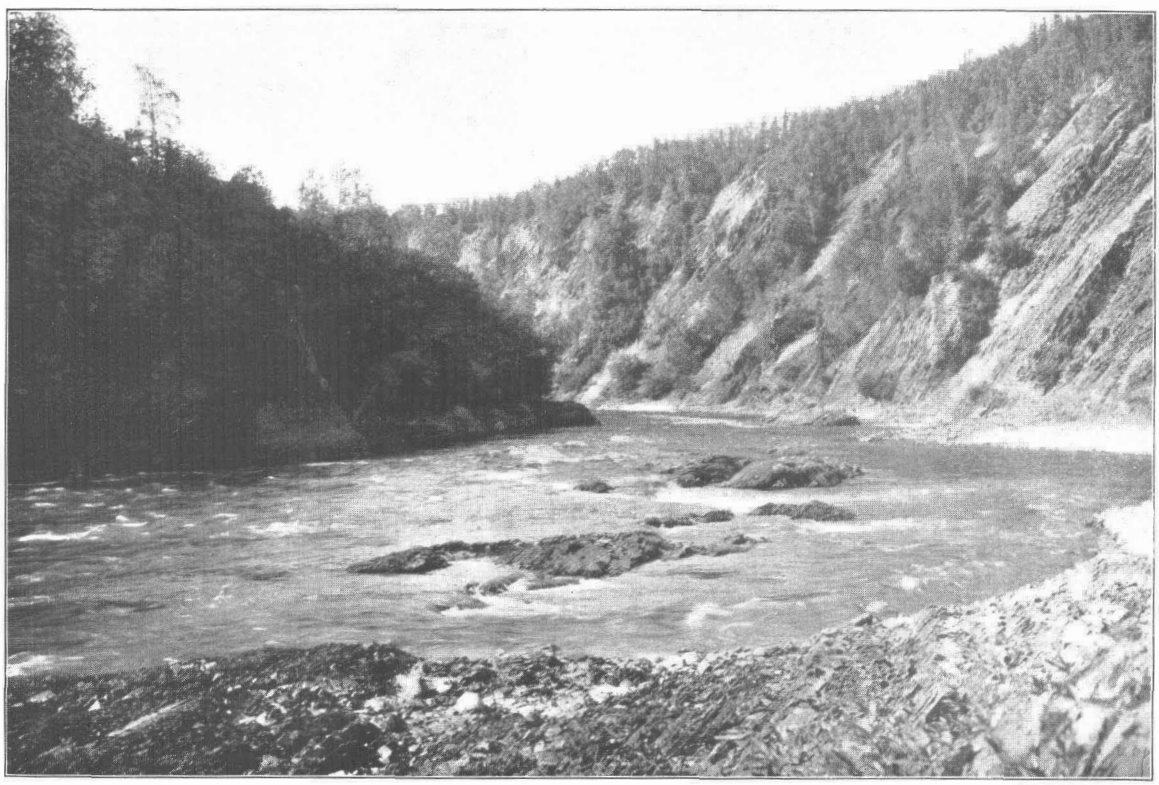
Above the mouth of the Kogoluktuk the Kowak swings against the north wall of its valley, and the rocks here exposed are green quartzose, micaceous, and chloritic schists. Quartz occurs as grains or lenses, from microscopic dimensions to bodies some feet in greatest diameter, and constitutes a very large percentage of the rock mass.

Near the head of Shingnek Creek, north of the range immediately adjacent to the Kowak Valley, Mr. L. M. Prindle reports limestones, mica-schists, and serpentines, and still farther to the north rugged ranges of schistose rocks. West of the lower course of the Ambler lies a high group called by Lieutenants Stoney and Cantwell the Jade Mountains, because of the occurrence of jade along their southern



A. UPPER KOWAK 1 MILE BELOW MOUTH OF KICHAIAKAKA CREEK.

In the background are mountains of schist.



B. SLATY ASPECT OF BERGMAN SERIES IN LOWER GORGE OF KOWAK RIVER.

The same general series presumably continues westward along the shores of Goodhope Bay to Rex Creek, where it was reported by Beechey and by prospectors to be succeeded by recent volcanics.

STRUCTURE.

But little definite structural evidence was collected in the region of the Dall River portage. The schists, where so extensively intruded by the porphyries, are generally nearly vertical, but exhibit very confused strikes. Near the southern edge of this area, where interbedded limestones gave datum planes from which to determine attitude, the schistosity and bedding were found to correspond. Here the dips were to the south at rather high angles, with strikes varying somewhat, but generally east and west or a few degrees north or south of these directions. The northern edge of this field was not reached nor anywhere closely approached, but the fact that the majority of the strikes and dips recorded near the southern margin are to the south and the greater proportion of the porphyritic intrusives occur some distance north of the margin nearer the center of the mass, suggests that the general structure may be anticlinal.

The schists where examined along and north of the Kowak almost universally exhibit east-west or nearly east-west strikes parallel to the Endicott Mountains, whose southern flanks they form here. Their dips are, as generally, southward, away from the mountains. They pass under the silts, gravels, and recent deposits of the Kowak Valley, and probably do not rise to the surface again on the south side of the mountains except at one or two points within the drainage basin of the Kowak. Hotham Peak and its immediate vicinity and the Sheklukshuk Range, although not examined, show topographic forms which are characteristic of the schistose series in other localities, and the streams draining them carry schistose pebbles, so that limited areas in the immediate vicinity of these mountains are probably made up of these older rocks. Hence the Kowak occupies a great strike valley, and probably portions of that valley are synclinal.

So closely do the measured strikes in the schists conform to the direction of the valley walls at each particular point measured that it is suggested that the minor irregularities of the valley (its local variations from an east-west direction) may correspond to and be dependent upon equivalent variations in the trend of the schistose series.

VEINS.

Along the Dall River portage the mass of old rocks is very siliceous, and blebs of pure white quartz, often of large size, occur. A lens exposed along the trail above Dall City is 10 feet in thickness and 40 or 50 feet long. It displays unbroken interlocking quartz crystals and rhombic cavities from which calcite has been dissolved, but no other mineralization is in evidence at the surface. Its

of July 6 there are masses of ultrabasic rock often much altered to serpentine, but identifiable in particular cases as pyroxenite and hornblendite. Their dark-red color when weathered is due to the iron, which they contain in sufficient amounts to cause a disturbance of the magnetic needle in their vicinity.

Greenstones and intrusive bodies, the latter belonging to dioritic or gabbroic magmas, continue to form the valley walls downstream from the occurrence just described until the river passes out into the lower flats, except for some bluffs along the right bank of the river in the vicinity of the camp of July 8, where more recent lavas and tuffs occur.

An isolated hill, 800 to 900 feet high, around whose southern base the river flows just before entering the flats, is the last outcrop examined which belongs to the rocks of this type. It proves to be a mass of serpentine with much later intruded diabase.

Two or three belts of granitic rock, apparently occurring as later intrusives, cut the series at adjacent points along the river.

INTERRELATIONS.

The rocks which have been grouped together here as the Kanuti series are very diverse in mode of occurrence, but with the exception of the hornstones described above they are generally basic igneous rocks or their pyroclastic equivalents. The oldest members are the greenstones and hornstones, which exhibit considerable mechanical alteration. Younger than these are the massive gabbroic rocks (and the serpentines derived from them), which are regarded as intrusive in the bedded greenstone members, while the most recent rocks of the series are the basalts, basaltic tuffs, and diabases, the latter intrusive in certain instances in the serpentines.

AGE AND EQUIVALENTS.

The entire series is regarded chiefly upon the basis of less extensive mechanical alteration as younger than that phase of the schistose beds studied along the Dall River portage. These are regarded as among the oldest of the schistose series, being probably of early Paleozoic age. The earlier of the Kanuti rocks may then be considered as Middle Paleozoic. Mr. Spurr's Rampart series,[a] consisting of diabases, which he regards as flows, and associated sediments and tufas, outcrops along the Yukon 50 miles southeast of the occurrences on the Kanuti River. Except that no equivalents of the massive gabbroic rocks of the Kanuti River are described along the Yukon, the resemblance between the occurrences is sufficiently close to suggest that they represent the same conditions and belong to the same period.

[a] Geology of the Yukon district, Alaska; Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, pp. 155–169.

155°

154°

153°

67°

Walker Lake

800

Aug. 11

RAPIDS

GORGE

Aug. 9 Var. 29°30' E.

Aug. 7

Kichaiakak Cr.

Aug. 8

RAPIDS

Aug. 10

Winter Portage

River

Reed River

Nutavuk Lake

Kowak

GORGE

Aug. 13

Aug. 14 Var. 29°20' E.

Cabins

Aug. 15

GORGE

Norulak Lake

Hogatza River

Allen

Rapid City

1000

July 30 Var. 29°10' E.

Help-me-Jack Cr.

July 27

July 25 Var. 28°30' E.

Beaver City

July 24

Portage to Hogatza

Seruuka Cr.

July 23

July 22

River

July 21

July 20

Struk Cr.

LEGEND

PLEISTOCENE

Silts, sands, and gravels

BERGMAN SERIES
MESOZOIC?

Sandstones, graywackes, and shales, latter sometimes slightly altered

Chiefly conglomerate and sandstone. On Kowak River includes red beds

METAMORPHIC COMPLEX
PALEOZOIC ?

Slate

Limestone

Schists of various types; may include slate and limestone

IGNEOUS

Diabasic intrusives

Vertical beds

Dip and strike

GEOLOGIC RECONNAISSANCE MAP

OF THE

REGION ABOUT THE PORTAGE FROM THE KOWAK TO THE ALLEN RIVER

Geology by Walter C. Mendenhall, Topography by D. L. Reaburn

1901

Scale

10 0 10 MILES

Contour interval 200 feet

Datum is mean sea level

Probable drainage not surveyed

Dates indicate camps

JULIUS BIEN & CO. LITH. N.Y.

BERGMAN SERIES.

LOCALITIES AND DESCRIPTIONS.

Twenty-five miles above its mouth the valley of the Kanuti River closes in abruptly and the stream enters a narrow defile with walls several hundred feet high, which are composed of folded sandstone; fine conglomerates; and dark, sandy shales. Below Mentanontli Creek outcrops of these rocks are less frequent, but the hills back from the river on either side are found to be made up of sediments of the same general character. They are well shown along the Koyukuk between Arctic City and Bergman, although more arenaceous here than in some localities, and they extend up the Allen to beyond the mouth of Helpmejack Creek. Usually the sandstones and shales are associated in thin, sharply defined alternating bands, but occasionally the sandstones disappear and broad belts of shale many hundred feet in thickness are found.

Passing northward up the Allen thin conglomerate beds begin to appear with pebbles of black and green flint and occasionally of quartz. The shales decrease in amount and become somewhat more fissile as the sandstones are replaced by the conglomerates.

In the vicinity of Beaver City outcrops of the basal portion of the formation consist almost exclusively of conglomerate, which is not usually coarse, and contains pebbles of diversified types derived from the older rocks to the north. The conglomerate lies nearly horizontal and extends eastward to Totsenbet River, where it has been reported by Mr. Schrader.

On the Kowak, a few miles above the outlet of Lake Nutavukti, conglomerates are exposed which, although exhibiting some variations from the type, are regarded as belonging to the Bergman series. The conglomeratic beds are here interbedded with red and green shales, and a considerable body of soft red sandstones occurs in one locality. In the conglomerate occur pebbles of slate, greenstone, and other types, which are recognized as derived from the older rocks to the north.

Through the mile gorge, a short distance above the outlet of Norutak Lake, the Kowak flows along the strike of a slaty phase of the Bergman, which is very similar lithologically to a belt crossed along the Allen nearly due east of here. The slates in the canyon of the Kowak carry small limestone lenses and are cut by narrow quartz stringers. They have been only very slightly metamorphosed.

Below the gorge the river enters a broad, filled valley with no rock exposures until the mouth of the Reed River is reached. Here slaty shales, similar to those in the gorge above, are found in outcrop and exhibit a northerly dip, while those in the gorge dip toward the south. Five or 6 miles farther downstream, soft, green, fractured sandstones and graywackes, frequently weathering red, are encountered.

A short distance above the mouth of Pah River the hills south of the Kowak are found to be composed of these same Bergman beds. The shales predominate here, and the topographic forms to which they give rise extend westward to the head of the Kuikcherk River and eastward as far as can be seen.

STRUCTURE.

The beds of the Bergman series are everywhere folded to a greater or less degree, the amount being dependent on the resistant power of a particular portion of the mass as well as on its situation relative to the stresses which have brought about the folding. In the first exposures observed along the Kanuti River, 20 or 25 miles above its mouth, the interbedded sandstones and shales are thrown into close folds, anticlines and synclines succeeding one another rapidly with maximum dips of 65°. No faults were observed. Along the Koyukuk, between Arctic City and Bergman, the beds, here more arenaceous, are likewise folded. A fault of unknown throw which crosses the river here has been figured by Mr. Schrader.[a] Along the Allen north of the Koyukuk the beds generally dip toward the south at angles of from 20° to 60°, only occasionally and for short distances exhibiting dips to the north.

Near the northern limit of the formation the basal conglomerates form a broad belt, and where exposed in the neighborhood of Beaver City are horizontal or dip to the south at low angles. Corresponding outcrops of conglomerate along the upper Kowak show higher dips, but in the same general direction.

The black shales in the lower gorge of the Kowak dip to the south at angles varying from 45° to 65°, and the similar and probably equivalent beds at the mouth of the Reed River have northerly dips, as do those just above the Pah. Some faulting has taken place in the sandstones below Beaver Creek, but it is probably not extensive.

To summarize, it may be said that the structure of the Bergman series is complex, involving abundant open folds and some faults of unknown extent, but that in a broad way it forms a synclinorium with bounding walls of older rocks outcropping toward the northwest and the southeast.

AGE.

The beds of the series were closely scanned by the writer over a broad area and have been carefully studied for two seasons by Mr. Schrader, but as yet no determinable fossils have been found in them. Indistinct and fragmental plant remains occur in places, and fragments of coaly material were noted in the conglomerate at one locality. The conglomerate forming the basal member of the series is derived

[a] Reconnaissance along Chandlar and Koyukuk rivers, Alaska, in 1899: Twenty-first Annual Rept. U. S. Geol. Survey, Part II, p. 469.

principally from the schists which have been described, hence the beds are later than these. Usually they are wholly unmetamorphosed, but the beginnings of metamorphism appear in some of the shaly phases along the middle Allen and in the gorge of the Kowak. These beds may eventually have to be separated from the Bergman series, but sufficient evidence was not gathered this season for such a separation, hence they are included with the entirely unaltered rocks. The induration is generally greater than that of the lignite-bearing Tertiary beds of Dall River and those of the lower Kowak, although folding is but little if any more complex. From these general characters, the beds are to be regarded as pre-Miocene, and since the older schists probably include members extending well up in the Paleozoic, we may assign the Bergman to the Mesozoic, pending the finding of more definite evidence.

KENAI SERIES.

LOCALITIES AND DESCRIPTIONS.

About a mile above the mouth of Coal Creek, a western tributary of the Upper Dall, there occurs an outcrop of soft gray, buff, or black shales, standing at an angle of about 30° and associated with a heavy bed of lignitic coal and bone. A short distance upstream from the mouth of Coal Creek, the Dall River receives a tributary from the north which carries lignite fragments, proving the occurrence of lignite-bearing beds somewhere within its drainage basin. No fossils were found in any of these Dall River beds, but because of the character of the lignite which occurs in them, and their own lithologic resemblance to well-determined strata in other parts of the territory, they are assigned with considerable confidence to the Kenai group.

Along the lower course of the Ambler, outcrops were examined which consisted of a series of conglomerates, soft, cross-bedded sandstones, and shales, which were often carbonaceous and carried obscure remains of plant stems. Some phases of the conglomerates are made up wholly of material derived directly from the mica-schists and but little sorted. White vein quartz, somewhat rounded, furnishes most of the material for the pebbles, which are embedded in a matrix, consisting chiefly of fine muscovite and chlorite foils. These beds make up the low hills between the lower Redstone and the Ambler and between the latter stream and the Kowak. Similar beds, associated with limestone, are reported by Mr. Prindle along the middle course of Shingnek Creek.

Just below the mouth of the Hunt River a hard quartz conglomerate containing coal fragments was found in place, and prospectors report similar beds as forming bluffs for several miles along the lower course of the Hunt River.

The most extensive exposures of these beds along the Kowak are found in outcrops along both banks for 8 or 10 miles below the mouth of the Reed River. Here a succession of conglomerate layers, with pebbles of quartz, mica-schist,

limestone, and serpentine embedded in a micaceous matrix, alternate with less resistant and hence less well-exposed beds. The individual conglomerate plates vary from 10 to 200 feet in thickness, but are quite uniform in character. The softer beds separating them are sandstones, shales, fire clays, and coals.

STRUCTURE.

These rocks are everywhere thrown into folds, whose details are not generally determinable from the evidence gathered. Faults were not observed. The rather uniform southerly dips which generally affect the older beds to the east are absent, the structures being more local in character.

AGE.

A few fossil plants were collected below the mouth of the Reed River and submitted to Dr. F. H. Knowlton for determination. He says, "This collection consists of five small specimens, the matrix being grayish, fine-grained, very hard sandstone. The plant remains are not retained with great fidelity, but fortunately all are determinable. Four species are represented, as follows: *Ginkgo* sp. probably *G. adiantoides* (Unger) Heer, *Taxodium distichum miocenum* Heer, *Taxodium tinajorum* Heer, *Populus arctica* Heer. With so few species as a basis for comparison, it is not possible to speak very dogmatically as to their probable age, but all things considered, I should incline to refer them to the so-called Arctic Miocene, which is now generally regarded as belonging, really, to the Upper Eocene."

This identification assigns these beds with much probability to the Kenai group, where they were placed on more general grounds by Dall and Harris[a] in 1892. The Ambler River occurrences are assigned to the same period because of lithologic resemblances, indistinct vegetable remains, and associated carbonaceous matter.

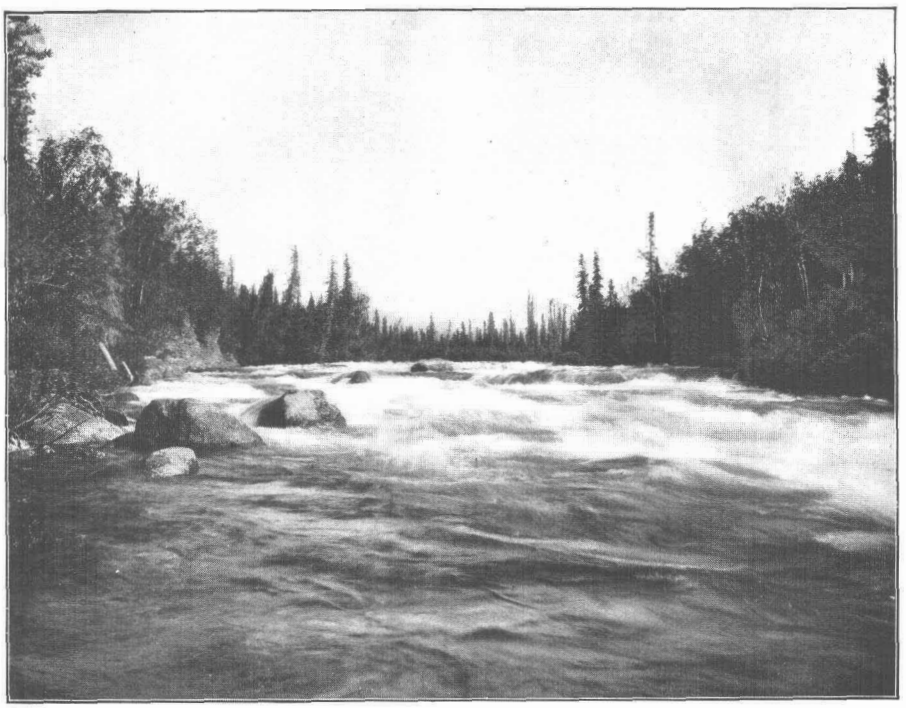
LAVAS.

Basalt.—Along the middle Kanuti River, in the vicinity of the camp of July 9, horizontally bedded vesicular olivine-basalts form bluffs 50 to 75 feet high on the north bank of the river, and similar bluffs south of the valley are probably due to the same formation.

South of Goodhope Bay, Beechey reported olivine-basalts, and the accounts of prospectors tend to confirm the presence of a recent lava here. Somewhat farther south, the writer[b] in 1900 found extensive sheets of basaltic lavas in the valley of the Koyuk River, and Mr. Collier[c] in 1901 found similar areas in the valley of the

[a] Bull. U. S. Geol. Survey No. 84, p. 248.
[b] Reconnaissance in the Norton Bay Region, Alaska, in 1900, p. 206.
[c] A reconnaissance of the northwest portion of the Seward Peninsula, Alaska: Prof. Paper U. S. Geol. Survey No. 2, p. 31.

A. OUTCROP OF TERTIARY (KENAI) SEDIMENT, COAL CREEK.



B. RAPIDS IN OUTLET OF WALKER LAKE.

The stream here for a few hundred yards cuts bed rock; throughout the remainder of its course it has gravel banks.

Kuzitrin. Their presence adds to the probability that the Goodhope occurrences are basalts.

Andesites and tuffs.—The most extensively distributed lavas in the Kanuti River Valley are hornblende-andesites and associated fragmental material. In the vicinity of the camp of July 8, massive flows and coarse breccias, the latter sometimes containing angular blocks 10 feet in diameter, embedded in fine ash or pumice, form bluffs 250 feet in height along the river. Downstream from this locality, the tufaceous form of the deposit disappears, but the low hills for many miles north of the river are made up entirely of massive andesites.

AGE.

The basalts and andesites were not found in contact, but both occur along the Kanuti River in horizontally bedded flows. The andesites lie at higher levels and are therefore perhaps younger. Since both are structurally undisturbed, they are more recent than the Kenai beds of the upper Dall River, which are extensively folded. The relation of the andesites to the topography is such as to suggest that the lavas flowed into valleys which had been cut to approximately their present depth, and thus brought about changes in drainage. The streams have since cut through or at least well into the lava and breccia filling, and have removed in some cases hundreds of feet of it. This cutting may have occupied all of Pleistocene time, but probably not more, so that the lavas are to be regarded as very late Tertiary or possibly early Pleistocene.

UNCONSOLIDATED DEPOSITS.

Dall River.—The Yukon Flats, with their characteristic deposits, which have been described in abundant detail by other writers, extend up the Dall for 60 miles or more. Throughout this lower part of the river they stand approximately at high-water mark, so that during the spring freshets the whole region is inundated, with the exception of only a few knolls which have been built up by accumulation of vegetable matter. Sections of the river banks exhibit alternating vegetable and silt layers, the former generally the more prominent. Associated with both there are occasional scattered bowlders and embedded gravels, which are regarded as ice-borne.

Nearer its source, the Dall River is found to be incised for 100 or 150 feet in beds which are chiefly fine silts, but contain sands and often, near the base, gravel and shingle layers. These become coarser farther up the valley and finally merge with indistinct and incomplete terraces of gravel, with no recognized fine material, which flank the hills about the headwaters of the stream.

Kanuti River flows through two basins filled with silt and gravel. In the upper, which is between 10 and 15 miles in length and 4 or 5 in width, the deposits grade from coarse river gravels at the upper end of the flats to fine muds and silts

at the lower end. They have been deposited by the stream while flowing at its present level, since the silts do not in any observed instance extend above the flood plain stage of the river. The lower basin of the Kanuti River is more extensive, and the deposits more complex. The flats begin about 140 miles above the mouth of the river and extend 100 miles downstream. At first they occupy a valley about 4 or 5 miles wide, but near the mouth of a large tributary from the south this valley and the deposits which fill it expand to a width of 20 to 25 miles. Usually the silts stand but a few feet above the water level, but near the center of this basin there occur several groups of hills composed of silt and sand, which rise from 100 to 200 feet higher. They are remnants of an earlier deeper filling, the rest of which has been removed by erosion.

Allen River.—The lower Allen Valley and the immediately adjacent parts of the Koyukuk Valley are filled with silts and gravels, and these extend up the Allen, increasing in coarseness but decreasing in lateral extent as the valley narrows, until they merge with comparatively coarse glacial deposits in the vicinity of Helpmejack Creek. The limits of glacial activity within the Allen Valley can not be accurately determined from the data at hand, but the character of the gravels is such that they may all be regarded as water-transported and sorted glacial débris.

Kowak River.—Similar material is abundant about the outlet of Walker Lake and is spread over the floor of the Kowak Valley as far down as the lower gorge of that stream. The truly glacial filling, however, is probably best developed within the valley drained by Helpmejack and Kichaiakaka creeks, along which the portage from the Kowak to the Allen lies.

Below the gorge of the Kowak the glacial aspect of the gravels and sands gradually fades, and the entire middle stretch of the river, from the gorge to the mouth of the lower Reed River, is filled by a mass of unconsolidated clays, silts, and sands, which, whether originally fluvial or glacial, can not now be distinguished from such deposits as occupy the Yukon Flats. The "Kowak clays," described by Cantwell from an outcrop just above the mouth of Jade Creek, and the subject of a notice by Dall and Harris, are perhaps the best exposure of the finer phase of these beds, although cut banks of similar material are not at all unusual in this section. The clays here occupy the same relation to the stream as do the sands and gravels farther up the valley, and are to be regarded as but a downstream and consequently finer representative of these. Both the silts of the middle section and the coarser deposits of the upper form bluffs which sometimes rise to heights of 150 feet above the water level.

The valley of the Kowak is comparatively narrow between the mouths of the Reed and Squirrel rivers, being here but 2 to 4 miles across as compared with

four or five times this width above, but below the Squirrel River the expansion of the delta begins, and where the waters of the various sloughs and channels enter Hotham Inlet the width along an approximately north-south line is 26 to 27 miles. The delta deposits are frozen muds and vegetable accumulations, with occasional masses of quite clear ice. Many writers since Kotzebue have discussed the origin of these ice cliffs, but the explanation given by Mr. L. M. Turner,[a] Messrs. E. W. Nelson and C. L. Hooper,[b] and Prof. I. C. Russell[c] seems to be entirely adequate. It is that many of the numerous lakelets scattered about over the tundra are gradually buried by the advance of their mossy borders toward the center. After their burial they are frozen, as is the entire tundra, a few inches below its surface and are later revealed by lateral river cutting, as in the Kowak delta, or by the work of waves, as at Elephant Point, and appear as masses of comparatively clear ice in the general deposit of frozen mud, sands, and vegetable matter.

Kotzebue Sound.—All of the peninsula which separates Hotham Inlet and Selawik Lake from Kotzebue Sound and its waters, with the exception of the extreme southwestern point (where members of the schistose series outcrop in Choris Peninsula), is made up of Pleistocene silts, clays, and embedded ice. Its outline and topography suggest that shoals which have formed off the mouths of the Noatak, the Kowak, the Selawik, and the Buckland have been raised into islands by slight local elevations, and that these islands have afterwards been tied into one long peninsula by the action of winds, waves, and currents.

Elephant Point is a famous locality for the bones of extinct and living species of mammals and has been visited by Kotzebue, Beechey, Nelson, Dall, and others. At Cape Blossom similar remains are found, and Cantwell reports tusks of the mammoth on the Kowak below the Ambler. Mammoth bones were observed this year near the head of Hotham Inlet, and they may be looked for anywhere in the frozen clays and silts of this region where there are exposures. For a fuller discussion of these fossils and of the formation in which they are found the reader is referred to Dall and Harris.[d]

GLACIATION.

That part of the region between the Yukon and the Koyukuk which was visited shows no evidences of glacial action and exhibits abundant phenomena to prove that there has been no such action there within geologically recent times. The slopes bordering the valleys have not been cleared of their mantle of débris; no rock

[a] Contributions to the Natural History of Alaska, Signal Office, Washington, 1886.
[b] Report of the cruise of the U. S. Revenue steamer *Thomas Corwin* in the Arctic Ocean, 1881,
[c] Surface geology of Alaska: Bull. Geol. Soc. Am., Vol. I, 1889, p, 128.
[d] Correlation papers. Neocene: Bull. U. S. Geol. Survey No. 84, p. 260 et seq.

scorings are to be seen; the recent deposits along the middle and lower courses of the Dall River are stream-laid silts, and the sands and gravels contain, so far as examined, no bowlder clays. The mountainous country about the head of the Kanuti, Dall, and Swift rivers and the various southern tributaries of the Koyukuk is characteristically rough in its higher portions, without evidence of the smoothing action of a general ice sheet, while in the upper Kanuti River Valley the dikes of granite-porphyry which intrude the slates and schists of the region form rough minor ridges near the present stream level and exhibit disintegration bowlders and other undisturbed forms due to weathering. The canyon below the upper basin of the river is likewise free from evidence of ice work, the disintegration mantle being usually present where the grade of the valley walls is such that it may be expected.

North from the Koyukuk, however, evidences of ice work begin to appear. The isolated mountain mass lying between Helpmejack Creek and the Alashuk River has suggestively smooth forms, and there are scattered about on its summit a few rounded quartz and quartzite pebbles. No definite striations and no considerable glacial deposits were noticed, but, standing as it does near the junction of the three valleys of the upper Helpmejack, the upper Alashuk, and Malemut creeks, it is conceivable that the ice which occupied these valleys may have temporarily capped this knob, although its general level was much lower.

More definite evidence is obtained in the neighborhood of the portage to the Kowak and about Walker Lake. Distinctly striated pebbles occur along upper Kichaiakaka Creek, and the confused topographic forms of the gravel fillings of this valley and its continuation westward across the portage to the Kowak immediately suggest ice action. Along Helpmejack Creek and the middle Allen drainage changes have taken place which are best explained by glacial action. The direct topographic continuation of the upper Helpmejack Creek Valley is eastward into the Allen by the pass which leads to the latter stream in the vicinity of Rapid City, but Helpmejack Creek at present leaves this broad, open way, turns to the south at right angles to its logical course, and reaches the Allen at Beaver City. Such a course probably was originally a spillway for glacial waters, and in it Helpmejack Creek became intrenched while the more northerly outlet was still occupied by ice. Upper Helpmejack Creek occupies a filled valley, but not a systematically filled one. The valley is occupied by incompetent meandering streams and numerous small ponds at varying elevations. Its ridges and terraces, while of waterworn sands and gravel, so far as examined, are at no constant elevation and bear no obvious relation to each other. In short, the topography and stream alignments are of the confused type which results from ice work, and

are in strong contrast to the more regular types which are due to normal stream growth.

The filling of the valley of Kichaiakaka Creek, is sufficiently deep to effectually conceal bed rock except at one doubtful point, and is made up of fine gravels and sands, including schist, quartz, and granitic pebbles, practically all local rocks, but no clays nor angular material, so far as observed. The area is but imperfectly drained; kettles without surface outlets, long, low ridges, transverse to the valley, and irregular gravel hummocks being typical forms.

On the islands in Walker Lake are exhibited the only roche moutonnée surfaces that were observed during the summer. These forms were revealed at first only near water level, where the bed rock was free from its usual vegetable cover, and their occurrence here suggested that the polishing might be due to the action of lake ice in the spring and fall, when under the influence of strong winds, but a close examination proved the action to have been regular and constant in direction, and that direction, as indicated by the well-marked grooves parallel in places to the shores of the islands, was at right angles to the lines along which lake ice would usually work. The striæ on these polished surfaces are generally parallel to the long axis of the lake, and, although well-marked stoss and lee sides do not exist, there can be no doubt that the glacier which occupied the lake basin flowed down from the high mountains northwest of the lake toward the valley of the Kowak.

The stream which drains Walker Lake flows between gravel banks except at one point midway of its course, where it cuts a bed-rock barrier and becomes for a few hundred feet a wild rapid. The low gravel hills about the lower end of the lake exhibit the same tumbled and irregular arrangement which marks those of the Kichaiakaka. Angular forms such as are produced by ordinary subaërial agencies mark the higher slopes bordering the lake, and a general rounding without evidence of violent action characterizes the lower slopes for at most a distance of but a few hundred feet above the present water level, so that the ice stream which filled the valley now occupied by the waters of the lake seems not to have been a deep one. The present outlet of the lake probably marks approximately the southern limit of the glacier at its principal stage of advance, and the materials discharged at its front, sorted and worn by the waters flowing from it, built up the valley beyond and remained as a dam after the retreat of the ice tongue. Along the eastern shore and near the southern end of the lake, exists a mass of angular material, probably representing a moraine built by an ice stream from Walker Lake or the upper Kowak.

Just above the mouth of the Reed River, at the junction of its valley with

that of the Kowak, is a low hill made up of the Bergman conglomerates, and leading out from its foot toward the mouth of the Reed River is a long train of angular rubble composed of schistose rocks. Evidently this is the moraine of an ice stream which occupied the valley of the Reed River and headed back among the altered rocks of its upper course, for material of the type represented in the moraine does not outcrop in this vicinity.

At the lower end of Lake Selby the gravel hills which dam it exhibit the general irregularities which characterize those of the Kichaiakaka Basin, and small undrained tracts are often inclosed in the encircling mounds. Along the west shore of the southern end of the lake three or four gravel ridges show a rough parallelism, all of them making a large angle with the axis of the lake. They are of waterworn material and belong rather to the esker than to the morainal type.

About 2 miles above the mouth of the Ambler River on its left bank occurs a deposit of blue bowlder clay 25 feet in thickness. Blocks and pebbles of dark crystalline limestone, much greenstone, and relatively small amounts of conglomerate and sandstone are scattered through the clay, and these bowlders are sometimes subangular and finely striated. The rocks of the lower course of the Ambler are sandstones and conglomerates, so that the greater part of the coarser material in the clay has been transported at least some miles. Overlying the clay are deposits about 100 feet in thickness of irregularly stratified yellow sands and clays without coarse material. The lower portion of this deposit at least is to be regarded as a true ground moraine, thus proving the extension of the Ambler Valley glacier to beyond this point.

The high mountain group separating the headwaters of the Noatak from those of the Kowak and extending thence eastward and westward was a center from which valley glaciers radiated along the principal drainage lines. These valley glaciers have extended down the northern tributaries of the Kowak at least to the main east-west valley of that stream, and have furnished much of the material with which the upper part of its course is encumbered. The upper part of the Allen Valley has no doubt also been occupied by ice. The ice streams, except near their source, have probably not been deep, and their principal topographic effect has been to fill valleys, disturb drainage, and build dams behind which lakes have grown. Their direct action probably has not extended far beyond the foot of the mountain range in which they originated.[a]

[a] Mr. Schrader has found striated pebbles on the hills back of Bergman. If these have been deposited in their present position by ice, the valley glaciers have had a greater maximum extent than the writer has indicated.

ECONOMIC GEOLOGY.[a]

COAL.

Dall River.—In the bed of Coal Creek, about 1 mile above its confluence with the Dall River, there is an outcrop of lignite with irregular clay streaks, which measures, as far as can be determined from the imperfect exposures, approximately 11 feet in thickness. At the base of the exposure is 4 or 5 feet of firm, bright lignite, while the remainder is soft, dirty, and of poor quality. Blocks of the coal have been washed down the creek and some distance down Dall River without breaking up; but certain portions of the seam slake rapidly when exposed to the atmosphere. Although no opportunity was afforded for making practical tests, the lower 4 or 5 feet of this seam is believed to be a lignite of good quality, while the remainder is probably of no value. This coal is contained in soft gray, buff, or black shales, which are supposed to be Tertiary (Kenai series).

Kowak River.—The Tertiary sediments in which the lignites occur outcrop along the banks of the Kowak between the mouths of the Squirrel and Reed rivers, and it is probable that they occur in the lower valleys of the Reed, Salmon, Kaligurecheark, and Hunt rivers. The Kowak occurrences are mentioned by Stoney and are more fully described by Cantwell and McLenegan, who attempted to use some of the coal as fuel in a steam launch, but with unsatisfactory results.

The coals occur in low bluffs along the river, interbedded with conglomerates and fire clays. Those sufficiently well exposed for examination are of poor quality and burn slowly, yielding abundant ash and the disagreeable gases which are characteristic of impure lignites. So far as could be determined, none of the coals outcropping here are more than 2 or 3 feet in thickness, and the majority of the seams are much thinner. Half a dozen, with a thickness of 6 or 8 inches, were examined during the reconnaissance. Economically the beds are valueless.

Coal is also reported in the valleys of the Kewalik and Buckland rivers, but this occurrence has not been confirmed.

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[a] Two geologic maps have been prepared. One is a general map of the entire region studied, upon which the facts gathered in the reconnaissance have been expressed by patterns, while those gleaned from other sources are printed in red. This map is intended to serve an economic as well as a geologic purpose, the known gold occurrences being confined to the area of the Metamorphic complex and the known coal occurrences to the area of the Kenai series. Coal, however, may occur in the Bergman series, although none is known at present in these rocks.

The larger scale map is introduced in order to show in somewhat greater detail than is possible on the general map the distribution, relations, and character of the rocks in the vicinity of the Kowak-Allen portage.

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GOLD.

Dall River.—Some prospecting has been done along this stream and a few colors may be found on the bars and on the rim rock where exposed in the upper valley, but no occurrences of sufficient richness for development are known.

Allen River.—Colors are also found on the upper Allen and some of its tributaries, including Helpmejack and Rocky Bottom creeks. During the summer of 1901 two prospectors were at work on the latter stream, but practically no work has been done here since the 1898 rush, when a number of men from the Koyukuk prospected in different parts of the Allen Valley and found colors in a number of localities, but developed nothing rich enough to justify any considerable expenditure of time or money.

Noatak River.—On a tributary of the Noatak, which is reached by a short winter portage from the head of the upper Reed River, two or three claims were staked in 1898, from which a little coarse gold is reported to have been washed. It is said that no fine gold occurs with the coarse, and that other ground in the vicinity of these claims is barren. The claims are located 5 or 6 miles from the main Noatak River, on a small mountain stream with a narrow valley, and but a small quantity of gravel in sight.

Several men with outfits intended to remain in Kotzebue Sound during the winter of 1901–1902 and advance supplies up the Noatak, with the idea of doing further prospecting there.

Kowak River.—Fine colors may be washed from the gravel of the upper Kowak and many of its tributaries, and this fact, duly exaggerated and well advertised in a sufficiently mysterious fashion, led to the stampede of 1898. So far as known, not a single strike of consequence was made, and but little prospecting has been done since, although a few white men were in the valley last season. Such colors as are found usually come from the northern tributaries of the river, although a small amount of very fine gold is reported at the head of the Pick.

Kotzebue Sound.[a]—Late in the fall of 1900 a movement began from the Nome region toward the shore of Goodhope Bay and adjacent parts of Kotzebue Sound, and as soon as navigation opened in July, 1901, the supply station of Deering was established at the mouth of the Ipnechuk River. Many prospectors and miners came in from the more southerly areas at this time and the Fairhaven mining district was created, and so defined as to include Goodhope, Cripple, Sullivan, Ipnechuk, Kugruk or Swan, and Kewalik rivers, together with the northwestern portion of the Buckland drainage system.

[a] For much information concerning the Fairhaven district the writer is indebted to Mr. R. J. Wynkoop, deputy recorder.

In the western part of this district those creeks which have been the scene of the most active operations during the past season and are most favorably reported upon are Old Glory, Perry, and Hannum and its tributaries. The gold from Old Glory Creek, which may be regarded as a fair sample of the region, is dark, rather fine, and assays[a] between $16.50 and $17 per ounce.

Candle Creek, concerning which encouraging reports have been made during the fall and early winter, is a western tributary of the Kewalik River, which it joins about 6 miles above the head of Spafarief Bay. The stream is 20 or 25 miles long, and with its tributaries was all staked during the early summer. Some unsystematic work was done during the fall of 1901 by snipers, usually working with rockers. Their operations were confined to the creek bed, but it is uncertain whether bed rock was reached in more than one or two instances. The width of the pay was not determined, nor in many cases the depth of the gravel. The latter is given at one or two localities as about 2½ feet. The gold, of which $20,000 to $25,000 is estimated to have been taken out during the late summer, is dull in color, considerably flattened, and assays nearly $17.

Dome, Minnehaha, Windy, Virginia, and Alder creeks, just west of Candle, have been prospected, and are reported to give good indications.

Beach diggings of limited extent have been carried on near the mouth of Alder Creek, and are reported to yield $8 or $10 per day to the man. The gold here is fine, and is evidently derived immediately from the dark-gray schists which form the bluffs back of the beach. Bed rock is reached at a distance of about a foot under the shingle of the beach, and the gold is taken from its surface. Some threads of wire gold are seen among the washings.

One bench claim has been located at the mouth of Chicago Creek, a tributary of Swan River, and is reported to prospect well.

Late in the fall of 1901, when exaggerated reports began to reach Nome of the Candle Creek finds, several boat loads of supplies were shipped into the sound, and a number of people accompanied the supplies, with the idea of wintering there. Besides these, many went overland after the snow fell. The work of another season will be required to determine whether the richness of the Candle Creek district is sufficient to justify the stampede, which has assumed rather large proportions.

NATIVES.

YUKON VALLEY.

At the mouth of the Dall River is a settlement of the Yukon Indians, who fish and hunt in the immediate vicinity of this stream. One or two of the more experienced men in the tribe occasionally act as river pilots through the Yukon Flats, and for this work are well paid. Others, besides their fishing and hunting,

[a] Assays by Mr. E. T. Allen, U. S. Geol. Survey.

work in the near-by wood camps or for traders at the various stations, receiving their pay in clothing and food supplies. They are quite independent and generally decline to work for strangers for less than $5 per day, and unless they are in need of supplies they may refuse altogether.

On the Kanuti River is a similar fishing settlement of perhaps 75 Koyukuk natives. They are very generally supplied with food and clothing of white manufacture through the work which they do for the Koyukuk miners, or by the exchange of game and furs for articles kept by the traders at the various stations.

KOWAK VALLEY.

Much the most enterprising and reliable of the native peoples encountered are the Eskimos of the Kowak Valley. Several young men belonging to this tribe were at work on the Koyukuk in 1901 and proved themselves very efficient laborers, contrary to the usual rule among natives. One was engaged as a guide from Bergman to the head of the Kowak, and he remained with the party until Kotzebue Sound was reached. He proved himself an expert boatman and his knowledge of the country was intimate, and, so far as could be determined, reliable. He seemed to take particular pains to answer inquiries truthfully. Others of his tribesmen had gone to Nome and to the Yukon in search of employment and its return in the much-coveted white man's food and wearing apparel. All the members of this tribe seem intelligent and imitative, and are very anxious to learn the English language and civilized ways. They are highly regarded by all of the whites who have visited the region in which they live.

The highest settlement of the Kowaks is near the outlet of Lake Selby, about 10 miles above Pah River, and from this point down to Kotzebue Sound native houses are frequently seen and there are constant signs of their occupancy of the valley. The estimated total number living along the Kowak in 1901 was 250. Mr. Samms, the missionary on Kotzebue Sound, after a careful estimate made during the winter of 1898, placed the number living in the valley at that time at 500. They are undoubtedly decreasing in numbers, but probably not at so rapid a rate as the difference in these estimates would indicate. Many of the prospectors who left the country in the spring of 1899 gave their outfits to natives, and these, believing that white men would continue to come into the valley, did not make their usual preparations for winter, so that numbers perished from exposure and starvation during the year or two following. Others have followed the white men to adjacent fields, and so there has been a decrease in the population of the valley without a decrease in the numbers of the tribe. A part of the difference may also be accounted for through the fact that Mr. Samms's estimate was made in winter, when all the Kowaks were in their winter homes, while the writer's was made during the summer season, when many were away on trading trips.

CLIMATE.

GENERAL.

Winter temperatures of 60° or 70° below zero are reached for a few days at a time in this interior region adjacent to the Arctic circle, but during these severely cold periods it is usually perfectly calm. The more dangerous times are those of higher temperatures and wind. At such times man can not face the gales and live. Much of the early and late winter weather, however, is not more severe than that in the north-central portion of the United States, and persons who have wintered on the Kowak or the Koyukuk prefer this season for the transportation of supplies and for travel generally, the air being dry and many days in each month bright and clear.

The summers are short but warm enough to be pleasant, the period from the middle of June to the middle of September, and in favorable years to October, being available for travel by the waterways or for prospecting. June and July are usually bright and clear, but after August 1 rains are to be expected, which often continue until freezing weather in September. There are then a few weeks of bright, cool, clear weather intervening between the beginning of freezing and the beginning of snowfall, which in many respects are the pleasantest part of the year, the mosquitoes and gnats, such intolerable nuisances during the summer, having disappeared entirely.

OPEN SEASON.

Lieutenant Stoney reports that in the fall of 1885 the Kowak River became clogged with ice on October 1, and that by the 13th it was frozen from bank to bank, and remained closed for the winter. In the spring of 1886 the ice cracked and began drifting on the 19th of May, and by June 3 the river was clear. In the fall of 1898 the ice did not begin to form until October 13. Three days later men and dogs were traveling over it. By June 1, 1899, the ice was gone. In the fall of 1900 the Dall River was frozen over on October 13, and ice was running on the Yukon, but the latter stream did not close until November 5. The following spring the ice broke on the Yukon at the mouth of the Dall on May 24, and the latter river was clear on the 27th.

The ice breaks first near the sources of the streams, and gorges are formed as this loose ice packs against the main body in its passage downstream. In 1901 the ice broke on the upper Yukon at the foot of Lake Laberge on May 18. A steamer which left for Dawson on that date arrived at the latter city on the 23d, one day before the ice broke at Fort Hamlin and several days before the Yukon was navigable there. At Bergman, on the Koyukuk, the ice began to move on the 29th of May, and by the 6th of June the river was open for

navigation. The Noatak is reported to free itself early in June ordinarily, but Kotzebue Sound is icebound until a much later date, so that the Noatak can not be reached by water often for some weeks after it is clear. In favorable seasons the sound is free from ice early in July, but during unfavorable years it may remain closed until August, so that the Noatak natives, following the ice down that river, are sometimes compelled to camp at its mouth for a month before they can reach Kikitaruk, almost in sight across the entrance to Hotham Inlet.

METEOROLOGIC DATA.

In the following tables the immediately available meteorologic data for the Dall, Koyukuk, and Kowak river valleys are assembled.

Meteorologic observations on Kowak River and vicinity.

Month.	Temperature.			Fair days.	Days of rain or snow.	Authority.	Locality.	Comment.
	Minimum recorded.	Maximum recorded.	Mean.					
1885.								
July	32	70	49	.....	.....	Lieutenant Stoney	Kowak River	Lieutenant Stoney publishes only temperatures, but these are summarized from records carefully made, with spirit thermometer.
Aug	32	68	47	.....	.....	do	do	
Sept	5	69	39	.....	.....	do	do	
Oct	− 4	46	16	.....	.....	do	do	
Nov	−44	15	− 9.5	.....	.....	do	do	
Dec	−65	29	−12.4	.....	.....	do	do	
1886.								
Jan	−70	31	−12.4	.....	.....	do	do	
Feb	−65	26	−22.5	.....	.....	do	do	
Mar	−38	36	− 3.8	.....	.....	do	do	
Apr	−22	49	13	.....	.....	do	do	
May	14	65	35	.....	.....	do	do	
June	32	74	49	.....	.....	do	do	
1898.								
June	.....	.....	.....	.....	16	McElwaine	do	
July	.....	.....	57.6	.....	11	do	do	
Aug	.....	.....	50.15	.....	18	do	do	
Sept	.....	.....	.....	.....	12	.....	.....	
1899.								
Feb	−67	10	34.27	.....	.....	.....	.....	
1900.								
Oct	−21	44	17	4	7	Heyman	Mouth Dall River	The temperatures given as mean are means of the morning and evening observations only. Observations taken three times per day. Observations made during thirty days only in May.
Nov	−43	10	−16.5	20	5	do	do	
Dec	−55	6	−19	12	6	do	do	
1901.								
Jan	−66	18	−31	23	6	do	do	
Feb	−56	38	−22	18	4	.....	.....	
Mar	−45	23	− 1	14	11	Heyman	Mouth Dall River	
Apr	− 4	49	21	17	4	do	do	
May	19	70	33	13	3	do	do	

Meteorological observations on Kowak River and vicinity—Continued.

Month.	Temperature.			Fair days.	Days of rain or snow.	Observer.	Locality.	Comment.
	Minimum recorded.	Maximum recorded.	Mean.					
1885.								
June...	49.5	79.5	63	9	3	Poto, U. S. G. S	Dall River.....	Observations began June 16. Lowest record of minimum thermometer 33.5, June 24.
July...	44	80.75	58	19	4	.....do.....	Koyukuk drainage...	Minimum thermometer recorded 16, July 31.
Aug ...	35.5	68	48	11	15	.....do.....	Kowak River.....	Minimum recorded 20, August 1.
Sept ...	41	55.5	45	5	7	.....do.....	Kotzebue Sound.....	Observations continued through first nineteen days only.

FISH AND GAME.

Before the advent of white men salmon were the main food of the natives of the Koyukuk and the Kowak. The fish, although perhaps decreasing in numbers, still run plentifully throughout the late summer and fall, and are dried for winter use, although through the advent of traders and stores they are of somewhat less importance to the natives as a food supply.

The Koyukuk Indians were found at their fishing stations about the middle of July, where they were awaiting the arrival of the salmon. Early in August this fish had ascended the Kowak to beyond the one hundred and fifty-fifth meridian and were abundant in the spawning grounds in the shallows of the river or its tributaries all along the stream from this point to the sea, and the natives, from Lake Selby down, were busy with their summer's catch.

A white fish of excellent flavor is netted along all of these rivers in summer, and numbers of pike are caught, especially in the delta of the Kowak and in the sloughs of this and other streams where their is but. little current and water plants flourish. Greyling may be found in all of the clear-water streams and a large trout is present in the mountain lakes. A small salmon of most excellent flavor is caught in large numbers by the whites in Kotzebue Sound in September, and cured for their winter use.

Waterfowl are plentiful along all of the streams, since they breed in great numbers in the lakes and ponds of the tundra, and while they are not evenly enough distributed to be depended on for food, may often be shot in sufficient numbers to add a very agreeable variety to the bill of fare. We killed numbers of geese and ducks on the Kanuti River and on the lower Kowak. The geese, while plentiful, are wary and difficult to capture unless hunting is made a business. Both the Canada goose and the American white-fronted goose were observed.

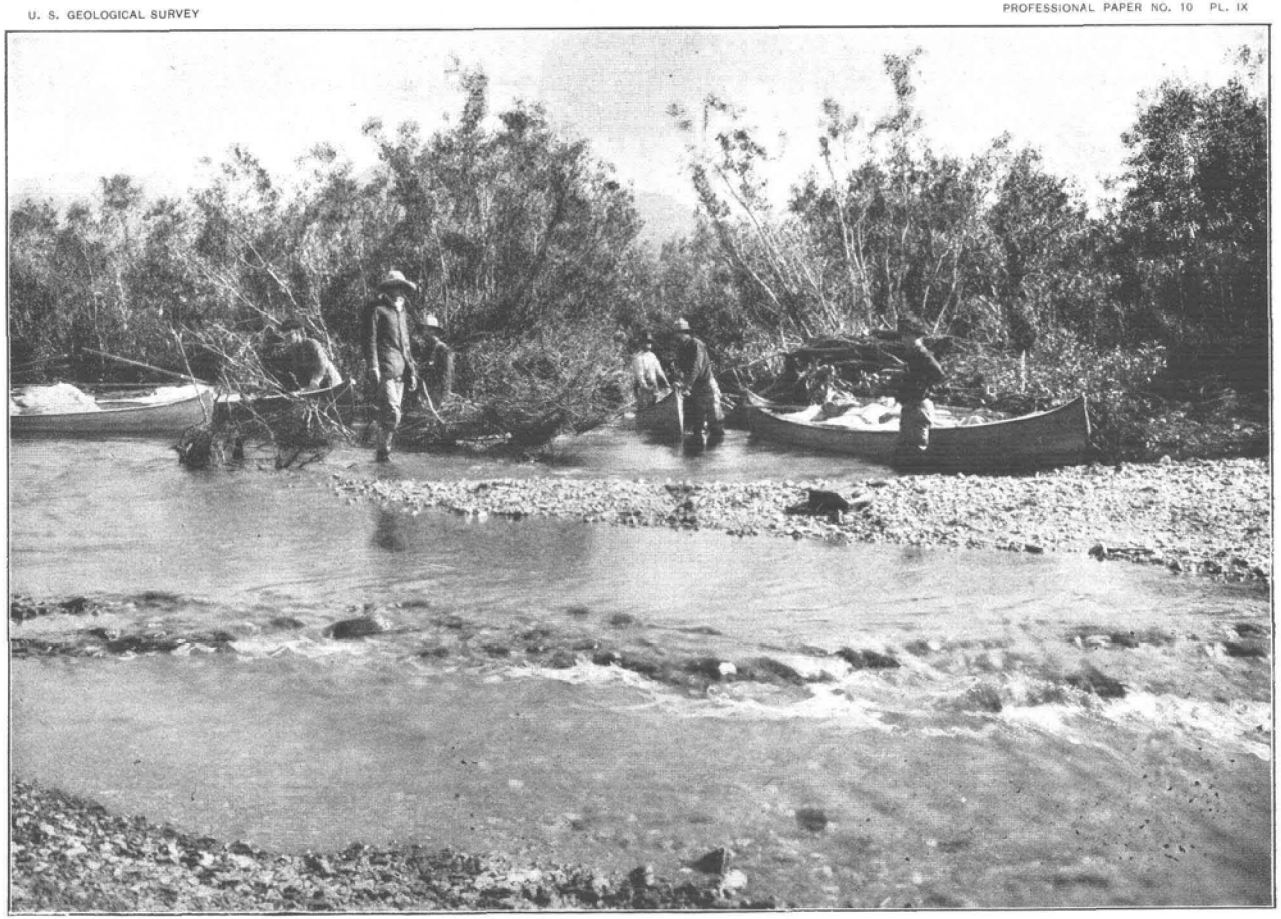
Young ducks, just before migrating in the fall, are fat and easily shot. They are particularly abundant along the marshes of the coast. Widgeon, green-wing teal, pintail, butterballs, and harlequins are among the varieties recognized. Swans, sandhill cranes, snipe, and plover are seen, but less frequently. Probably the most valuable food bird, because of its very general distribution, is the willow ptarmigan. It is very abundant on the tundra, where it seeks shelter in the willow and alder patches, but is less abundant in the mountainous districts. Another somewhat smaller ptarmigan inhabits the rocky sides and tops of the mountain. It is less numerous and found in smaller coveys than the bird of the lowlands. A few Canada grouse live in the spruce forests.

There are caribou in the region about the head of the Kanuti River, and herds are occasionally reported on the hills between the upper Kowak and the Koyukuk, but the Kowak natives now are generally forced to cross over to the Noatak Basin, or eastward to the head of the Totsenbet River, in order to secure caribou skins for clothing. A few white mountain sheep are killed in the high country about the head of the Allen, the Colville, and the Kowak, but this game is not at all abundant. Black bear are distributed, although not anywhere numerous, throughout the district, and some of the brown variety are shot along the lower Kowak and Noatak. Moose are not plentiful anywhere. They are more abundant toward the south and east in the Yukon drainage basin, where there is a heavier timber growth. Natives said that a few are known as far north as Chandlar Lake, in the Colville drainage basin. This is beyond the spruce limit, but cottonwood groves may give them the necessary shelter. At present they seem to be entirely absent about the upper Kowak, although it is but a few years since they occupied this region.

Smaller animals are plentiful in certain localities. The flesh of the muskrat, which is very abundant in the Kowak delta, is used as food by the Eskimos there, and its pelt is made into clothing when caribou or reindeer skins can not be obtained. Red and white foxes are caught in limited numbers, and occasionally marten, beaver, and mink skins are offered for sale.

VEGETATION.

Spruces, "cottonwoods," or poplars, and birches are to be found at the lower levels throughout the entire district traversed from Fort Yukon to Deering, with the single exception of the area along the southern and eastern shores of Kotzebue Sound. Spruce trees extend down half way through the Kowak delta and approach very close to the shores of Hotham Inlet, near the mouth of Noatak. On this river for a distance of 75 or 80 miles they are reported to grow in sufficient size and numbers for the construction of cabins.



NEAR HEADWATERS OF HELPMEJACK CREEK, ABOUT 3 MILES BELOW BEGINNING OF KOWAK PORTAGE.

Shows willow growth along streams and illustrates character of navigation along the approaches to the portage.

SALIX BEBBIANA Sargent.

Dall River, 65 miles above mouth.

SALIX FUSCESCENS Anders.

Willow small and creeping, from 3 to 10 inches high. Common in high places. Collected on Kowak portage, between the Allen and Walker Lake. July 3.

SALIX GLAUCA L.

Bushy willow, 3 to 10 feet high. Common along streams from the Yukon to the lower Kowak.

SALIX PULCHRA Cham.

Willow quite common on the Allen and upper Kowak, generally about 6 feet high. Grows in clumps.

SALIX RETICULATA L.

Small plant, common on divide in mossy places. Headwaters of Kowak River. August 8.

SALIX.

Dall River, 75 miles above mouth, June 25; Allen River, 30 miles above mouth, 2 to 4 feet high, July 21; along Helpmejack Creek, about 5 feet high, near camp of July 26; on bank of small stream near camp of August 20, about 4 feet high.

MYRICACEÆ (Bayberry family).

MYRICA GALE L. Sweet gale.

Dall River, 75 miles above mouth. June 25.

BETULACEÆ (Birch family).

BETULA ALASKANA Sargent. Birch.

Very common tree on mountain slopes; grows up to 50 feet high, trunk 7 or 8 inches in diameter. Bark white and papery.

BETULA GLANDULOSA ROTUNDIFOLIA (Spach) Regel.

Dall River trail, 10 miles above Dall City. July 1.

ALNUS ALNOBETULA (Ehrh.) Koch. Alder.

Dall River, 35 miles above mouth. June 21.

POLYGONACEÆ (Smartweed family).

RUMEX. Dock.

Plant not common. Observed in rather moist places. Grows from 15 to 30 inches high. Kanuti and Upper Kowak.

OXYRIA DIGYNA (L.) Camptd. Mountain sorrel.

Plant not common. Observed on gravel bank of Helpmejack Creek near camp above Beaver City. July 26.

POLYGONUM ALPINUM ALASKANUM Small.

Conspicuous plant 1½ to 4 feet high, on moist hillsides near Allen River.

POLYGONUM PLUMOSUM Small.

Headwaters of Kanuti River, a branch of the Koyukuk. July 3.

POLYGONUM VIVIPARUM L.

Plant observed frequently in moist places on Kowak River; near camp at Walker Lake. August 10.

PORTULACACEÆ (Portulaca family).

CLAYTONIA SARMENTOSA C. A. Meyer.

Observed in low mossy place near Helpmejack Creek, near camp above Beaver City. July 26.

ALSINACEÆ (Chickweed family).

ALSINE LONGIPES (Goldie) Coville.

Dall River trail, 3 miles above Dall City. June 29.

MERCKIA PHYSODES Fisch.

Kanuti River, a branch of the Koyukuk. Collected about 10 miles below Caribou Mountain. July 8.

ARENARIA.

Kanuti River. Collected about 20 miles below Caribou Mountain. July 9.

ARENARIA ARCTICA Stev.

Dall River trail, 12 miles above Dall City. July 1.

MOEHRINGIA LATERIFLORA (L.) Fenzl.

Dall River, 35 miles above mouth. June 21.

RANUNCULACEÆ (Buttercup family.)

ACONITUM DELPHINIFOLIUM DC. Monkshood.

Flowers observed occasionally along Helpmejack Creek and Allen River.

ANEMONE RICHARDSONI Hook.

Dall River, 75 miles above mouth. June 26.

PAPAVERACEÆ (Poppy family).

PAPAVER RADICATUM Rottb.

Kanuti River. Collected about 20 miles below Caribou Mountain. July 9.

CAPNOIDES PAUCIFLORUM (Willd.) Kuntze.

Kanuti River, 4 miles above Caribou Mountain. July 6.

CAPNOIDES SEMPERVIRENS (L.) Kuntze.

Dall River trail, 3 miles above Dall City. June 29.

BRASSICACEÆ (Mustard family).

SISYMBRIUM.

Plant observed on hill, 2½ to 4 feet high. Along beach on Hotham Inlet, 6 miles from Quaker Mission. Not common. September 5.

CARDAMINE.

Plant not common. Found in sandy places along Lower Kowak River.

ALYSSUM AMERICANUM Greene.

Kanuti River. Collected about 10 miles below Caribou Mountain. July 8.

PARRYA.

Kanuti River, 4 miles above Caribou Mountain. July 6.

SAXIFRAGACEÆ (Saxifrage family).

SAXIFRAGA.

Plant seen frequently on hillsides near Allen River. From 6 to 18 inches high.

SAXIFRAGA TRICUSPIDATA Retz.

Kanuti River. Collected about 10 miles below Caribou Mountain. July 8.

PARNASSIA KOTZEBUEI Cham. and Schlecht.

Inconspicuous plant along Allen River in moist shady spots. July 23.

RIBACEÆ (Currant family).

RIBES HUDSONIANUM Richards.

Dall River, about 20 miles above the mouth. June 23.

RIBES RUBRUM L. Red currant.

Dall River, 35 miles above mouth. June 21.

ROSACEÆ (Rose family.)

SPIRÆA BETULIFOLIA Pall.

Dall River, near Dall City. June 27.

RUBUS ARCTICUS L.

Kanuti River. Collected about 20 miles below Caribou Mountain. July 9.

RUBUS CHAMÆMORUS L. "Salmon berry," Cloud berry.

Dall River, 55 miles above mouth. June 27.

POTENTILLA FRUTICOSA L.

Dall River, 75 miles above mouth. June 26.

COMARUM PALUSTRE L.

Plant observed in low, marshy ground. Not common. About 20 miles below Walker Lake. August 14.

DRYAS INTEGRIFOLIA Vahl.

Dall River trail, 2 miles above Dall City. June 29.

SANGUISORBA MEDIA L.

Plant rather common. Observed near upper Kowak River in sandy places; 15 to 30 inches high. August 13.

ROSA ACICULARIS Lindl.

Kanuti River. Collected about 10 miles below Caribou Mountain. July 8.

VICIACEÆ (Vetch family).

LUPINUS.

Dall River, 75 miles above mouth. June 26.

ASTRAGALUS ALPINUS L.

Dall River, 75 miles above mouth. June 26.

HEDYSARUM AMERICANUM (Michx.) Britton.

Thirty miles above mouth of Allen River. Very common. Observed frequently on Kanuti and Allen rivers, 12 to 24 inches high, in clusters. Root used for food by Indians, raw and cooked. Best after frost. Indian name "muchet." July 21.

VIOLACEÆ (Violet family).

VIOLA LANGSDORFII Fisch.
Kanuti River, near headwaters. July 5.

ONAGRACEÆ (Evening primrose family).

CHAMÆNERION LATIFOLIUM (L.) Sweet. Fire weed.
Kanuti River. Collected about 10 miles below Caribou Mountain. July 8.

CORNACEÆ (Dogwood family).

CORNUS CANADENSIS L.
Plant found on portage between the Allen and the Kowak. August 3.

PYROLACEÆ (Wintergreen family).

PYROLA ROTUNDIFOLIA L.
Dall River, 35 miles above mouth. June 21.

MONESES UNIFLORA (L.) Gray.
Plant not common. Observed in low mossy spot on Helpmejack Creek, above Beaver City. July 26.

ERICACEÆ (Heather family).

LEDUM DECUMBENS (Ait.) Lodd.
Dall River, 75 miles above mouth. June 26.

CHAMÆCISTUS PROCUMBENS (L.) Kuntze.
Dall River trail, 11 miles above Dall City. July 1.

CASSIOPE TETRAGONA (L.) D. Don.
Dall River trail, 8 miles above Dall City. June 30.

ANDROMEDA POLIFOLIA L. Wild rosemary.
Dall River trail, 4 miles from Dall City. June 29.

CHAMÆDAPHNE CALYCULATA (L.) Moench. Leather-leaf.
Dall River, 75 miles above mouth. June 26.

VACCINIACEÆ (Huckleberry family).

VACCINIUM ULIGINOSUM L. Bilberry.
Very generally distributed.

VACCINIUM VITIS-IDÆA L. Mountain cranberry.
Dall River, 75 miles above mouth. June 26.

PRIMULACEÆ (Primrose family).

DODECATHEON FRIGIDUM Cham. and Schlecht. Shooting star.
Kanuti River, in the vicinity of Caribou Mountain. July 6.

GENTIANACEÆ (Gentian family).

GENTIANA.

Plant rare. Very few observed on sandy beach, Walker Lake. August 12.

POLEMONIACEÆ (Polemonium family).

PHLOX SIBIRICA L.

Dall River trail, 2 miles above Dall City. June 29.

POLEMONIUM.

Kanuti River, near the headwaters. July 5.

BORAGINACEÆ (Borage family).

ERITRICHUM SPLENDENS Kearney.

Kanuti River. Collected about 15 miles below Caribou Mountain. July 6.

MERTENSIA PANICULATA (Ait.) Don.

Conspicuous blue flower in birch woods. Abundant. Dall River, 35 miles above mouth. June 21.

SCROPHULARIACEÆ (Figwort family).

CASTILLEJA PALLIDA Kunth.

Plant not common. Observed on bank in rather mossy place, 65 miles above mouth of Allen River. July 23.

PEDICULARIS.

Plant not very common. Observed in mossy spot along Helpmejack Creek, above Beaver City. July 26.

PEDICULARIS.

Headwaters of Kanuti River. July 3.

PEDICULARIS LANATA Willd.

Dall River trail, 8 miles above Dall City. June 30.

RUBIACEÆ (Madder family).

GALIUM BOREALE L.

Flower quite common; found generally on rocky cliffs, Allen River. Collected on Kanuti River.

VIBURNACEÆ (Honeysuckle family).

VIBURNUM PAUCIFLORUM Pylaie. High-bush cranberry.

Dall River, 75 miles above mouth. June 25.

LINNÆA BOREALIS L. Twin flower.

Flower quite common in mossy places. Collected near Beaver City. July 26.

VALERIANACEÆ (Valerian family).

VALERIANA CAPITATA Pall.

Flower quite common in moist places along Allen River and Helpmejack Creek. Collected above Beaver City. July 26.

CAMPANULACEÆ (Bluebell family).

CAMPANULA LASIOCARPA Cham.

Plant observed on hill at 2,000 feet. Upper Kowak River. Not very common. August 14.

CICHORIACEÆ (Chicory family).

TARAXACUM. Dandelion.

Only two plants observed. About 15 miles above the mouth of Allen River. July 20.

CARDUACEÆ (Thistle family).

SOLIDAGO. Goldenrod.

Flower not very common. Collected on Walker Lake and Allen River.

ANTENNARIA.

Dall River trail, 10 miles above Dall City. July 11.

MATRICARIA INODORA L.

Plant observed growing in clusters along beach at Nimiuk Point, on Hotham Inlet. September 3.

TANACETUM.

Plant observed along bank of the lower Kowak River in gravel.

ARTEMISIA TILESII Ledeb.

Plant abundant along the Lower Kowak and Hotham Inlet. Grows 2 to 3½ feet high. September 5. Upper Kowak River, 1½ to 2½ feet high. August 10.

PETASITES.

Kanuti River, near its source. July 5

ARNICA.

Dall and Kanuti rivers.

SENECIO LUGENS Richards.

Plant rather abundant. Grows from 1 to 2 feet high in sandy places, a few miles from Walker Lake. August 12.

SENECIO PSEUDO-ARNICA Less.

Plant observed on gravel beach along Kotzebue Sound near Cape Blossom. September 7.

SAUSSUREA.

Plant rather abundant along Upper Kowak.

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PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Professional Paper No. 10.]

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Correspondence should be addressed to

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

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