TWENTY-FIRST ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

1899-1900

CHARLES D. WALCOTT
DIRECTOR

IN SEVEN PARTS

PART II.—GENERAL GEOLOGY, ECONOMIC GEOLOGY, ALASKA

WASHINGTON
GOVERNMENT PRINTING OFFICE
1900

TWENTY-FIRST ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

PART II.—GENERAL GEOLOGY, ECONOMIC GEOLOGY, ALASKA

CONTENTS.

	Page.
Cross, W., and Spencer, A. C. Geology of the Rico Mountains, Colorado (Pls. I-XXII)	7
Matthes, F. E. Glacial sculpture of the Bighorn Mountains, Wyoming (Pl. XXIII)	167
Turner, H. W., Knowlton, F. H., and Lucas, F. A. The Esmeralda formation, a fresh-water lake deposit, by Mr. Turner; accompanied by a report on the fossil plants of the formation, by Mr. Knowlton, and by a report on a fossil fish, by Mr. Lucas (Pls. XXIV-XXXI)	191
Weed, W. H. Mineral vein formation at Boulder Hot Springs, Montana (Pls. XXXII-XXXIV)	227
Taff, J. A., and Adams, G. I. Geology of the eastern Choctaw coal field, Indian Territory (Pls. XXXV-XXXVII)	257
Taff, J. A. Preliminary report on the Camden coal field of southwestern Arkansas (Pls. XXXVIII-XXXIX)	313
Brooks, A. H. A reconnaissance from Pyramid Harbor to Eagle City, Alaska, including a description of the copper deposits of the upper White and Tanana rivers (Pls. XL-L)	331
Rohn, O. A reconnaissance of the Chitina River and the Skolai Mountains, Alaska (Pls. LI-LIX)	393
Schrader, F. C. Preliminary report on a reconnaissance along the Chandlar and Koyukuk rivers, Alaska, in 1899 (Pls. LX-LXVIII)	441
Baker, M. Alaskan geographic names	487
Index	511

A RECONNAISSANCE FROM PYRAMID HARBOR TO EAGLE CITY, ALASKA, INCLUDING A DESCRIPTION OF THE COPPER DEPOSITS OF THE UPPER WHITE AND TANANA RIVERS

BY

ALFRED HULSE BROOKS

CONTENTS.

	Page
Introduction	337
Itinerary	337
Previous explorations	340
Geography	344
Coast line	344
Orographic features	345
Coast Range	345
St. Elias Range	345
Nutzotin Mountains	346
Yukon Plateau	346
Drainage	347
Chilkat River	347
Alsek Basin	348
White River Basin	350
Tanana Basin	351
Fortymile River	353
Physiographic notes	353
Geology	356
Gneissic series	356
Kotlo series	357
Greenstone schists	358
Nutzotin series	359
Intrusives	360
Tertiary rocks	362
Tok sandstones	362
Tertiary effusives	362
Pleistocene deposits	363
Sediments	363
Effusives	364
Glacial phenomena	364
Volcanic tuff	365
Ground ice	366
Table of hypothetical correlations	367
Summary of geology	368
Mineral resources	373
Gold	373
Porcupine gold district	374
Fortymile gold region	376
Copper	377
Rainy Hollow copper deposits	378
Kletsan copper deposits	379
Tanana-Nabesna copper deposits	381
Development of copper	382
Coal	382

	Page.
Routes and methods of traveling	383
Dalton trail	384
Routes to the Upper White and the Upper Tanana	384
Railway routes	386
Timber	387
Game	387
Climate	388
Inhabitants	388
Natives	388
Whites	390

ILLUSTRATIONS.

		Page.
PLATE XL.	Map showing route from Pyramid Harbor to Eagle City, and location of gold and copper deposits so far as determined	338
XLI.	*A*, Pleasant Camp and Jarvis Glacier from Dalton trail; *B*, Upper Tatshenshini Valley, showing benches along valley slope	344
XLII.	Mountain ranges of Central Alaska	346
XLIII.	Topographic map showing route from Lynn Canal, via headwaters of White and Tanana rivers, to Eagle City	In pocket
XLIV.	*A*, Dissected Yukon Plateau, near camp; elevation about 4,700 feet, looking northwest; *B*, Dissected Yukon Plateau, near camp, elevation about 4,700 feet, looking north	348
XLV.	*A*, O'Connor Glacier from Slims River Valley; *B*, Moss-covered plateau in foreground; Mount Natazhat in distance	350
XLVI.	*A*, View looking northwest across the Donjek, down the valley of the Koidern River, showing low divide between the Koidern and the Donjek; *B*, View looking across the Donjek, showing canyon on the right	354
XLVII.	Geological reconnaissance map of parts of Alaska, British Northwest Territory, and British Columbia	356
XLVIII.	Profiles of St. Elias Range and Yukon Plateau, with geology so far as known	368
XLIX.	Sketch map showing location of Porcupine gold district	374
L.	Sketch map showing location of Kletsan copper deposits	380
FIG. 21.	Sketch map showing former drainage channel	355

A RECONNAISSANCE FROM PYRAMID HARBOR TO EAGLE CITY, ALASKA, INCLUDING A DESCRIPTION OF THE COPPER DEPOSITS OF THE UPPER WHITE AND TANANA RIVERS.

By ALFRED H. BROOKS.

INTRODUCTION.

In the spring of 1899 I was detailed to accompany an exploring expedition which was to proceed from Pyramid Harbor, on Lynn Canal, to Eagle City, by way of the headwaters of White and Tanana rivers, and which was to make such surveys along the route of travel as time permitted. The party was constituted as follows: William J. Peters, topographer, in charge; Alfred H. Brooks, geologist; Gastrow S. Phillip, topographic assistant; and Thomas M. Hunt, Ed. Brown, and Joseph Cahill, camp hands. To Mr. Phillip and to the three camp hands Mr. Peters and I wish hereby to acknowledge our indebtedness, for the success of our expedition was in a large measure due to the untiring and faithful service rendered by these four men.

The following report is only a hasty summary of the results of our investigations. A prolonged illness and the stress of other work has prevented me from working up the field notes in detail. The facts that much of the region is so little known and that there is at the present time much interest in the copper deposits are believed to be sufficient excuse for publishing an incomplete report. It has been my aim to give such facts and conclusions as may be of practical value rather than to attempt a technical treatment of the large amount of matter on hand.

ITINERARY.

The party assembled at Pyramid Harbor on May 21, and five days later started inland. One hundred days' provisions and the equipment were packed on 15 horses, while the 6 members of the party walked (see Pl. XL, XLIII). Our route lay up the broad valley of the Chilkat as far as the Indian village of Klukwan, just north of which runs the present (1900) provisional boundary line between the United States and the Canadian possessions. At Klukwan our course turned westward up the Klehini River, a west fork of the Chilkat, and on May 28 we reached Pleasant Camp, some 40 miles from the coast. A Canadian custom-house and the Northwest mounted police post are situated there, which was then (1899) considered the conventional international boundary. The spring of 1899 was unusually late, and we were forced to wait at Pleasant Camp about three weeks before the trail opened.[1] A part of this time was spent in studying the geology of the neighborhood, but the presence of considerable snow made traveling difficult and rendered the work unsatisfactory, because so many of the outcrops were covered.

On June 21 we left Pleasant Camp by the Dalton trail, which, leaving the Klehini River, crosses a high spur and then descends again to Rainy Hollow, at the headwaters of the same river. Here a delay of a day to rest our horses enabled me to pay a hasty visit to some newly discovered copper deposits in the neighborhood.

Beyond Rainy Hollow the trail crosses a divide to a tributary of the Chilkat and then leads across a second divide to the headwaters of the Chilkat. Beyond that it leaves the Lynn Canal drainage and descends to the Tatshenshini River, an east fork of the Alsek.

On June 25 we reached the Tatshenshini River, at a point opposite Dalton House. Here a day was spent in ferrying our outfit across the river in Indian canoes and in swimming our horses. At Dalton House there is a trading post, a Northwest mounted police post, and near at hand a large Indian village.

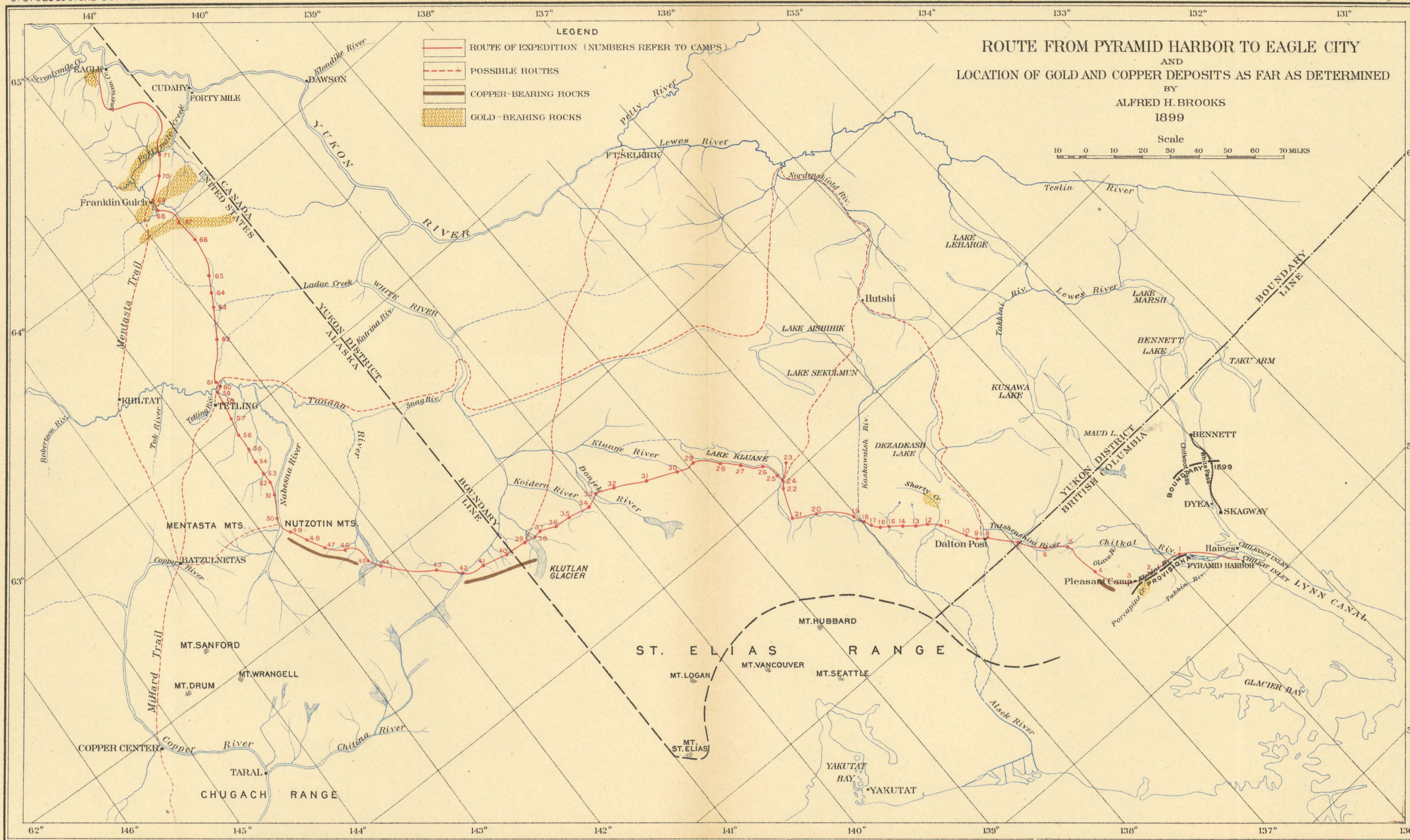
On June 30 we left the post, and with it left behind us the last vestige of civilization. Up to this point we had followed the Dalton trail, but this now turned northward toward Lake Dezadeash. Continuing in a westerly direction, we reached the Kaskawulsh River, a west fork of the Alsek, on July 15.[2] Two days were spent here in building a boat and in getting the outfit and horses across the river.

On July 17 we crossed the moraine of the O'Connor Glacier,[3] which occupies a divide between the Alsek and White River waters and which drains in both directions. Two days later we reached the upper end of Lake Kluane, where we were forced to build another boat for ferrying across the Slims River. Our route led us along the shores of the lake for several days, and we then crossed a low divide to the Donjek River, which we reached on July 31. The fording of this turbulent stream proved a difficult and dangerous task and threatened

[1] We are indebted to Dr. S. M. Frazer, of the Northwest mounted police, for many kindnesses shown us during our delay at the post, of which he was in command.

[2] On the Kaskawulsh we met Messrs. D. D. Garvey and J. J. Haley, two prospectors who had come from Yakutat Bay. We are indebted to them for much information about the country, and especially for a sketch map of a part of the Alsek drainage basin.

[3] This glacier was named after Capt. J. O'Connor, who crossed it in 1898 and furnished us with a sketch map of his route.



JULIUS BIEN & CO. LITH. N.Y.

us with the loss of our leader and a horse, who were swept downstream by the madly rushing current. We were much relieved when the entire expedition reached the west bank in safety.

On August 6 we reached the Klutlan Glacier, which we attempted to cross, but were forced to turn back because of the precarious footing which it offered our horses. The river below the glacier was almost as dangerous to cross as the Donjek, but we passed it in safety.

We remained near Kletsan Creek[1] two days to afford time for a hasty examination of the copper deposits, and on August 12 reached the White River. We followed the White nearly up to its glacial source, and then, turning westward, laid our course for a low divide, beyond which we hoped to find Tanana waters. We crossed this divide and on August 14 reached the glacier in which the Tanana River heads. Thence we made our way across a second divide to the Nabesna, a west fork of the Tanana. We followed the Nabesna downstream for about 20 miles, and then, taking a northwesterly course, reached the Tanana, near the mouth of the Tetling River, on September 1. On September 3, having built a boat and ferried our outfit and swum our horses across the Tanana, we continued our course in a northerly direction toward Fortymile River. After traversing the flat swamp- and lake-covered valley bottom for a few miles we reached the north wall of the valley, which rises by a gradual slope. The watershed lies close to the Tanana Valley, and to the north we followed a stream occupying a shallow valley. About 30 miles north of the Tanana this stream makes an abrupt turn to the east and probably flows into the White River. We continued on our northerly course and after crossing a second divide reached a broad valley which is tributary to Dennison Creek, a branch of the South Fork of Fortymile. We reached the South Fork of the Fortymile on September 10, and having renewed our supply of provisions,[2] which had run rather low, continued on by trail to the mouth of Steele Creek. Here a boat was procured and four of the party, including the topographer and the geologist, continued the journey to Eagle City by water, while the other two men brought the remaining 7 horses by trail. On September 16 the entire party assembled at Eagle City.

Our route was over 600 miles in length, and we made the journey in sixty-six days. Of this distance we were obliged to chop a trail for about 40 miles. We started with 15 good horses and 8 of them were left by the wayside, most of them being shot because they were too weak to keep up with the others.

[1] We there met E. J. Cooper and H. A. Hammond, who had come with a pack train from Copper River. Mr. Cooper gave us some valuable information about the region.

[2] In this connection we are indebted to Mr. Thomas Martin, of Napoleon Creek, who, true to the traditions of the Alaskan pioneers, received us hospitably and shared with us what provisions he had.

PREVIOUS EXPLORATIONS.

It is not my purpose to attempt a complete history of the previous explorations of the region traversed by our party. To give an account of the explorations and mapping of the southeastern part of Alaska would be almost to write a history of the explorations in the northern Pacific Ocean since the middle of the sixteenth century.[1]

The head of Lynn Canal is said to have been first explored in 1796 by Shultz, an employee of the Russian-American Fur Company.[2] Since the purchase of the territory in 1867 the United States Coast and Geodetic Survey has steadily progressed in the mapping of the coast line and adjacent areas. The investigations of Professors Pratt and Davidson in connection with that Bureau have contributed much to our knowledge of this region. The reports and maps will be found in the publications and maps of the Coast Survey. In recent years the work of the International Boundary Survey has extended the mapping of the mountains adjacent to the coast of southeastern Alaska. The studies and explorations of Mr. John Muir, Profs. I. C. Russell, H. Fielding Reid, and G. Frederick Wright have added much to our knowledge of the glaciers of the Alaskan coast.

1877. Lieut. C. E. S. Wood,[3] U. S. A., made a journey into the Mount Fairweather region with a party of native hunters, and was probably the first white man to see Glacier Bay.

1879. Prof. John Muir[4] and Rev. S. Hall Young visited the Muir Glacier and explored Icy Bay. They were the first white men to explore Glacier Bay.

1872–1879. Arthur Harper made several prospecting trips into the White and Tanana river basins.[5]

1880. Captain Beardslee[6] visited Glacier Bay in the steamer *Favorite*, and Ensign Hanus made rough surveys of the lower end of the bay.

1880. Mr. John Muir made a second visit to Glacier Bay.[7]

1882. Dr. Arthur Krause made explorations of Chilkoot and Chilkat passes.[8]

---

[1] Those interested in this matter are referred to Alaska and Its Resources, by William H. Dall; Bancroft's History of Alaska; and Report of the Population, Industries, and Resources of Alaska, by Ivan Petroff. For a bibliography of publications relating to Alaska, see Pacific Coast Pilot, Appendix 1, U. S. Coast and Geodetic Survey, 1879, William H. Dall and Marcus Baker.

[2] Dall, op. cit., p. 317.

[3] Among the Thlinkits: The Century Magazine, July, 1882.

[4] The discovery of Glacier Bay, by John Muir: The Century Magazine, June, 1895.

[5] A reconnaissance in the White and Tanana river basins: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 435 and 437.

[6] Senate Ex. Doc. No. 105, second session, 46th Congress.

[7] The discovery of Glacier Bay, by Eliza Ruhama Scidmore: Nat. Geog. Mag., Vol. VII, April, 1896, p. 143.

[8] Deutsche Geographische Blätter, Bd. V, Heft 4, 1882, with map. Zeitschrift für Erdkunde, Berlin, Bd. XVIII, 1883. Yukon district and British Columbia, by G. M. Dawson: Geol. Surv. Canada, 1887–88, p. 181 B.

1883. Lieut. Frederick Schwatka crossed the Chilkoot Pass and descended the Lewes and Yukon rivers, making surveys en route.[1]

1885. Lieut. Henry T. Allen, U. S. A., with a small party, ascended the Copper River, crossed to the Tanana by the Suslota Pass, and floated down that river to its mouth.[2]

1886. Lieut. Frederick Schwatka, accompanied by Prof. William Libbey and Lieut. H. W. Seton-Karr, and two camp hands, made an attempt to ascend Mount St. Elias, and reached an elevation of 7,200 feet.[3]

1886. Prof. G. Frederick Wright[4] devoted a month to the study of the Muir Glacier.

1888. W. H. and Edwin Topham, with George Broca and William Williams, ascended the southern slope of Mount St. Elias to a height of 11,460 feet.[5]

1888. William Ogilvie, Dominion land surveyor, made surveys from Dyea, on Lynn Canal, to the International Boundary, on the Yukon.[6]

1888. Dr. G. M. Dawson studied the geology of the Lewes River, Chilkoot Pass, and the head of Lynn Canal.[7]

1890. Prof. I. C. Russell, with Mark B. Kerr, topographer, and six camp hands, attempted the ascent of Mount St. Elias, under the joint auspices of the National Geographic Society and the U. S. Geological Survey.[8]

1890. Prof. H. F. Reid, with five companions, spent the summer in studying and mapping the region about Muir Glacier.[9]

1890. Messrs. S. J. Wells, E. J. Glave, and A. B. Schanz, on an expedition organized by Frank Leslie's Weekly, ascended the Chilkat River and, crossing the coast range, explored Lake Kusawa (then called Lake Arkell).[10] There the party divided, and Schanz and Wells proceeded to the Yukon, while Glave, accompanied by Jack Dalton, crossed the divide to the Alsek waters and proceeded down that river to the coast.

---

[1] Military reconnaissance in Alaska, 1883, with maps; second series: Senate Ex. Doc. No. 2, Forty-eighth Congress.

[2] A report on an expedition to the Copper, Tanana, and Koyukuk rivers, in the Territory of Alaska, in the year 1885. This report includes maps of three rivers, which up to 1898 were the basis of all maps of the region.

[3] Shores and Alps of Alaska, by H. W. Seton-Karr: New York Times, October 17, 1886. The expedition of the New York Times, by Frederick Schwatka: The Century Magazine, April, 1891, with sketch map.

[4] The Ice Age of North America, 1889; Chapter III.

[5] Scribner's Magazine, April, 1889; Alpine Journal, August, 1889.

[6] Klondike Official Guide, 1888.

[7] Ann. Rept. Geol. Surv. Canada, Vol. IV, 1888-89, Part B, with maps.

[8] Expedition to Mount St. Elias, by I. C. Russell: Nat. Geog. Mag., Vol. III. 1891-92, with maps.

[9] Studies of the Muir Glacier, by H. F. Reid: Nat. Geog. Mag., Vol. IV, 1892-93. Notes on the geology in the vicinity of the Muir Glacier, by H. P. Cushing: Nat. Geog. Mag., Vol. IV, 1892-93. Glacier Bay and its glaciers [with maps]. Sixteenth Ann. Rept. U. S. Geol. Survey, 1896, Pt. I, pp. 421-461.

[10] Report on the population and resources of Alaska, 1891, Eleventh Census, p. 9.

1890. Mr. S. J. Wells,[1] of the Frank Leslie Exploring Expedition, with one companion, crossed from Fortymile to the Tanana and continued down that river to its mouth.

1891. Prof. I. C. Russell, with a party of six men, made a second attempt to reach the summit of St. Elias, again under the auspices of the U. S. Geological Survey and the National Geographic Society.[2] At an elevation of 14,500 feet they were forced to turn back because of severe storms.

1891. Lieut. Frederick Schwatka, U. S. A., Dr. C. Willard Hayes, of the United States Geological Survey, and a prospector named Mark Russell, reached the head of White River by an overland route from Fort Selkirk.[3] They crossed Skolai Pass and reached the coast by way of Copper River.

1891. E. J. Glave and Jack Dalton, with four pack horses, followed up the Chilkat River, crossed the two forks of the Alsek, and reached the upper end of Lake Kluane, then returned to the coast by the same route. They were the first to use pack horses in Alaskan explorations.[4]

1896. Jack Dalton,[5] who accompanied E. J. Glave in 1890 and 1891, established a trail now known as the Dalton trail, from Pyramid Harbor to the mouth of the Nordenskiold River. He had some years before established trading posts at Pleasant Camp on the Klehini, and at Dalton House on the Tatshenshini. He has made several trips into the White River country from Pyramid Harbor.

1896. J. E. Spurr,[6] assisted by H. B. Goodrich and F. C. Schrader, studied the geology of the Yukon gold district, paying especial attention to the Fortymile and Birch Creek districts.

1897. Prince Luigi, with a strong, well-equipped party, succeeded in reaching the summit of Mount St. Elias.[7]

1897. J. J. McArthur made survey of Dalton trail, running from Pyramid Harbor to the mouth of Nordenskiold River.[8]

---

[1] Report on the population and resources of Alaska: Eleventh Census, 1893. In a previous publication (A reconnaissance in the White and Tanana River basins: Twentieth Ann. Rept. U. S. Geol. Survey) I unfortunately omitted to mention this exploration of Mr. Wells.

[2] Second expedition to Mount St. Elias, by I. C. Russell: Thirteenth Ann. Rept. U. S. Geol. Survey, Part II [with maps].

[3] An expedition through the Yukon district [with maps], by C. Willard Hayes: Nat. Geog. Mag., pp. 117-162, May 15, 1892.

[4] Pioneer pack horses in Alaska, by E. J. Glave: The Century Magazine, Vol. XLIV, Nos. 5 and 6, September and October, 1892.

[5] Mr. Dalton, of Pyramid Harbor, is the best informed man of the region, and we are much indebted to him for information furnished us.

[6] Geology of the Yukon gold district, by Josiah Edward Spurr, with a chapter on the history and condition of the district, by Harold Beach Goodrich: Eighteenth Ann. Rept. U.S. Geol. Survey, Pt. III, pp. 87-392.

[7] La Spedizione di S. A. R. il Duca degli Abruzzi al Monte Sant' Elia (Alaska), 1897; Ulrico Hoepli, Milano, 1900. The ascent of Mount St. Elias by H. R. H. Prince Luigi Amedeo; Archibald Constable and Co., Westminster, 1900. The ascent of Mount St. Elias: Sierra Club Bulletin, Vol. II, No. 3, Jan., 1898.

[8] This survey is embodied in Dawson's map of portion of the Yukon district, Sheet III, corrected to January, 1898: Geol. Surv. Canada, 1888.

1898. J. B. Tyrrell studied the geology along the route of the Dalton trail. He also made explorations westward from Hutshi to the White River.[1]

1898. Lieut. P. G. Lowe, U. S. A., with a pack train, went from Valdes to Fortymile post on the Yukon, by way of the Copper River. He crossed the Tanana near the mouth of the Tetling River.[2]

1898. Capt. W. R. Abercrombie ascended the Copper River to Mentasta Pass.[3]

1898. E. C. Barnard, United States Geological Survey, mapped the topography of the Fortymile quadrangle.[4]

1898. Russell L. Dunn visited the Dalton trail region and published some geological and mining notes.[5]

1898. W. J. Peters and Alfred H. Brooks, with a small party, ascended the White River and its tributary, the Snag River, in canoes, then portaged across to Tanana waters and followed the river of that name to its mouth. They made surveys along the entire route.[6]

1899. Oscar Rohn, employed by the United States Army as topographer, ascended the Chitina River with pack train to the foot of the Nizina Glacier. He then, with one companion, crossed by this glacier to the head of the Tanana, and continuing westward they crossed the divide to the Nabesna, and then returned to the coast by way of the Copper River.[7]

1897–1899. The Klondike excitement of these two years led to much exploration in this region by prospectors hunting for gold. Parties entered the region from almost every point of the compass. Some crossed the glaciers from Yakutat Bay to the Alsek, and ascended that stream, while some left the coast by way of Copper River and reached the White River by way of Skolai Pass. Others again came in from the Lewes River, and many along the well-worn Dalton trail. There are no authentic data relating to most of these parties. Here, as elsewhere in this northern region, in probably not a few cases, bleaching bones are the only records left to mankind of the indomitable will and unheralded heroism of the American prospector.

---

[1] Summary Report, 1888, Geol. Surv. Canada, pp. 36–46.

[2] A narrative of this expedition, together with a sketch map, is published in Reports of explorations in the Territory of Alaska, 1898; War Department, Adjutant-General's Office, No. XXV, July, 1899.

[3] No surveys were made by this expedition, but a narrative is published in Reports of explorations in the Territory of Alaska, 1898; War Department, Adjutant-General's Office, No. XXV, July, 1899.

[4] Explorations in Alaska in 1898, Map 10, p. 76; U. S. Geol. Survey, 1899.

[5] The country of the Klondike: Mining and Scientific Press, San Francisco, Cal., 1898; Vol. LXXVII, Nos. 1998, 1999, 2000, Oct. 22–29, and Nov. 25.

[6] The White River and Tanana expedition, by W. J. Peters and Alfred H. Brooks: Explorations in Alaska, 1897; U. S. Geol. Survey, 1899. A reconnaissance in the White and Tanana river basins in 1898, by Alfred H. Brooks: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, 1900.

[7] An account of this expedition, with map, will be found elsewhere in this volume.

GEOGRAPHY.

The region on which our investigations throw more or less light is approximately blocked out by the Lynn Canal on the east, by the St. Elias Range on the south, by the 142d meridian on the west, and by the Yukon on the north (see Pls. XLI and XLII). It may roughly be regarded as a parallelogram along whose southern and western sides our route of travel lay and which lies for the most part within the Yukon Plateau belt.[1] While the investigations of 1899 were limited to a narrow zone along this route, yet a previous familiarity with the section from Lynn Canal across the Coast Range and down the Lewes to the Yukon, as well as previous studies along the Lower White and Tanana rivers, together with a liberal use of reports of the published work of others, will enable me to suggest some correlations which would hardly be warranted by the work of one season.

COAST LINE.

Lynn Canal, a deep indentation of the coast line, is one of the many tidal fiords which are so characteristic of the southeastern Alaskan coast and which indicate a drowned topography. Along the canal the steep slopes of the mountain rise precipitously, here and there interrupted by a bench marking a former level of depression.[2]

At the mouths of the larger rivers broad deltas have been built out into the fiord, and offer opportunities for settlements along a shore which is usually very precipitous. Such plains exist at the mouths of the Chilkat, Skagway, and Dyea rivers, and have been utilized for habitation. The upper part of Lynn Canal is divided by a narrow neck of land into two embayments, called Chilkoot and Chilkat inlets. The larger, containing Davidson Glacier, discharges into Lynn Canal near the mouth of Chilkoot Inlet, and the drainage of numerous other glaciers which do not reach tide water finds its way to Lynn Canal. The general aspect of the country near the canal is rugged and forbidding.

West of Lynn Canal is another fiord, Glacier Bay, one of the best known points in Alaska, annually visited by many tourists, who come to view its famous glaciers. Cross Sound connects these waters with the Pacific. West of Cross Sound, as far as Cape Suckling, which lies just east of Copper River, the cragged peaks of the St. Elias Range rise precipitously from near the coast and many glaciers clothe the mountain slopes, frequently fronting the sea. This stretch of the coast is remarkably even, its uniformity being broken only by Lituya Bay, Dry Bay at the mouth of Alsek, and by the larger indentation known as Yakutat Bay.

[1] A reconnaissance in the White and Tanana river basins, Alaska, 1898: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 425–494.

[2] At Pyramid Harbor benches were observed at about 100, 300, 400, and 700 feet above tide water.

A. PLEASANT CAMP AND JARVIS GLACIER FROM DALTON TRAIL.

B. UPPER TATSHENSHINI VALLEY, SHOWING BENCHES ALONG VALLEY SLOPE.

OROGRAPHIC FEATURES.[1]

COAST RANGE.

North of Lynn Canal a chain of mountains, called the Coast Range, separates the Pacific and Yukon waters. Near Dyea the watershed is only about 20 miles from tide water. The range extends southeastward, close and parallel to the coast line, into British Columbia. Northwest of Chilkoot Pass the range trends inland, and finally loses its distinctive character and merges into the Yukon Plateau. Some mountains lying west of Lake Dezadeash, which have been called the Dalton[2] Range, possibly represent an extension of the Coast Range uplift. These mountains, as Dr. Hayes[3] has shown, form a broad, elevated mass, having no dominant range. Near Lynn Canal, from an elevation of about 5,000 feet, the range is seen to be made up of innumerable peaks and minor ranges, whose crests rise to about the same elevation and show a remarkably even sky line. The Coast Range does not everywhere form the watershed between the Pacific and interior waters, for a number of rivers, such as the Stikine and the Taku, have their sources north of the Coast Range.

ST. ELIAS RANGE.

West of Lynn Canal, where the Coast Range passes inland, the St. Elias Range occupies the continental margin, and is a broad mountain chain stretching to the northwest of Cross Sound and Icy Strait (see Pl. XLII). To the southeast of these two straits, which lie nearly at right angles to the direction of its axes, the St. Elias Range is partially submerged, and is represented by the highlands of the Alexander Archipelago. Northwest of Cross Sound lies the Fairweather group of mountains, and still farther to the northwest the range increases in elevation, culminating in the peaks of St. Elias and Logan and probably others which have not been determined. To the northwest of these peaks the range, as Dr. Hayes[4] has shown, bifurcates, and the most northerly of the two chains, called the Skolai Mountains on the accompanying maps, forms the watershed between the Chitina on the south and the Tanana and Nabesna rivers on the north, and also includes the Wrangell group of volcanoes. The southern chain approaches the coast and merges into the Chugach Range,[5] on the Lower Copper River. The St. Elias Range proper has a length of about 300 miles and an extreme width of about 70 miles. From Cross

[1] See Pls. XLII and XLIII.
[2] Compare topographic map of Dalton trail, by J. J. McArthur.
[3] Expedition through the Yukon district: Nat. Geog. Mag., Vol. IV, p. 128.
[4] Op. cit., p. 129.
[5] A reconnaissance of a part of Prince William Sound and the Copper River district, Alaska, 1898, by F. C. Schrader: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 341-423.

Sound to the Copper River it is a continuous mountain barrier except for the broad valley of the Alsek, which cuts completely across its axis. To the south of our route of travel from Lynn Canal to the White River we could see the bewildering mass of snow-clad mountain chains and peaks which make up this great range. The topography is cragged, and innumerable glaciers occupy the higher valleys, fed by extensive nevés.

NUTZOTIN MOUNTAINS.

In a previous report I have described the Nutzotin Mountains, from which the Nabesna and Tanana rivers emerge, and whence they debouch on the broad gravel plain of the Upper Tanana Valley. From the Nabesna these mountains have a southeasterly course and extend through to White River, but in the last 20 miles they decrease very much in elevation and become a low range of hills. The extension of the axis of this range to the southeast of the White would coincide with mountains to the north of Lake Kluane, which attain considerable altitude. These mountains, so far as we could observe, seem to constitute a more or less well-defined range as far as the Kaskawulsh River, beyond which they probably merge with the Yukon Plateau, though the mountains lying immediately north of the Chilkat River may belong to the same uplift. To the northwest of the Nabesna River this range is continued by what are called the Mentasta Mountains, which, in their northwesterly extension, join the great Alaskan Range. The extreme width of this chain is about 20 miles and its highest peaks measure 10,000 or 11,000 feet.

The above description of the Coast and St. Elias ranges and Nutzotin and Mentasta mountains includes all the mountain ranges proper embraced in the areas under discussion. Within the plateau belt to be described below mountains which rise above the general elevation of the plateau are not uncommon. In some cases a series of such mountains, arranged more or less linearly, suggests a synchronous uplift, but such mountains are usually separated by plateau areas, and can not be regarded as definite ranges. Mountains of this class are common between the Tanana and the Yukon. The Kechumstuk Hills[1] belong to this category.

YUKON PLATEAU.[2]

North from the Coast and St. Elias ranges stretches the great interior upland which has been called the Yukon Plateau.[3] This is a dissected upland, whose remnants show an even sky line and mark a gently rolling plain, which slopes toward the northwest. In it the larger

[1] Often called the Razor-back Divide by prospectors.

[2] The relation of the plateau and the mountain ranges is shown in the profiles on Pl. XLVIII.

[3] See Pl. XLIV, *A* and *B*, and Pl. XLV, *B*.


MOUNTAIN RANGES OF CENTRAL ALASKA
Topography by U. S. Geological Survey, U. S. Coast and Geodetic Survey, International Boundary Survey, and Geological Survey of Canada.
Scale 1/3,600,000
60 50 40 30 20 10 0 60 120 180 Miles
YUKON RIVER
Fort Yukon
Fort Hamlin
LOWER RAMPARTS
Rampart City
TANANA HILLS
Porcupine Dome
Mastodon Dome
Circle
Charlies Vil.
UNEXPLORED
ALASKAN RANGE
TANANA RIVER
KECHUMSTUK HILLS
KLONDIKE REGION
Fort Reliance
Dawson
Ogilvie
UPPER RAMPARTS
Fort Selkirk
MACMILLAN MTS.
GLENLYON MTS.
Mt. Hayes
Mt. Kimball
Mt. McKinley 20460
NUTZOTIN MOUNTAINS
Mt. Allen
Mt. Sanford
Mt. Drum
Mt. Wrangell
Mt. Natazhat
SEMINOFF HILLS
MINERS RANGE
Mt. Lorne
Michie Mt.
CHUGACH MTS.
ST. ELIAS RANGE
BOUNDARY LINE
Mt. Logan 19534
Mt. Vancouver
Mt. Augusta
Mt. Hubbard
Mt. St. Elias 18024
Mt. Cook
Malaspina Glacier
Yakutat
Valdes
PR. WILLIAM SOUND
Orca P.O.
Montague I.
Cape Cleare
Middleton I.
COOK INLET
KENAI PENINSULA
Tyonek
Ft. Kenai
Kasilof
Homer P.O.
Iliamna Peak 12066
Iliamna
Augustine I.
Cape Elizabeth
Redoubt Volc.
SUSHITNA RIVER
TORDRILLO RANGE
TERRA COTTA MTS.
Chilkat Village
C. Suckling
C. St. Elias
Kayak I.
Icy Bay
C. Fairweather
Lituya Bay
Dyea
Skagway
Juneau
ICY STRAIT
Lion Head
JULIUS BIEN & CO. LITH. N.Y.

rivers have cut broad valleys, the relief varying from 1,000 to 3,000 feet. This plateau has been traced from the region of the Upper Liard, in British Columbia, to the Lower Tanana, and thence to the big bend of the Yukon. In this distance it decreases in elevation from 5,000 or 6,000 feet in British Columbia to 2,500 feet near its northwestern limit in Alaska. While in general the surface of the plateau slopes northwest there are irregularities in the plain marked by the plateau remnants, which, it has been suggested, may be due to warping.[1] The Yukon Plateau was first named by Dr. Hayes and has been described in more or less detail by various writers.[2]

DRAINAGE.

CHILKAT RIVER.

Of the three drainage basins which are in part included in this area that of the Chilkat River is the smallest. The river rises in a broad depression, which forms the divide between it and the Alsek River system. It has a southeasterly course, and in a distance of about 60 miles empties into Chilkat Inlet, an embayment of Lynn Canal.

In the upper part of its course the Chilkat River flows through a canyon or canyon-like valley which is incised in an older valley floor. The bottom of the older valley is marked by benches which extend from either side of the canyon to the base of the mountain slopes. About 10 miles above the Indian village of Klukwan the character of the Chilkat Valley changes. From this point to the coast the river is diversified into numerous channels and wanders over a broad gravel-filled valley bottom. This part of the valley probably represents a former inland extension of the tidal fiord, which has been filled with gravel and silt. The valley slopes rise abruptly, with an occasional bench, the highest one observed being about 1,000 feet above the water.

At its mouth the river has a broad delta which occupies the head of the inlet, and is gradually encroaching upon it. The delta is extended seaward by broad silt flats which are covered at high tide. The two most important tributaries are the Takhin and Klehini, both flowing from the west. The former joins the Chilkat 10 miles from the inlet, and the latter some 10 miles above. The Takhin rises in a glacier

---

[1] A reconnaissance in the White and Tanana river basins, Alaska, in 1898: Twentieth Annual Rept. U. S. Geol. Survey, Pt. VII, p. 448.

[2] The Yukon district, by C. Willard Hayes: Journal of School Geography, Vol. I, No. 8, pp. 236–241. On the late physiographical geology of the Rocky Mountain region and Canada, with special references to the changes in elevation and to the history of the Glacial period, by Geo. M. Dawson: Trans. Roy. Soc. Canada, 1890, Vol. VIII. Report on an exploration in the Yukon and MacKenzie basins, Northwest Territory, by R. G. McConnell: Ann. Rept. Nat. Hist. Survey of Canada, Part D, Vol. IV, 1888–89. Geology of the Yukon gold district, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, pp. 259–260. The Yukon district, by Alfred H. Brooks: Explorations in Alaska in 1898; U. S. Geol. Survey, 1899, pp. 85–100. A reconnaissance in the White and Tanana river basins, Alaska, by Alfred H. Brooks: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 425–494.

which is part of the great snow and ice field north of Glacier Bay. The Klehini, up which our route lay, has its source in a broad, flat divide, similar in character to that at the source of the Chilkat. Up to Pleasant Camp the Klehini River occupies a gravel-floored valley, similar to that of the Lower Chilkat and showing similar benching. Above Pleasant Camp it flows through a narrow rock canyon which has been incised in an older valley floor.

An examination of the accompanying map (Pl. XLIII, in pocket at end of volume) will show that the headwaters of the Chilkat, Glave, and Klehini rivers are separated by very broad, flat divides. This broad depression, below which the rivers have cut sharp canyons, evidently marks an old water course which has been robbed of its drainage by the Chilkat and its tributaries.

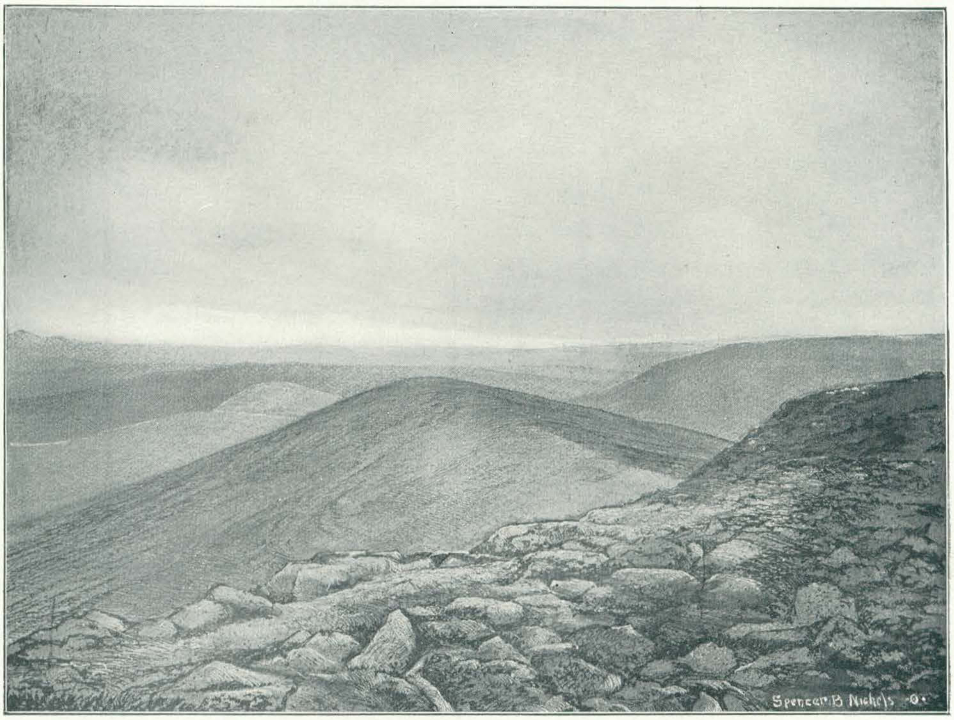
The relief in this drainage basin is from 3,000 to 7,000 feet, and the divides stand at about 3,000. Small lakes are not uncommon, and so far as observed are the result of an interruption of the drainage by glacial action. The rivers of this system are all more or less glacier-fed streams and are, as a rule, turbid. They are swift flowing and, except for the lower course of the Chilkat, unnavigable. Their shifting channels and bowlder-covered bottoms usually make them difficult to ford.

ALSEK BASIN.

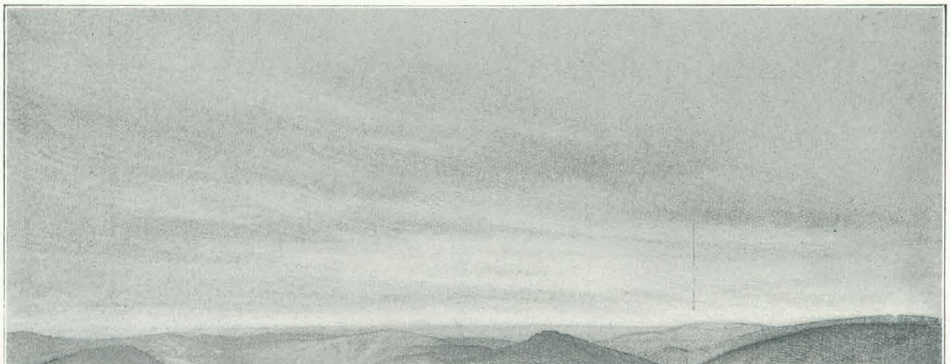
The Alsek River forks some 40 miles above its mouth. The eastern fork, called the Tatshenshini,[1] has its source, as has been described, near the head of the Chilkat. In its upper course it flows through a succession of rock canyons and broad gravel-filled valleys, the latter often containing silt and gravel terraces (see Pl. XLIV, *B*). Where the river occupies a canyon this has been incised in an old valley floor. Below Dalton House the river enters such a rock canyon but a few hundred yards wide and probably 100 or 200 feet deep. Above the canyon is a broad bench marking the old valley floor, which is several miles wide. Below this point the river has not been surveyed, and the only information available was obtained from prospectors. According to statements and sketch maps made by prospectors who are familiar with the Tatshenshini Valley, the river flows in a rock canyon 500 or 600 feet deep for most of the distance between Dalton House and its mouth. Above the canyon there is said to be a bench, sometimes several miles wide, which extends to the valley slope proper. This bench probably marks an old valley floor.

[1] This nomenclature is in accordance with Canadian official maps. On the Yukon map, sheet 4, issued by the surveyor-general's office of Canada, March, 1898, the name Alsek is given to a river which is represented to have its source near Mount Logan, and which is shown to join the Kaskawulsh near the sixtieth degree of latitude. The best information obtained from prospectors would go to show that there is no river of such size coming in from the west, and that if it exists at all it must be an unimportant tributary. This being the case, the name Alsek would apply only to the lower river, below the junction of the Kaskawulsh and Tatshenshini.

For Alaskan names see pp. 487–509 of this report.



A. DISSECTED YUKON PLATEAU NEAR CAMP NO. 53; ELEVATION ABOUT 4,700 FEET; LOOKING NORTHWEST.



B. DISSECTED YUKON PLATEAU NEAR CAMP NO. 53; ELEVATION ABOUT 4,700 FEET; LOOKING NORTH.

The west fork of the Alsek, which is called the Kaskawulsh, has its source in a large, irregularly shaped lake, called Dezadeash, lying about 20 miles northwest of Dalton House. It leaves the lake with a northeasterly course, and in a distance of about 20 miles makes a sharp bend to the west, flowing in this direction for about 30 miles, when it turns to the southwest, and then keeps a general southerly course until it joins the Tatshenshini.

In its upper course the Kaskawulsh[1] flows through a broad, flat valley, and as far as our information goes it preserves this general character until it enters the mountains (see topographic and route map, Pl. XLIII, in pocket). Where crossed by the party the river valley has a basin-like character, is about a mile wide, and is bounded by low hills. It enters this basin through a constricted part of the valley and leaves it through a narrow rock canyon. The eastern valley slope rises by a series of small terraces up to 100 feet, and then extends inland for several miles as a broad, level bench. These terraces are undoubtedly of lacustrine origin, and the lake was drained by the cutting down of the canyon below the basin.

So far as known, the one large tributary of the Kaskawulsh is the river[2] draining the Aishihik Lake, which joins it near the point where it makes its southwesterly bend. The O'Connor River is another important tributary, which has its source in the O'Connor Glacier (see Pl. XLV, *A*); and this, in turn, has a tributary of considerable size, which rises in the direction of Mount Hubbard and joins the O'Connor near its mouth. This, like the O'Connor, is a turbid stream, and has a glacial source.

The Alsek River system includes a region of extremely varied topography. Its upper waters lie within the Yukon plateau, and here the valleys have been cut some 3,000 to 4,000 feet below the general level. The basin is drained by valleys which cut entirely through the St. Elias range, and here the relief must be many thousand feet, but accurate data are entirely lacking. The Alsek is said to be fed by numerous glaciers in that part of its course where it cuts the range. Waterfalls and rapids have been reported on both the lower Tatshenshini and the Kaskawulsh. The elevation of the Dalton House is about 2,500 feet, so that the Tatshenshini waters fall about that much in the distance of 100 miles to the sea. As would be expected from this fact, the reports state that the river is swift and turbulent. The maps show that the Alsek empties into Dry Bay, which reaches almost to the base of the mountains. This bay was thus named because its bottom is uncovered at low tide.

---

[1] See map by J. J. McArthur.

[2] This is sometimes called the Jarvis River by prospectors.

WHITE RIVER BASIN.

The White River has been heretofore described by me, in part from my own investigation, and in part from descriptions published by Dr. Hayes.[1] The following[2] is quoted for the sake of making the description of the geographic features complete:

The White River rises in the northern lobe of the Russell Glacier, which comes down from the St. Elias Mountains and flows east for about 40 miles nearly parallel with the range, and receives from it numerous tributaries. In its upper course it has a broad, gravel-floored valley some 10 miles in width, which gradually narrows down and assumes a canyon-like character. The narrow valley continues for a distance of 20 miles, and then the river debouches on a broad valley lowland. This second basin has a length of over 75 miles and an extreme width of 50 miles, while its floor is also composed of river gravels. It embraces not only the White River Valley and some of the confluent streams, but is extended through to the Tanana by broad, flat valleys, while to the east it is continued by the valley of the Nisling River. Here and there the comparatively even plain of the lowland is interrupted by knobs, hills, and mountainous masses, which rise rather abruptly. . . .

Some 10 miles below the mouth of Snag River the flats end abruptly and the White enters a narrower valley. In this part of its course the valley bottom is some 1,300 feet below the plateau surface. Terraces are found on both sides as far as the mouth of the Klotassin, below which they are replaced by steep granite bluffs. The Klotassin, which at its mouth is some hundred yards wide, is a clear-water stream flowing in a broad, flat-bottomed valley. Between the Klotassin and the Katrina rivers the White River Valley is rather contracted, with abruptly rising walls, while below the Katrina it gradually widens out and continues in this form to its junction with the Yukon. The valleys of both the Katrina River and Ladue Creek are broad and flat, and they are both clear-water streams. At the junction with the White the Yukon makes a right-angled bend to the northeast, so that the axis of the White River Valley is extended by the Yukon below its mouth. On the Yukon, opposite the mouth of the White, steep bluffs rise rather abruptly some 1,400 feet above the river. The junction of the two rivers is in British Northwest Territory, some hundred miles above Dawson, and the total length of the White is about 200 miles.

Throughout its course the White is a turbid, swiftly flowing stream, and it is shallow, with numerous channels, and is studded with constantly shifting sand bars and islands. It has all of the characteristics of an overloaded stream. No current determinations were made on the White River, but rough estimates show currents of from 5 to 10 miles an hour.

In the above the confluent streams of the Lower White, which are comparatively small, are described, but those of the upper river, with which I was not then familiar, are omitted. The largest tributary of the White is the Donjek, which rises in a large glacier fed by the ice-covered St. Elias Range, and, flowing in a northwesterly direction, joins the White some 60 miles below its source. For the first 20 miles the Donjek has a broad, gravel-filled valley; then, turning northward, it enters a canyon. This canyon is not many miles in extent, and where the Kluane joins the Donjek the valley broadens out again. The Kluane has one of its sources in Lake Kluane, which it leaves through a canyon-like valley. Lake Kluane is about 50 miles long,

[1] An expedition into the Yukon Basin: Nat. Geog. Mag., Vol. IV.
[2] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 448–449.

A. O'CONNOR GLACIER FROM SLIMS RIVER VALLEY.

B. MOSS-COVERED PLATEAU IN FOREGROUND; MOUNT NATAZHAT IN DISTANCE.

and occupies a part of a former valley which extended from Lake Dezadeash to the White, crossing the Donjek and joining the flat of the Middle White by the Koidern Valley. Creadon River, joining the Kluane from the east, occupies a part of this former drainage channel. Another tributary is Slims River, which has its source in the O'Connor Glacier (see Pl. XLV, *A*). The volume of the Donjek is probably equal to that of the main White River.

The Koidern, which occupies a part of the old valley described above, is a comparatively small river. The Klutlan, which joins the White above the canyon, is fed by the large glacier of that name, and, considering its length, has a large volume of water.

TANANA BASIN.

The Tanana River rises south of the Nutzotin Mountains in a glacier of the same name. Near its head it is joined by two tributaries, nearly equal to it in size and also having glacial sources. These headwaters lie in a broad basin having an elevation of about 5,000 feet, which is connected with the White River waters by a broad gap about 1,000 feet in elevation. The gap between the Tanana and Nabesna rivers is narrower, but has about the same elevation.

Below this basin the Tanana, flowing northeastward, enters the Nutzotin Mountains, and here its valley is constricted for a distance of about 20 miles. It then debouches on the broad valley lowland of the Upper Tanana, here about 25 miles wide. It flows across this plain until it reaches the north wall of the valley, and then turns abruptly to the northwest.

The Nabesna is the largest tributary of the Tanana. It has a glacial source on the northern slope of the Mount Wrangell group, flows in a northeasterly and northerly direction, and joins the Tanana near the western margin of the Upper Tanana Basin. Throughout its course, as far as known, the Nabesna[1] flows in a broad valley, and is probably much older than the gorge of the Tanana. Both the Tanana and Nabesna are swift-flowing streams until they reach the valley lowland already referred to.

I quote the following from the report on the Tanana:[2]

> The broad lowland ends near the mouth of the Tetling, where the valley is contracted to about 7 miles. West of Mount Chisana the Tanana Valley is formed by a series of connecting basins, possessing outlines of parallelograms. These will be described below, and their origin ascribed to structural lines. This basin-like character is more or less well marked to about the mouth of the Silok River, where the recession of the south wall of the valley produces another lowland, some 30 miles wide, and which continues to broaden out to the west. Something of the same basin-like character is preserved in this part of the valley by the succession of reentrant angles in the northern escarpment.

[1] The headwaters of the Nabesna have not been explored above the point where our route crosses the river.

[2] Twentieth Ann. Rept. U.S. Geol. Survey, Pt. VII, pp. 450 and 451.

Where the Tanana leaves the mountains, near its headwaters, the peaks on either side of the gorge rise over 4,000 feet above the river level. The summit of Mount Chisana, a part of the old plateau surface, is some 1,500 feet above the river, and the top of the escarpments which form the southern valley wall of the Middle Tanana are believed to have about the same amount of relief, though the elevations were unfortunately not determined and the contouring on the accompanying topographic map was made purely from estimated elevations. The ridges which bound the Tanana on the north near its mouth stand not over 300 or 400 feet above the water.

The northern tributaries of the Tanana are all sluggish streams, flowing in broad valleys, and have considerable depth. They are as a rule clear or only slightly turbid, carry little sediment, and have no deltas at their mouths. The southern tributaries, having their sources in the high mountains, are all shallow, turbid, swift-flowing streams, usually with large deltas. The formation of these deltas is probably the chief cause for the position of the Tanana River close to the north wall of its valley, though this may have been aided by warping.

The Nabesna River is the most important tributary of the Upper Tanana and nearly equals it in size. Like the Tanana it leaves the mountains through a narrow valley, and on reaching the lowland continues its course to the northeast until it joins the main river. The Tetling is a river of secondary importance, draining a group of small lakes which lie within the valley. These lakes probably owe their origin to the damming of the former course of the Tetling by the delta deposits of the Nabesna. Its old course is marked by a series of small lakes which may be seen on the topographic map. The Tok River is of comparatively small size and in its character is the exception among the rivers from the south. Rising as it does in the depression between the Nutzotin and Alaskan mountains, it is not fed to any extent by glacial streams or streams from the snow mountains, and therefore has clear water. The Robertson and Johnson rivers are both swiftly flowing, shallow, turbid streams, and the waters have a slightly greenish tinge. These rivers leave the mountains through narrow valleys, and both have broad deltas and glacial sand bluffs at their mouths. The Goodpaster and Volkmar rivers flow in broad valleys and are sluggish streams. The Volkmar is said to have its source in a rather rugged mountain region. The Delta River is much like the Robertson and Johnson in its general character, except that its valley is somewhat broader. The Mahutzu and Silok rivers are similar in character to the Delta, but are considerably smaller.

The Salchaket and Chena rivers were not visited by our party, but both have broad, flat valleys. The Nilkoka River and Baker Creek have the characteristics of the other rivers of the north side of the valley. The Cantwell has turbid waters and many sand bars, but in its long journey across the valley it has lost something of its swift character. The Toklat is a deep, muddy stream, and in its lower course has a comparatively moderate current. It has never been explored, so of its upper course we have no information.

From where the Tanana leaves the mountains until it reaches the north side of the broad valley at its first great bend it is a shallow, swift-flowing stream, comparable in every way to the White River. Below this point to the contraction of the valley, near where the Fortymile trail reaches it, the Tanana has a very slow current and a very tortuous course; in many places it consists of little but a chain of ox-bow lakes. A few short riffles occur in this part of the river, but usually the current does not exceed 2 or 3 miles in all. Below this sluggish part of the Tanana to a point about 10 miles above the Cantwell River the current is usually very swift. Several rapids are marked on the map, none of which, however, are due to rock barriers. In the region of Bates Rapids the river has spread out until it is several miles in width and has innumerable channels, sand bars, and islands. Below the Cantwell River to the mouth of the Tanana it is usually confined to one or two channels and has a current of from 3 to 5 miles an hour.

FORTYMILE RIVER.[1]

This river is tributary to the Yukon, which it joins in British Northwest Territory about 30 miles above the international boundary. The drainage basin of Fortymile lies entirely within the Yukon Plateau, and its headwaters reach far southward close to the Tanana Valley. About 60 miles from its mouth the Fortymile forks, the southerly branch and its tributaries heading near the Tanana and tributaries of the White. The north fork has a general east-and-west course and heads opposite the Volkmar and Goodpaster rivers, which flow into the Middle Tanana. The north fork has been but little explored, and its location on the accompanying maps is only approximate. It is said to flow through broad, shallow valleys. The basin of the south fork has been fairly well explored, and its creeks flow in broad, shallow valleys, the relief being from 800 to 1,500 feet. Fortymile Creek itself has a well-marked bench some 400 feet above the present water level, which Goodrich has shown to be an old valley floor.[2] Below this bench the river flows through a narrow canyon for much of its course. It leaves this canyon about 20 miles from the Yukon, and from there on has a broad valley. In this lower course it has but a sluggish current, while above swift water is frequent and rapids are not uncommon.

The broad, shallow valleys at the headwaters of this stream are probably synchronous in origin with the old valley floor of the Lower Fortymile. While the basin lies entirely within the Yukon Plateau and the even upland surface is a very marked feature of the topography, yet a number of isolated mountains and mountain masses rise above the plateau surface. Examples of these are Fortymile Dome, Glacier Mountain, and Sixtymile Butte.

PHYSIOGRAPHIC NOTES.

In a previous report[3] I have attempted a brief summary of the physiographic development of the White River and Tanana River basins. The area now under discussion belongs to the same physiographic province, and hence the history of the development of its topographic forms is similar. The investigations of the past season (1899) throw much light on some of the problems, but as yet the notes have not been worked up in detail. In studying this area the physiographer is still hampered by the lack of sufficient topographic data and by the fact that even where contoured maps are available the elevations given

[1] See Pl. XLIII.

[2] Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, 1886-1897, p. 276.

[3] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 452-460.

are only approximate, they having been determined very largely by aneroid barometer.

The Yukon Plateau, already described, is a peneplain which was formed probably in Middle Tertiary times. It slopes gently to the north and west, but has some undulations which have been ascribed to deformation. Unreduced areas or monadnocks rise above the peneplain, in some cases to the height of 1,500 feet or more. The ranges lying to the south of the plateau are rugged, with sharp outlines, and are comparatively young topographic forms. Some broad gaps which are found in these ranges, such as Mentasta Pass and some depressions at the head of the Cantwell, are believed to have been formed at the same time as the peneplain. Subsequent to the planation an orographic movement took place and the area was elevated far above its present position, and during this cycle the rivers carved deep, broad valleys. A depression followed which brought the plain nearly to its present position, and the rivers began building up their flood plains. Another elevation revived the activity of the streams, and they incised their channels in their former flood plains, whose remnants are now seen as terraces and bluffs.

In the previous discussion of the development of the present drainage system it was shown that the great gravel-filled basin of the Middle White and Tanana represents a part of an old river valley which formerly drained eastward, and which was called the White-Tanana. It was also shown that the constricted portion of the Tanana Valley is a comparatively new cutting, and that in this part of the river a divide existed between this lower part of the Tanana and the river described above, which occupied parts of the Upper White and Tanana valleys. The Lower White, probably having its source in Ladue or Katrina rivers, was also a distinct river from the old White-Tanana.

The work of the past season enabled me to trace the former water course of the White-Tanana eastward. It leaves the Middle White River Basin by the present valley of the Koidern (see Pl. XLVI, *A* and *B*), then, crossing the Donjek, finds its way by a broad, flat divide to Lake Kluane. From the eastern end of this lake the broad, flat valley of the Creadon River continues the old water course, probably reaching Lake Dezadeash by way of the Schwack Valley. From Lake Dezadeash the old river turned southward across the flat divide which separates the lake from the Tatshenshini waters. From this point on I have no personal knowledge of this old waterway, but the best evidence available indicates that it found its way to the sea by the Tatshenshini[1] and Alsek valleys. The Alsek is probably an antecedent river which maintained its position during the St. Elias uplift.

[1] In the former discussion of this old drainage channel it was suggested that it might have reached the sea by way of Lynn Canal. The studies of the past summer proved that this supposition was erroneous, as the gaps on the divide between the Chilkat and Alsek basins are too high to admit of such an outlet.

A. VIEW LOOKING NORTHWEST ACROSS THE DONJEK DOWN THE VALLEY OF THE KOIDERN RIVER, SHOWING LOW DIVIDE BETWEEN THE KOIDERN AND THE DONJEK.

B. LOOKING ACROSS THE DONJEK, SHOWING CANYON ON THE RIGHT.

The basin of the Upper White during this time drained through a broad valley now occupied by a small stream and lake and running almost due eastward from the front of the Klutlan Glacier. This stream joined the main water course near the head of Koidern River. The accompanying sketch (fig. 21) shows the position of this old water course. The fact that the divides marking this old drainage system have small relief compared to the present waterways goes to show that this change in drainage has been very recent. Our present facts do not warrant a definite statement as to the cause of this change in the river system. I would call attention, however, to the fact that a northwesterly tilting, corresponding to the present inclination of

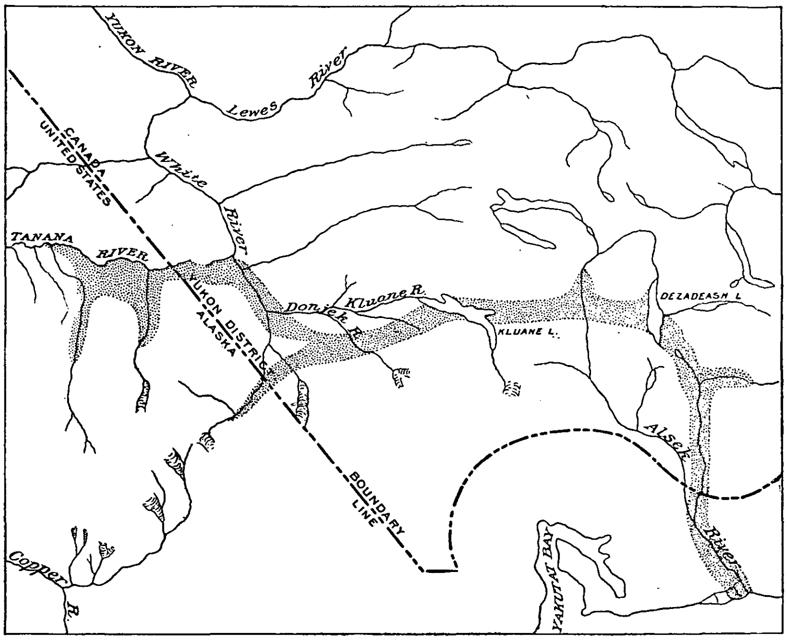


FIG. 21.—Sketch map showing former drainage channel.

the plateau, would give the northward- and westward-flowing streams the advantage in rapidity of cutting, which would be quite sufficient to cause this change in drainage. The position of the ice front may have been the cause of the change. Where the Cordilleran Glacier reached its maximum extension the southward-flowing streams would be ice dammed, while the drainage to the north would be unimpeded.

Among the striking features of the topography are the broad, flat east-and-west valleys. The series of broad depressions which mark the old drainage channel of the Tanana-White have already been referred to, and there are several others running parallel to these. As examples we have the valleys of the Nisling, the Klotassin, and the East Fork of the Kluane. A similar depression is said to connect the lower end of Aishihik Lake with the upper end of Lake Kluane. Another connects the valley of Kashaw River with Lake Dezadeash. In each case the size of the present stream is entirely disproportionate to the size of the valley. The drainage of many of these old valleys is taken by rivers flowing directly across them and leaving them by narrow canyons. The Upper White, the Donjek, and the river draining Lake Kluane flow northward across broad valleys and thence through narrow canyons. The broad depressions must be classed as consequent, the canyons as subsequent, drainage. Pl. XLVI, *A*, is a view looking westward across the Donjek and showing the consequent valley, which is parallel to the strike. Pl. XLVI, *B*, shows the subsequent drainage through the canyon of the Donjek.

The unadjusted drainage conditions are well illustrated by the Kashaw River. Shorty Creek, which is the name given to the upper part of this river, leaves the mountains through a narrow gorge and debouches on a broad alluvial fan in the Kashaw Valley. Though but a few miles from Lake Dezadeash, and separated from it by a very low divide, Kashaw River flows southward, away from the lake. It is stated on good authority that Shorty Creek sometimes flows southward, sometimes northward, depending on what part of its alluvial fan it is occupying. An examination of the topographic map (Pl. XLIII) will show that this diversity of drainage involves a circuit of a hundred miles or more.

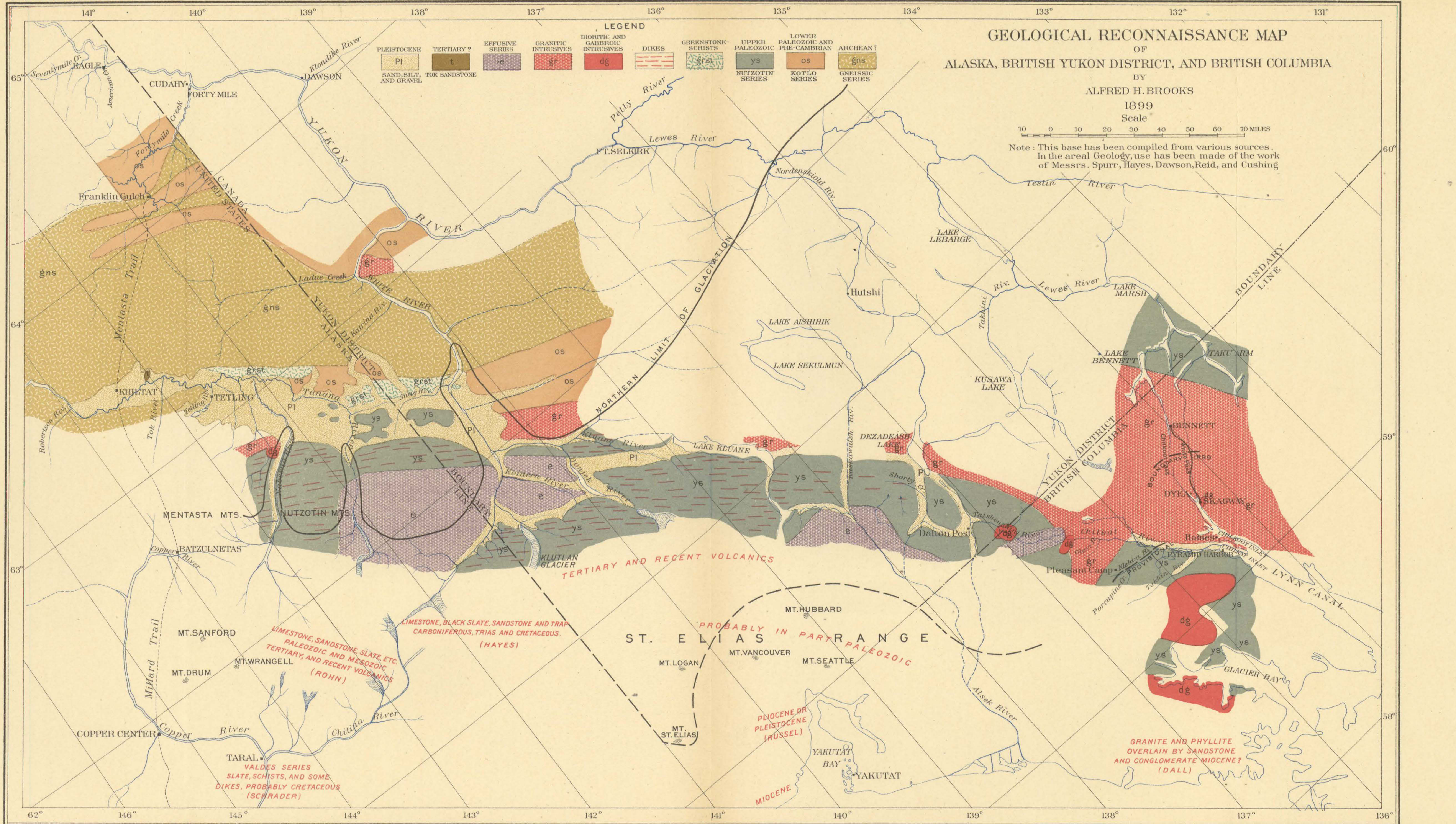
GEOLOGY.[1]

GNEISSIC SERIES.

The oldest rocks of the region, so far as determined, are a complex of gneisses with various basic and acid intrusives. The gneisses, with which are associated crystalline schists, are intricately folded and often much sheared. In general, they are of an acid character, but basic schists are also present. The associated igneous rocks can be divided into two classes, namely, those that were intruded previous to the major deformation, which are much sheared, and the later intrusives, which are comparatively massive. They include several varieties of granite with some dioritic and gabbroic rocks. If the relative amount of deformation be used as a criterion, the basic rocks are the older, the younger intrusives being of an acid character. The latest intrusive rock is a white granite, often aplitic, which is found massive in dikes throughout the series.

The gneissic complex is well exposed on the Lower White, where it was studied by me in a previous season. The investigations of the past season (1899) have added but few facts relating to this group of rocks, for in the region north of the Tanana, where the main gneissic belt was crossed, there were very few exposures. A somewhat more detailed

[1] See Pls. XLVII and XLVIII.



JULIUS BIEN & CO. LITH. N.Y.

description of the various rock types found with the gneisses is given in the report already cited.

The gneisses are classed as Archean because they are apparently older than all of the sedimentary rocks. The sedimentary series are believed to overlie the gneisses uncomformably. On the accompanying geological map (Pl. XLVII) the gneissic series is shown to occupy a broad belt lying between the Yukon and the Tanana and extending eastward across the White. The extension of the gneisses east of the White is made on the bases of some notes furnished me by Dr. Hayes.[1] To the north the continuity of the gneisses is interrupted by two belts of the older sedimentary series, which are infolded with them. According to the best information these belts of sediments do not extend far to the west, and are so represented on the map.

The general strike of the gneisses is northwest and southeast. The dip of the foliation is usually low and variable, though prevalently to the southeast. The series is entirely crystalline and includes no rocks, so far as known, of sedimentary origin. The cross jointing of the series has been previously described,[2] and the variation in direction of the jointing and its consequent effect on the topography has been ascribed to two synchronous thrusts coming from different directions.

KOTLO SERIES.[3]

Mr. Spurr, in his account of the geology of the Yukon district, describes three series of sediments, which he names the Birch Creek, Fortymile, and Rampart series. He shows that the first two are conformable and are overlain unconformably by the Rampart rocks. In my previous report on this region I describe two groups of rocks—the Nasina series and the Tanana schists. These were believed to be the equivalents of the rocks described by Spurr, but as no definite correlation could be made I was forced to use a new nomenclature. The western extension of the Tanana schists was recognized by Mr. W. C. Mendenhall,[4] and he applied the same name to them.

On the accompanying map all these older sedimentary rocks have been grouped together under the name "Kotlo series." I have thus grouped together under this heading a number of different formations, probably including vast thicknesses of strata, but will make no attempt here to describe them in detail. For special descriptions see the reports already cited.[5]

[1] I am much indebted to Dr. Hayes for the use of his geological notes, made on the trip which has already been referred to.

[2] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 464–465, 481–482.

[3] On the plate showing profiles and known geology (Pl. XLVIII) these rocks are termed the Older Sedimentary series.

[4] A reconnaissance from Resurrection Bay to the Tanana River, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 265–340.

[5] In a recent publication Mr. R. G. McConnell has described the rocks of the Klondike region and has grouped them in four different formations, having given to each a new name. These formations are probably equivalent to some of the rocks studied by Spurr and myself in the Fortymile region, and would therefore be included in the older sedimentary (Kotlo) series. See Preliminary report on the Klondike gold fields: Geol. Surv. Canada, 1900, No. 687.

This series is of especial interest, because it probably embraces all the gold-bearing rocks of the Upper Yukon. The rocks have only this one character in common, and are far from being a stratigraphic unit. The age of these older sediments has not been established. Mr. Spurr, in his studies of the Rampart rocks, believes them to be probably Silurian. The only paleontological evidence is a single shark's tooth. As far as known to the writer, no other fossil has ever been found in them. If the Rampart series are pre-Silurian, the Birch Creek, Fortymile, Nasina series, and Tanana schists are probably lower Paleozoic or pre-Cambrian.

These rocks have a general parallelism in strike to the gneisses, and their dips are very variable. In general the dips are low, the type structure being an open fold. The rocks of the older series in this subdivision are considerably metamorphosed, being often quite crystalline. The lowest beds of this group are quartz-schists, frequently containing some clastic crystalline material (Birch Creek series and Tanana schists). These quartz-schists become calcareous upward and are succeeded by a vast thickness of limestone, which is usually crystalline (Fortymile series, Nasina series). Above the limestones an unconformity occurs, and above this effusive rocks of vast thickness are found (Rampart series). The beds below this unconformity show evidence of having suffered much more deformation than those above. Throughout the older sediments acid and basic intrusives are not uncommon.

GREENSTONE-SCHISTS.

The greenstone-schists shown on the geological map in the White and Tanana River valleys are chiefly of a gabbroic and dioritic character, with numerous schists made up largely of secondary minerals, such as chlorites, actinolite, zoisite, and epidote. Among them are some finely banded rocks which, when studied under the microscope, were found to be tuffaceous. The investigations of 1898 showed these rocks to be largely intrusive and to be younger than the Tanana schists, which are here included in the Kotlo series.[1] These rocks are differentiated from the gabbroic and dioritic rocks, to be described below, because they are far more schistose. These greenstone-schists seem to be more closely related to those found associated with the gneisses than to any other intrusives of the region. They were in a previous report correlated with Spurr's Rampart series, but this correlation, on further study, seems doubtful, and they are therefore mapped as a distinct series.

[1] A reconnaissance in the White and Tanana river basins: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, p. 470.

NUTZOTIN SERIES.[1]

Along our route of travel from Pyramid Harbor to the Nabesna River were exposed slates, white limestones, and flags, with some sandstones. These rocks are rather closely folded and strike in a northwest-southeast direction. From the general facts of their distribution and the relative amount of deformation it is believed that they are younger and that they overlie the older sediments unconformably. Future work will undoubtedly resolve the rocks of this series into many different horizons, but for the present purpose it has been thought best to group them together. Professors Reid and Cushing in their work around Glacier Bay[2] found a series of white limestones and argillites. In the former they found fossils of Carboniferous age. These rocks of Glacier Bay have been included with the younger sediments, both on lithological similarity and paleontological evidence.

In the upper basin of the White River, on Kletsan Creek, are exposures of a white limestone which carries many fossils. Many of the fossils collected from this point were unfortunately lost, but a few which were submitted to Mr. Charles Schuchert, of the United States National Museum were determined to be of Carboniferous age. I make the following extract from Mr. Schuchert's report on these fossils:

Kletsan Creek ("9 AB 171"):

Productus cora	White crystalline limestone.
Productus, 2 undet. species.	
Seminula, 1 undet. species.	
Stenopora, 1 undet. species.	

Pebble from Kletsan Creek ("9 AB 150"):

Fusulina (not the common American species, *F. cylindrica*).

These two localities are of one general horizon in the Upper Carboniferous, which seem to be the same zone as that near Circle City discovered by Mr. Spurr (Takandit series) or a closely related one. I have made no specific determinations, since the fauna is not to be correlated with that of the Upper Carboniferous of the Mississippi Valley, but with the *Fusulina* zone of China, India, and the eastern slopes of the Urals.

This belt of limestone was traced from near the Kashaw River to the Nabesna with more or less interruption. Immediately underlying the white limestone are series of slates or argillites, possibly the same as those on Glacier Bay, already referred to.

In the report cited I have described what I have called the Wellesley formation, which consists of heavy conglomerate beds associated with black slates. The few fossils which were collected from these slates show that the formation is of either Devonian or Carboniferous age, and this area, therefore, is included with the younger sedimentary series.

[1] On the plate showing profiles and known geology (Pl. XLVIII) these rocks are termed the Younger Sedimentary series.

[2] See footnote 9 on p. 341.

On the above rather fragmentary evidence a belt of rocks running parallel to the St. Elias Range at its northern margin has been indicated on the accompanying map and provisionally named the Nutzotin series. This belt is interrupted by the younger effusive rocks and by the Pleistocene deposits of the larger valleys.

Like that of the rocks of the region, the strike of this series is about northwest and southeast. The dips are variable, but more often to the south than to the north. The type of structure is rather of closed folds, sometimes plainly overturned to the north. The deformation resembles the Appalachian structure and differs very materially from the open-fold type of the older rocks lying to the north.

If the interpretation is correct, the oldest bed of this series is the heavy conglomerate, included in a previous report in the Wellesley formation, on the Upper White and Tanana. This is succeeded by black slates, often much crumpled, and becoming more calcareous toward the top. Then there is a great thickness of slates, graywackes, and impure limestones, in ascending order, intruded by many basic dikes and containing probably some effusive igneous rocks and tuffs.

This part of the series was well exposed on the Nabesna River, along our route of travel. It here contains much igneous material and somewhat resembles Spurr's Rampart series of the Fortymile basin, but for structural reasons, as well as because of its areal distribution, it is correlated with the younger clastic series—the Nutzotin series. Deposits believed to be the equivalent of these beds, exposed on the Nabesna and Lynn Canal, contain little, if any, igneous material. The youngest beds of the series is the limestone, usually crystalline, in which, as has been stated, fossils have been found.

When the region is studied in detail this series will undoubtedly receive many subdivisions, for as mapped it must include beds aggregating many thousand feet in thickness. It is quite probable, also, that in this hasty reconnaissance some older beds have been included in this younger series.

At several localities igneous rocks which are plainly effusive rocks were found associated with this series. These effusives are quite distinct from those regarded as Tertiary and Pleistocene and are probably much older. No areas of these older effusives were found large enough to represent on the accompanying geological map. With them were found some tuffs and conglomerates, the pebbles of the latter being made up of effusive material. Such rocks were noted along the southern margin of Lake Kluane.

INTRUSIVES.

The intrusive rocks of the region have been differentiated into two classes on the accompanying map—those of a granitic type and those of dioritic and gabbroic types. The former are by far the most extensive. The largest area of granite is that of the Coast Range, which has been traced by Dr. Dawson, Dr. Hayes, and others from British Columbia to the Chilkoot Pass. Typically this is a hornblende- or biotite-granite, usually more or less uniform. I found a granite of this character near Rainy Hollow and again near the eastern end of Lake Kluane; also on the Nabesna. Near the Kluane Valley Dr. Hayes crossed a similar belt of granite, which is represented on the accompanying map. Granite has also been reported both southeast and northwest of Dezadeash. The distribution of these areas suggests that they all belong to the same intrusive mass, which was injected along an axis running northwest and southeast. It is quite possible that future work will trace a continuous body of granite throughout this belt. In the work of the past summer the granite was found to be massive, but to have well-developed joint planes.

In studying the section from Skagway across the White Pass shear zones were found in the granite, along which it had been altered to a finely foliated schist. These shear zones are of very small extent and are probably lines of faulting. At Skagway and at other points along this route the granite is found to be cut by dikes of dioritic and diabasic character. About 5 miles west of Skagway a large mass of porphyritic rocks was observed, which is probably effusive. The talus slopes and stream gravels at other points along this route indicate that there are other considerable masses of effusive rocks at various localities within the area of the Coast Range granite. At the upper end of Lake Kluane dioritic and diabasic dikes were found cutting the granite, and also syenitic rocks. Coarse pegmatites have there also an extensive development. On the Middle and Lower Tanana hornblende-granites of a similar type were found associated with the gneisses and mica-schists, which are classed as Archean. These granites lie on the extension of the same axis of intrusion. Similar areas of granite entirely distinct from those on this axis were found in various parts of the region, but most of them are too small to show on the accompanying map. One mass is represented at the big bend of the Lower White. My investigations lead to the conclusion that this granite is post-Carboniferous and pre-Cretaceous, and Dr. Dawson has determined that it is post-Triassic in age.[1]

Of the more basic intrusions of the region little can be definitely stated. In the rocks of both the lower and the upper sedimentary series dikes which should be classed with this group are found. The greenstone-schists of the Upper Tanana and White have already been classed with similar schists which occur in the gneisses. The rocks here indicated as dioritic and gabbroic intrusives, probably including diabasic and other basic rocks, are almost entirely massive, and are a distinct

[1] Yukon district and British Columbia: Geol. Surv. Canada, Vol. III, 1887-88, Pt. I, p. 32 B.

series in these greenstone schists. Professors Cushing and Reid have mapped as diorites and quartz-diorites rocks of this character occurring on Glacier Bay. Along the Upper Tatshenshini I found some pyroxene-feldspar rocks which are put in this group. The innumerable dikes of this character found in some parts of the Nutzotin series have already been described. While this grouping together of rocks of such varied character is unsatisfactory, yet it is all that our present knowledge warrants.

TERTIARY ROCKS.

TOK SANDSTONE.

A small area of this rock was described and mapped in 1898, and I quote as follows from my report:

> A few miles below the mouth of the Tok River several exposures of a soft, yellow sandstone were found. This sandstone, though of small areal distribution, has been given a special name because it is probably younger than any of the formations already described. It has a yellowish color, is friable, and is thin bedded. Beds of fine feldspathic conglomerate of no great thickness are found in it. The sandstone itself showed a thickness of somewhat over 50 feet at one locality.
>
> Several basic dikes of considerable size were found cutting the sandstone at right angles to the bedding, and these were usually deeply weathered. A microscopic examination of one of the dikes showed it to be an olivine-diabase. The strike of these beds is about E. and W., and the dip, which is rolling, not over 5° or 10°. This strike is entirely at variance with that of the gneisses which are near at hand.
>
> Fragmental plant remains were found in the Tok sandstone, but unfortunately are not well enough preserved to give any clue as to the age of the beds. From their slight deformation and unaltered appearance I am inclined to regard them as post-Paleozoic and most likely of Tertiary age.[1]

While we were in the valley of the Kaskawulsh River we could see far to the south of us high escarpments of bedded rocks dipping southward, forming the front of the St. Elias Range. Interbedded with them were masses of dark intrusives, which in places could be seen to cut the bedding. This series was seen to overlie some older rocks unconformably. No opportunity was afforded to study this series, except from a distance, but it seems probable that they are of Tertiary age.

TERTIARY EFFUSIVES.

On the accompanying geological map large areas of effusives are marked as occupying the northern margin of the St. Elias Range. These rocks include rhyolitic, andesitic, dacitic, and basaltic types, but no detailed study has been made of them. Volcanic tuffs are also not uncommon, and some fragments of volcanic glass were found. The age of this series is not definitely determined. They are inti-

[1] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, p. 473.

mately associated with volcanic rocks which have been but recently ejected, and which must be considered as of Pleistocene age. The larger masses, however, show evidence of being older and have been more or less deformed. This deformation manifests itself in monoclinal uplifts which dip south and present fault escarpments to the north. Along these escarpments evidences of crushing and shearing were found wherever opportunity was offered to study them. Along the route of travel between the Kaskawulsh and Nabesna rivers, at different points, we saw innumerable escarpments of this series, but opportunity was given for studying only the ones lying adjacent to our course. In general, it can be stated that where these effusive rocks occur along the northern margin of the St. Elias Range they appear in these faulted blocks. The type of structure is similar to that described by Russell along the southern margin of the range, near Yakutat Bay, where the fault blocks dip northward.

As our best evidence goes to show that no dynamic disturbances of this character have occurred since Tertiary times these effusive rocks are regarded as of Tertiary age. In a broad depression which connects the Upper White with the Upper Tanana there are a great number of mesas made up of volcanic material and usually capped by some hard rock. These effusive rocks exhibit a slight tilting to the south.

On the headwaters of the Tatshenshini River some effusive rocks were found which have been grouped with the others on the accompanying map. They show relatively the same amount of deformation, but in the hand specimen have the appearance of rocks considerably older. They can be conveniently grouped under the field term "felsites." With them are tuffs and conglomerates containing fragments of the Coast Range granite, showing them to be of younger age and separated by an erosion interval. At various localities in this region rocks of similar type have been found, but these have not been studied in detail. In a previous report the mention has been made of some andesitic rocks on the Lower White, and also on the Middle Tanana in the vicinity of Tok River. From their general appearance these rocks should be grouped with those of the Upper Tatshenshini, and probably represent the oldest outbursts of Tertiary times.

PLEISTOCENE DEPOSITS.

SEDIMENTS.

On the accompanying map (Pl. XLVII) the water-laid Pleistocene deposits are represented. The limit of glaciation is shown, but no attempt has been made to map the purely glacial deposits, as the region has not been studied in sufficient detail. The Pleistocene beds are, for the most part, old river gravels, lacustrine silts and sands, together with the moraine river gravels and silts. The old river gravels have the same history and the same origin as those which are at present being laid down. In some cases the slight elevation has resulted in a new river channel being incised in the old deposits, thus giving the silt and gravel terraces which are so common in some parts of the region. In other cases these old gravels are distributed along valleys which, by the change of drainage, are now abandoned, the drainage having sought new water courses. In the study of both the older Pleistocene deposits and those which are now being laid down in the lakes and rivers, it has been found impossible to differentiate the fluvial from the lacustrine deposits. Such differentiation, in my opinion, can be made only from topographic and physiographic evidence.

EFFUSIVES.

The effusive rocks of the region have already been described and the probable Tertiary age of some of them has been considered. Some of these effusives undoubtedly belong with the Pleistocene deposits, as they are of very recent ejection. No attempt has been made on the accompanying map to differentiate the Pleistocene and Tertiary volcanics. Effusive rocks of recent age have been described from various parts of Alaska and are probably synchronous outpourings. Examples of these are the volcanics of the Wrangell group,[1] the basalt flows of White-Horse Rapids and Fort Selkirk, and the volcanic rocks of the Alaskan Peninsula, Aleutian Islands, and Lower Yukon.

GLACIAL PHENOMENA.

The glacial phenomena of the region can be differentiated into that of the present glaciers and that of the Cordilleran ice sheet. On our trip from Lynn Canal to the Nabesna River we saw innumerable glaciers which had their source in this snow range and the White River route. A few of these are shown on the accompanying map, but many it is impossible to locate (see Pls. XLI, *A*, and XLV, *A*). Among the larger glaciers which we passed were the O'Connor, the Donjek, the Klutlan, and the Tanana. These all occupy valleys of considerable size. In every instance studied by the writer the glaciers were found to be retreating. A few small glaciers were also seen in the Nutzotin Mountains, to the north of our route of travel. These are of interest because they are probably the most northerly glaciers thus far found in Alaska.

The limit[2] of glaciation on the accompanying map shows three long tongues extending down the valleys of the Nabesna, Tanana, and White

[1] Mr. Rohn kindly furnished some information in regard to the region between the Chitina and the Upper Tanana.

[2] East of White River this limit of glaciation is determined by the work of Dr. Hayes, Dr. Dawson, Professor Russell, and Mr. J. B. Tyrrell, in reports already cited.

rivers. Of these, the Nabesna and White River tongues were determined by field observations; the Tanana tongue only by inference. They simply represent a valley glacier which extended beyond the ice front at the time of maximum glaciation. In the case of these valley glaciers the sides of the valleys are found to be glaciated only up to a certain limit, which gradually decreases in elevation to the northward. At the end of the valley glacier of the Nabesna River a morainic topography was observed.

It seems quite probable that there was no connection between the glaciation of the Alaskan Range and that of the St. Elias Range. From the best reports we have, the region between the Upper Copper and the Upper Tanana is not glaciated, and hence the Alaskan Range probably represented a different center, from which the ice radiated in all directions. Whether this glaciation in the Alaskan Range was synchronous with that of the St. Elias must be determined by future investigation. In the glaciated region the deposits are not plentiful; only a few exposures of till have been observed. Glacial erratics are, however, very common. At a number of localities glacial moraines were observed, but these belong very largely, if not entirely, to the present epoch of glaciation. On the accompanying geological maps no attempt has been made to differentiate the glacial from the other Pleistocene sediments.

VOLCANIC TUFF.

The white volcanic ash which is found on the Pelly, Lewes, and the Upper White has been noted by many writers, and has been especially studied by Dr. Dawson and Dr. Hayes. In a previous publication I have added some notes to Dr. Hayes's accounts of its distribution. The work of the past summer has yielded considerable information in regard to this interesting deposit, but it is not within the province of this paper to discuss it. In a westerly direction the volcanic ash has been traced far beyond what was formerly supposed to be its limits. It occurs as far west as the Forty-mile Basin and east to the O'Connor Glacier. Near the margin of the area it is found simply as a thin film immediately underneath the soil, and can be observed only when the conditions are favorable. In thickness this deposit varies greatly. On the Upper White, as described by Dr. Hayes and observed by the writer, large drifts 100 feet deep were seen, while near the margin of the region the thickness of the bed is hardly measurable. That this is a wind-laid deposit[1] is clearly shown by its distribution. It occurs on mountain tops and on valley slopes, as well as along river bottoms.

[1] Professor Heilprin's theory that this ash is a lake deposit becomes utterly untenable when the facts of its distribution are studied. It seems doubtful whether Professor Heilprin had read Dr. Hayes's paper, for the facts presented in it are sufficient to confute the theory of its being a lacustrine deposit. See Alaska and the Klondike, pp. 228–233.

Along the valley of the Upper White River it is distributed as huge drifts, which from a distance closely resemble snowdrifts.

The location of the volcano from which these ejecta came is not yet determined. From the distribution of the ash and the relative coarseness of the material at different localities the writer is inclined to believe that the volcano lies to the south of the Klutlan Glacier, well in the heart of the range. The Klutlan Glacier, besides carrying much ash, also brings down considerable white pumice, the fragments being sometimes 6 inches in diameter. These are probably a part of the same ejecta as the ash. Of the glaciers and streams the Donjek and the Klutlan must have their sources nearest the volcano.

It is of interest to note that at several localities two layers of ash were observed, separated by several inches of soil. This fact suggests that there were two outbursts separated by a considerable time period. In favorable localities the soil was able to gain a foothold before the second outburst. At the Klutlan Glacier some pebbles of a white volcanic rock were found, which may represent lavas of the same period of activity.

GROUND ICE.

The ground-ice formation of Alaska has been frequently described and needs no further description here. Below the immediate vegetation of the surface the ground is, as a rule, frozen throughout the year. Thawing takes place only along fresh stream cuttings or where the moss or grass has been stripped off. In some cases this ground ice is clear, resembling glacial ice, but in origin it differs little from that of the frozen soil. These clear ice masses represent small lakes which have congealed.

The dense growth of moss, which covers nearly the entire surface of the country, retards erosive action very materially. Streams are usually clear, even after rainfall, unless they have glacial origin or are undercutting silt banks. Where rocks are exposed among the higher peaks as cliffs, disintegration takes place very rapidly, probably because of the extremes of temperature.

Table of hypothetical correlations.

	Spurr; Yukon district, 1896.[1]	Brooks; Pyramid Harbor to Fortymile River, 1899.	Brooks; White and Tanana river districts.[2]	Mendenhall; Resurrection Bay to the Tanana River, 1898.[3]	Spurr; southwestern Alaska, 1898.[4]	Eldridge; Sushitna Valley, Alaskan Range and Cantwell River, 1898.[5]	Schrader; Copper River district, 1898.[6]
Pleistocene	Silts and gravels.	Silts, sands, and gravels. Effusive rocks in part.	Silts and gravels.	Sands and gravels.	Silts, sands, and gravels.	Sands, gravels, and bowlder clays.	Silts and gravels.
Tertiary	Twelvemile beds, Porcupine beds, Nulato sandstone, Palisade conglomerate.	Tok sandstone and effusive rocks in part.	Tok sandstone. (?)		Tyonek beds, Hayes River beds, Nushagak beds.		
	Kenai series.				Yentna beds.	Kenai series.	Orca series. (?)
Cretaceous	Mission Creek series.			Matanuska series.	Tordrillo series, Holiknuk series, Kolmakof series, Oklune series.		Valdes series. (?)
Jurassic					Naknek series, Skwentna series, Terra Cotta series.		
Devonian and Carboniferous.	Tahkandit series.	Nutzotin series.	Wellesley series, Nilkoka beds. (?)	Sunrise series.	Tachatna series.	Cantwell conglomerate. (?)	
Silurian and pre-Silurian sediments with intrusive and extrusive rocks.	Rampart series, Birch Creek schists, Fortymile series.	Greenstone schists, Kotlo series.	Greenstone schists (?), Tanana schists, Nasina series.	Greenstones, Tanana schists.		Sushitna schists.	Klutena series.
Archean	Basal granite.	Gneissic series.	Gneissic series.			Basal granite and gneissic series.	

[1] Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U. S. Geol. Survey.
[2] A reconnaissance in the White and Tanana river basins, Alaska: Twentieth Ann. Rept.
[3] A reconnaissance from Resurrection Bay to the Tanana River, Alaska: Twentieth Ann. Rept.
[4] A reconnaissance in southwestern Alaska: Twentieth Ann. Rept.
[5] A reconnaissance in the Sushitna Basin and adjacent territory, Alaska, 1898: Twentieth Ann. Rept.
[6] A reconnaissance of a part of Prince William Sound and the Copper River district: Twentieth Ann. Rept.

SUMMARY OF GEOLOGY.[1]

A broad belt of crystalline rocks extends in a northeast-southwest direction in the region of the Tanana-Yukon divide, embracing a series of gneisses, mica-schists, basic schists, and various intrusives, chiefly of an acid character. Near the Middle Tanana this series bends to the west and south, and its continuation is to be sought for in the region of the Upper Kuskokwim.[2] To the southeast this belt is probably continued by the granitic rocks on the Pelly River, described by Dawson. What evidence we have goes to show that this is the basal series of the Yukon Basin, and as it contains no recognizable detrital material it can properly be assigned to the Archean. Whatever the original character of the rocks may have been, they are now essentially mica-schists and gneisses, with considerable intrusive material. The gneisses and schists, and in part the intrusives, have been subjected to intense dynamic metamorphism. Their metamorphic condition is the strongest argument for considering them older than any of the sedimentary rocks. The intrusives are both sheared and massive and hence were injected both during and after the period of folding.

After the era of the folding of the gneisses the next important epoch in the region is that during which the older sediments, the Kotlo series, as marked on the accompanying map, were deposited. The oldest rocks of this series contain more or less detrital crystalline material, and it is probable therefore that during this epoch a part of the Archean area was exposed as a land mass, and was, in part at least, the source of the sediments. The oldest rocks of the series are present—quartz-schists with impure limestones, called the Birch Creek series by Spurr (Tanana schists, Brooks). This series aggregates many thousand feet in thickness. This period was followed by the deposition of an immense thickness of limestone beds.[3]

Acid and basic rocks are found in both the arenaceous and calcareous beds. The close of the deposition of this calcareous series was marked by dynamic disturbances, and these beds were folded, and probably during this time the intrusion of the igneous rocks took place.[4] After the dynamic forces had become quiescent once more, these older series, in part, formed land masses, which contributed sediments. A stratigraphical break is here marked by the unconformity below the Rampart[5] series and greenstone-schists, which constitute the upper member of the Kotlo series. This epoch was characterized by the extrusion and intrusion of a vast amount of igneous

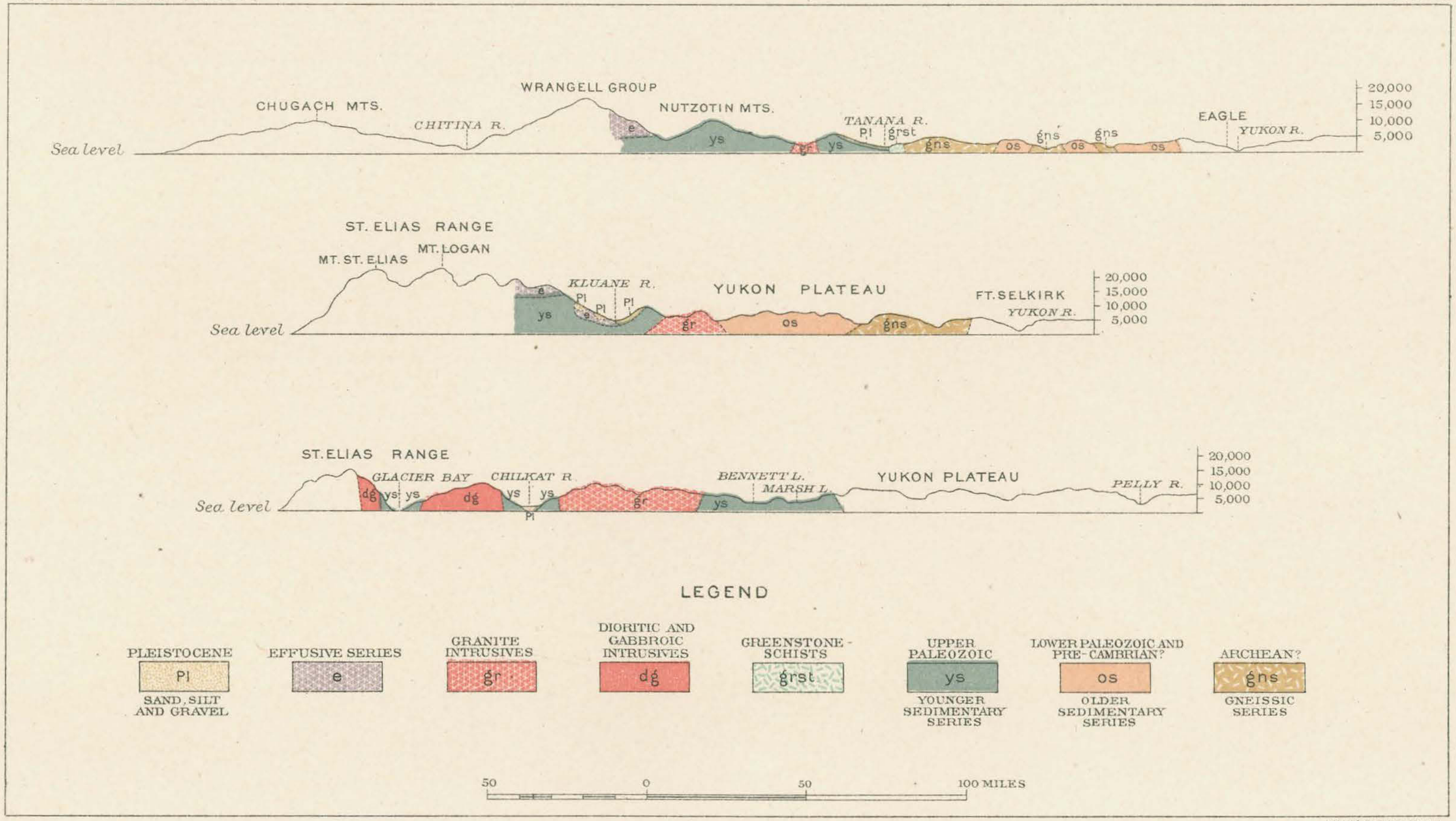
[1] See Pls. XLVII and XLVIII.

[2] Spurr's crystalline rocks of the Kaiyuh Mountains, which he regards as basal, seems to be a distinct belt lying to the northwest of the one under consideration: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, p. 241.

[3] Fortymile series, Spurr, and Nasina series, Brooks.

[4] Geology of the Yukon gold district, pp. 255–256.

[5] Spurr, op. cit. The greenstone-schists have been provisionally correlated with the Rampart series.



JULIUS BIEN & CO. N.Y.

PROFILES OF ST. ELIAS RANGE AND YUKON PLATEAU WITH GEOLOGY AS FAR AS KNOWN

BY

ALFRED H. BROOKS

rocks, chiefly of a basic character. This upper member of the Kotlo series is believed to belong to the lower Paleozoic. To the east of the areas mapped the Kotlo series has not been recognized, while to the west Spurr has identified them in the Birch and Mynook Creek basins. The series is of the utmost importance because the gold of the Yukon district, so far as determined, has been derived from the mineralized zones found in it.

The Nutzotin series is the next succeeding formation marked on the accompanying geological map. This series is of Devonian and Carboniferous age, and, as determined in the Fortymile[1] and upper Tanana basins, overlies the Kotlo series unconformably. This unconformity was rather one of erosion than of deformation. The older rocks were in part above water and contributed sediments while this series were being deposited.

I have described the heavy conglomerate of the Wellesley formation in the upper Tanana and White River region,[2] which there represents the basal member of the Nutzotin series. These are succeeded by black slates, which are overlain by impure limestones. Above these is a considerable thickness of gray and greenish slates and graywackes, growing more calcareous upward, and with them is a great quantity of basic intrusives, together with tuffs and extrusive rocks. These igneous rocks can be conveniently grouped together under the field term greenstones until they have received careful microscopical determination. The uppermost member of this series is a bed of limestone probably exceeding a thousand feet in thickness, which is usually highly crystalline. This slate, limestone, and greenstone series was traced eastward along our route of travel to Lynn Canal. Reid and Cushing have described the sedimentary rocks of the Muir Glacier region as argillites and limestones, and these have been provisionally correlated with the Nutzotin series on the accompanying map. The rocks lying adjacent to the Coast Range along the Lewes River route, as determined from descriptions by Dr. Dawson and from personal observations by myself, undoubtedly belong to the same series, and have been so colored on the accompanying map.

Fossils have been found in this series at several localities, so that its position in the stratigraphical column is approximately determined. On the Yukon Spurr[3] has found an upper Carboniferous fauna. On the Tanana[4] fossil evidence goes to show that this series is Devonian or Carboniferous. The Glacier Bay[5] limestones have been proved to

[1] Spurr's Tahkandit series is included in the Nutzotin series. For the distribution and relation of the Tahkandit series see Spurr's report.

[2] Op. cit., pp. 470–472.

[3] Op. cit., p. 170.

[4] A reconnaissance in the White and Tanana river basins: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, p. 472.

[5] Glacier Bay and its glaciers, by Harry Fielding Reid: Sixteenth Ann. Rept. U. S. Geol. Survey, Pt. I, pp. 433–434.

be of Carboniferous age. Dr. Dawson[1] has found Carboniferous fossils in the limestones of Tagish Lake north of the Coast Range. These facts show that the Nutzotin series is largely Devonian and Carboniferous, but as represented on the accompanying map it may include older beds.

No Cretaceous rocks are represented on the geological map, though it is quite possible that they may be found on more detailed examinations.[2] Dr. Dawson has determined some areas of Cretaceous along the Lewes River, notably on Lake Lebarge. Spurr's Mission Creek series of the Yukon district is believed to be of Cretaceous age. These Cretaceous rocks, as shown by these writers, are thrown into open folds.

Intrusives are common throughout the series which have been so far described. They can be classed as rocks of granitic, dioritic, gabbroic, and diabasic character. The largest mass of intrusive rock is represented by the Coast Range granite. This is a medium-grained hornblende- and biotite-granite of a rather uniform character. At Lynn Canal this belt is about 60 miles wide. To the northwest a similar granite was found near Lake Kluane and on the Nabesna. It seems probable that the belt is continuous, though it has not been traced by field observations. To the southeast Dr. Dawson has traced this granite as far as the Stikine River. The investigations of the writer lead him to believe that the granite is post-Carboniferous and pre-Cretaceous. Dr. Dawson[3] has determined that it is post-Triassic in age. In the section across the White and Chilkoot passes some shear zones are observed in the granite, along which it has been altered to a mica-schist. This goes to show that some dynamic disturbances have taken place since the intrusion of the granite.

A second class of intrusives, which are shown on the accompanying map, are classed as dioritic and gabbroic in character. The only large area of this type shown is that of the region of Muir Glacier, which is taken from Professor Reid's geologic map. These rocks are believed to be younger than the granite, in which are found dikes of the same character.

Of Tertiary sediments we have only one small area in the region. This is the so-called Tok sandstone, found near the mouth of the Tok River, the beds of which are gently undulated.

The large belts of effusive rocks shown on the geological map are probably but the scalloped margins of much larger areas occurring to the south. This is shown by the abundant volcanic material brought down by the streams and glaciers which have their sources in the mountains of that region. In the Wrangell region we have more

[1] Exploration in Yukon district, Northwest Territory, and in British Columbia, p. 33 B.

[2] Jurassic fossils were found by Hayes south of the Skolai Pass (op. cit., p. 140), and beds which were probably Jurassic are reported by Rohn from the Wrangell region.

[3] Op. cit., p. 32 b.

definite information of the occurrence of large masses of effusive material.[1]

No study has been made of the various effusive rocks which were collected by me, but a hasty examination showed rhyolitic, andesitic, dacitic, and basaltic types. Tuffaceous rocks are very common, and some fragments of volcanic glass were found near the Klutlan Glacier.

No attempt has been made on the accompanying map to differentiate the volcanics of different epochs. In general it can be stated that the outburst began in late Tertiary times and probably reached its maximum development in comparatively recent times. Some of the volcanoes of the Wrangell group are still smoking, but it is not known whether or not this is simply a temporary quiescence or the solfataric stage which precedes the complete cessation of activity. To the north of the region mapped small areas of recently extruded rocks are not uncommon. As examples, we have the basalt of White Horse Rapids, at Fort Selkirk, and at various other points on the Yukon. One of the manifestations of recent volcanic activity is the white volcanic ash whose wide distribution has already been referred to.

The volcanic rocks of the northern margin of the St. Elias Range and of the upper White River show evidence of having suffered some disturbance. To the south of our route of travel, between the Donjek and the White, we could see a number of northward-facing escarpments, the nearest of which was determined by actual observations to be made up of volcanic rocks; the others, lying to the south, were of a similar character, so far as could be determined by examination with field glasses. The tops of these escarpments are moss and grass covered and slope gently southward in conformity with the bedding of the constituent rocks. At several points the most northerly escarpment was examined and the rocks were found to be much sheared and shattered. This evidence goes to show that faulting has taken place along the escarpments, and that, in fact, these are monoclinal blocks tilted to the south and faulted on the north side. In the broad depression which connects the upper White with the upper Tanana there are a great number of mesas formed of volcanic material and usually capped by some hard bed. In these the strata also show a tilting to the south.

The history of the unconsolidated Pleistocene deposits has been referred to in the physiographic notes, and has been somewhat more fully discussed in a previous publication. At only one locality in this region was there any evidence of the deformation of the unconsolidated beds, such as has been noted elsewhere in Alaska. In the mud flats at the mouth of the Slims River at the head of Lake Kluane, some silt beds were observed which rise above the general level of the flood plain

[1] Messrs. Hayes, Allen, and Rohn.

in a series of little hummocks. On examination the material was found to be a finely banded blue clay which had been thrown up into a series of gentle folds. This folding may have been produced by some local cause and not by a deformation due to dynamic forces. In general, during Pleistocene times the dynamic disturbances have been orographic elevations and depressions rather than deformations.

The geological history of the important orographic features of the region has already been referred to, but a brief summary is necessary for the sake of emphasizing certain leading features. The Yukon Plateau is a dissected upland plain lying between two great mountain systems. On the north it is bounded by the Rocky Mountain chain which lies between the Mackenzie and Yukon basins. This chain has a northwesterly trend nearly to the Arctic Ocean, then makes an abrupt turn to the west and continues parallel to the frozen sea. Its westward extension, which decreases very much in elevation, probably reaches the sea in the vicinity of Cape Lisburne. This part of the Rocky Mountain chain is practically unexplored.[1] It is, however, known that the Paleozoic column is represented in northern Alaska[2] as well as the Cretaceous, and there is at least no evidence against a correlation of this northern range with the Rocky Mountains.

To the south the Yukon Plateau is limited by several distinct ranges. The most westerly of these is the great Alaskan Range, which lies west of Cook Inlet and the Sushitna Valley and extends in a northeast direction to the Tanana. This range, so far as known, is largely made up of metamorphic schists, which should probably be included in the older sedimentary series of the accompanying map. To the east of the Alaskan Range the boundary of the plateau is continued by the Mentasta and Nutzotin mountains. These, as has been shown, are composed of the younger sedimentary rocks—the Nutzotin series. Still farther east the plateau is bounded by the St. Elias Range, the geology of which is but little known. The rocks of the Chugatch Mountains, a branch of the St. Elias Range lying to the south of the Chitina River, Schrader regards as probably Cretaceous. The beds exposed near Skolai Pass Hayes determined as Mesozoic or younger. At Yakutat Bay Russell[3] found Pleistocene beds, and at Lituya Bay Dall[4] reports phyllites and granite overlain by sandstones and conglomerates, probably of Miocene age. Beds of Miocene age have been found between Controller Bay and Icy Bay on the southeast coast of Alaska.[5] At Glacier Bay Reid and Cushing found Carboniferous limestones overlying phyllites of undetermined age.

[1] The northern portion of the Canadian Rockies has been studied by R. G. McConnell. See An exploration in the Yukon and Mackenzie basins: Geol. Surv. Canada, Vol. IV, 1888–89, Pt. II.

[2] Report on Paleozoic fossils from Alaska, by Charles Schuchert: Seventeenth Ann. Rept. U. S. Geol. Survey, Pt. I, pp. 899–900.

[3] Nat. Geog. Mag., Vol. III, 1891–92, p. 167.

[4] Seventeenth Ann. Rept., Pt. I, p. 784.

[5] A reconnaissance in southwestern Alaska, by J. E. Spurr: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 263–264.

In the extension of the St. Elias Range to the southward Paleozoic and younger rocks have been found. The studies of the writer have shown that there are Carboniferous rocks along the northern margin of the range overlain by Tertiary or recent volcanics. The evidence, fragmentary as it is, points to the conclusion that while the coastal region of the St. Elias Range has been uplifted during Pleistocene times, as Professor Russell has shown, yet there was a much older protaxis, and that the range is in part made up of older rocks. That a part of the range is considerably metamorphosed compared with the coast belt is shown by the garnetiferous schists which have been reported among the glacial débris brought from the mountains, both at Yakutat and at Glacier Bay. The Coast Range, as has been shown, is a large mass of granite which was intruded in late Cretaceous or early Triassic times.

MINERAL RESOURCES.[1]

GOLD.

Most of the region under discussion lies without the gold belt of the interior of Alaska, and we did not see the rocks of the gold-bearing series until we reached the Fortymile basin. Much of the area included in the accompanying geological map is occupied by rocks younger than those which have made the Fortymile region and the Klondike so famous. This series of rocks, however, has been locally found to be highly mineralized and to carry some gold. It seems probable, from the best accounts, that the gold-bearing rocks of Atlin probably belong to the horizon of the younger sediments, as marked on the accompanying map—the Nutzotin series. There can be but little question that the rocks of the Porcupine gold district, in Chilkat River basin, belong to the Nutzotin series. It seems probable that the Shorty Creek district of the Kashaw River basin also derives its gold from this series.

Considerable panning was done by our party as opportunity offered, and colors were occasionally obtained, but I am forced to the conclusion that the regions west of Dalton House, as far as the Fortymile basin, will never produce gold in commercial quantities. From accounts given by prospectors the Shorty Creek district does not seem to have turned out as well as had been expected last year. Some brief statements in regard to this district were published by Mr. Russell L. Dunn,[2] from whom I quote as follows:

> What has generally been referred to as the Shorty Creek district is in the singular isolated mountain mass of metamorphic Jurassic slates lying west of Lake Desardeash, 150 miles inland from Pyramid Harbor and accessible by the Dalton trail. * * * Shorty Creek, though gold bearing and the locus of the first discovery, does not seem to contain commercial values. * * * The district is, on the whole, not

[1] See Pl. XL.

[2] Mining and Scientific Press, October 29, 1898, p. 425.

one to which prospectors can go expecting to make a strike in the first season, nor even to anticipate very rich mines in. Miners, however, can make fair wages from many claims; incidentally they may discover something worth the attention of capital.

Our expedition passed some 10 or 12 miles to the south of Shorty Creek, but I was unable to visit this locality. I am not inclined to agree with Mr. Dunn in regard to the Jurassic age of the slates, and these are represented on the accompanying map as belonging to the Nutzotin series, which is of Upper Paleozoic age.

It will be seen that this belt of rocks, as a whole, is not gold bearing, yet it frequently is mineralized and in some places, as on Porcupine Creek, which will be described below, and possibly at Shorty Creek, may carry gold in commercial quantities.

PORCUPINE GOLD DISTRICT.[1]

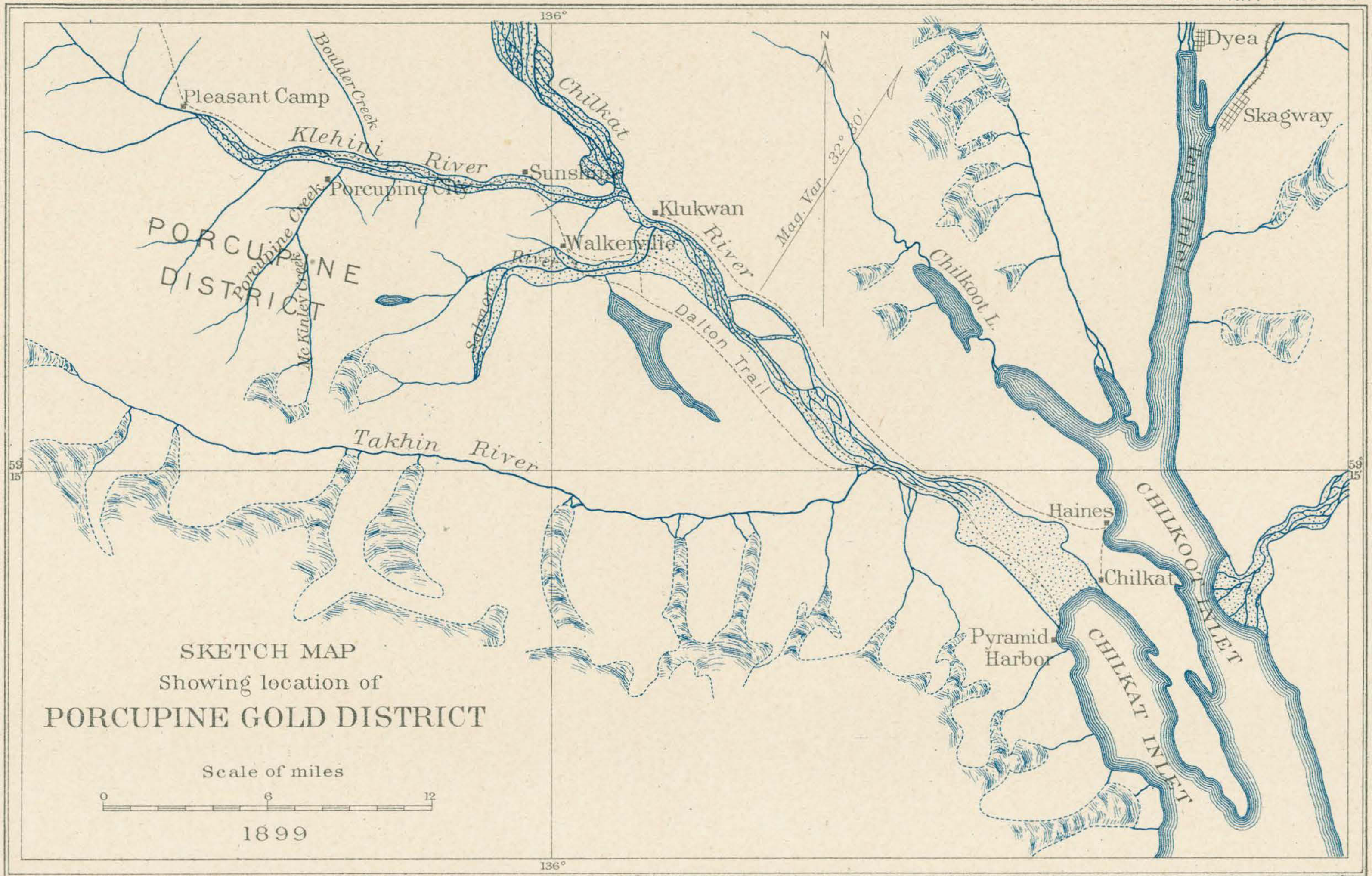
This district lies on Porcupine Creek, which joins the Klehini River about 35 miles from Pyramid Harbor and 7 miles below Pleasant Camp. During the brief visit made in June, 1899, only a few general facts could be gathered in regard to this district, for the upper courses of the creeks were then deeply buried in the snow.

Near the mouth of Porcupine Creek there is a belt of white crystalline limestone which strikes about northwest and southeast, and has steep dips, usually southwest. It is often much sheared and faulted, and the bedding is obscured. The belt is less than half a mile wide, and above it is a broader belt of clay slates which are usually highly contorted. The strike of the slates is about N. 20° W., and hence at variance with that of the limestone. There would seem to be an unconformity here, though the region is so much faulted that the structural relations can be determined only by a closer study than I was able to give.

In the stream gravels are found abundant pebbles of hornblende-granite, diorite, and quartz-diorite, and of some more basic rocks. None of these rocks were found in place and in only one locality were any dikes observed—about 2 miles from the mouth of the creek, where a deeply weathered grayish dike rock was found cutting the slates and locally altering them to a hornstone. The dike, so far as could be determined, was of dioritic character.

There is a marked absence of quartz veins, both in the bed rock and in the stream gravels of Porcupine Creek. I found a few pebbles of vein quartz in the creek bed, but saw absolutely none cutting the slates. Calcite veins are, however, not uncommon in the slates and are frequently charged with pyrites. The slates, as a whole, are highly mineralized and assays from average samples showed that they carry traces of both gold and silver. Even though my visit was a very hur-

[1] See Pl. XLIX.



JULIUS BIEN & CO. LITH. N.Y.

ried one, I saw enough to convince me that the gold of the placers was derived from these mineralized slates. Such being the case, the extent of the district will depend on the width of this slate belt, which I was unable to determine on account of the snow. It is possible that the entire belt is not mineralized, and this fact should be borne in mind by prospectors. According to such facts as I was able to gather, I am led to believe that toward the headwaters of the creek there are large masses of granite and other intrusive rocks, probably similar in character to those already referred to on Glacier Bay. Coarse gold has been found on McKinley Creek, a tributary of Porcupine Creek.

The placers that were being worked on Porcupine Creek during my visit were irregular benches which are formed of large bowlders more or less irregularly tumbled together. These stream benches can not be traced a great distance and are apparently due to the damming caused by rock barriers. The best pay dirt has been found above these rock barriers, among the large bowlders and gravels which have been deposited by the stream and contributed by the talus from the slopes of the valley. The presence of these very large bowlders, sometimes several feet in diameter, very much increases the cost of working the claims. The bars of the creek itself can be worked only at considerable outlay, because of the difficulties of getting rid of the water. The Porcupine gold rates high in value as far as known, is rather pure, and the grains are usually very flat, as would be expected of gold derived from mineralized slates. The pay dirt, so far as my observations go, is from 2 to 4 feet thick and lies on bed rock. A pan of gravel which I washed out from one of the claims yielded about 20 cents in gold in 5 different grains. I was informed that pans running 60 to 80 cents are not uncommon, and that the largest nuggets have been from $3 to $5 in value. Since leaving there I have been informed that the attempt was made to reach bed rock in the bed of the creek and that the miners passed through 18 feet of gravel without reaching the bottom. These gravels were said to have all carried values.[1]

Since my visit discoveries have been reported in the Salmon River Basin, east of Porcupine Creek, and on Glacier Creek, west of Porcupine. I have no definite information that there have been any placers of commercial value found outside of the Porcupine Valley, but would rather expect that the northeast and southwest extensions of the gold-bearing series would yield placers. The Porcupine district was discovered in June, 1898, by Messrs. Mix and Finley, who located the Discovery claim about 2 miles from the mouth of the creek.[2] They are said to have taken out some $1,500 during the season.

[1] Mr. W. H. P. Jarvis, of Bennett, British Columbia, informs me that since my visit 16 feet of pay dirt has been found on Porcupine Creek, giving $50 a day to the man. He estimates that the district produced some $60,000 during the past season, but states that there is no official basis for these figures. The output in the coming season will undoubtedly be very much greater, as in 1899 much of the time and energy of the miners was given to prospecting rather than to the development of the claims.

[2] According to another statement the credit of the discovery belongs to E. Hackley.

The Porcupine district is easily accessible from the coast. Its open season is rather long, extending from June to September. The Dalton trail will enable miners to carry in provisions at no very great expense. Even if it is not so rich as some of the other placer regions of Alaska it possesses some advantages over those of the interior, and if it turns out as well as it promises we may expect it to continue to be a gold producer.

FORTYMILE GOLD REGION.

The first discoveries in gulch placers were made in the drainage basin of Fortymile River in 1886, and since that time the work of placer mining has been continuously carried on in the basin. This region has been reported on by Mr. Spurr,[1] and it is my purpose to give here only a few supplementary notes which were gathered on the recent trip.

Fortymile River joins the Yukon about 30 miles above the international boundary, and its mouth is, therefore, in Canadian territory. Its drainage basin is, for the most part, on the Alaskan side of the line, as are also most of its gold placers, so far as determined. The gold, as shown by Spurr, is derived from metamorphosed sedimentary rocks, which he divided into three formations. On the accompanying geological map these are all included in the Kotlo series. The derivation of the gold is from quartz veins and from zones of impregnation, but up to the present time there have been no discoveries of veins reported which would warrant the introduction of mining machinery.

Important creeks, from the standpoint of the gold prospector, are Napoleon, Chicken, Franklin, and Canyon creeks, as well as Nugget Gulch. All of these have produced gold in commercial quantities. There are innumerable smaller creeks and gulches which have been worked, many of them quite successfully, but most of them are not so rich as those that have been named.

The important discovery of the past year has been Wade Creek. Wade Creek joins Walker Fork about 5 miles from South Fork. Its drainage basin lies immediately south of the trail leading from Franklin Creek to Steele Creek, and the valuable discoveries are said to have been made in the upper half of the basin. The pay streak is said to be rich but not very thick, and lies on bed rock some 12 or 14 feet below the surface. Bench claims as well as creek claims are being worked. I was not able to visit this creek in person, and these facts were gleaned from various sources. As to the value of the claims I can give no definite information, but well-authenticated rumors state that fractions of claims had sold at from $30,000 to $40,000. The creek basin lies within the gold-bearing series and there seems to be a strong probability that this is the same series in which

[1] Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III. Also, Explorations in Alaska in 1898.

the famous Klondike gold occurs. There is every reason to believe, therefore, that it has an important future as a gold producer.

Like many of the creeks of the Fortymile Basin, Wade had long been prospected and had been reported as not carrying values. This is probably accounted for by the fact of the great depth to bed rock. The discoveries are said to have been made in March, 1899, and a steady influx of prospectors took place during the spring and summer months. The creek is easily accessible by a good trail from the mouth of Steele Creek, a distance of about 12 miles. Steele Creek can be reached by a trail which comes from Eagle City or by a small boat up Fortymile River from the Yukon. In the latter case prospectors will pass the United States custom-house at Sam Patch's, and will have to pay duty on their outfits unless they can prove that they were purchased in American territory.

Though the Fortymile Basin has been more or less prospected during the last fifteen years, and especially since the Klondike rush, yet it still offers a field for those who are willing to spend money and time in more detailed investigations. In the past the high price of provisions and the uncertainty and expense of transportation compelled the prospector to confine his attentions to deposits which would give immediate return. The conditions now are becoming more settled, more or less of the element of boom having been eliminated, and there is strong hope that careful prospecting will develop other gold placers in the Fortymile region.

Of the other gold districts of this part of Alaska, Sixtymile River continues to attract a good many prospectors and to yield return for work expended, some of the claims on American Creek, near Eagle City, continuing to be gold producers. I saw a nugget valued at $192 which had been taken from a claim on American Creek in September, 1899.

COPPER.

Copper was probably the first metal which was reported from the Territory, for as far back as 1741 the Bering expedition found evidence of its use among the natives of the southeast coast of Alaska.[1] It seems to have been extensively employed among the aborigines of Alaska, for many of the native languages contain a word signifying copper when they lack a name for either iron or gold. The Copper River took its name from the fact that large copper deposits were reported to occur on its banks.[2] The natives of the Copper River, the Upper White, and the Upper Tanana have long been known to have access to native copper deposits, and it is probable that all the native copper in circulation previous to the ingress of the white traders was obtained from these natives. The natives used it for arrowheads and

[1] Dall, op. cit., p. 272.

[2] Report on population and resources of Alaska, p. 77, Tenth Census.

later for bullets, and, it is said, for cooking utensils, and when the coast was first visited by white men copper knives were said to be still in use. Not having any other metal than copper they adapted it to various purposes. The extent to which the intertribal trade in copper was carried out is witnessed by the fact that copper utensils are in use by the Haida Indians of Queen Charlotte Islands.[1] These copper utensils of the Haida Indians were obtained by barter with the Chilkats, who in turn secured the copper from the Indians of the interior, probably of the White River. At the present day copper has a comparatively limited use among the Alaskan Indians. They still use it for arrowheads, but these have been largely supplemented by firearms. As most of them now use breech-loading rifles, they have no reason for manufacturing bullets of copper. Moreover, it is probable that the copper accessible to the natives has been very largely exhausted. Their crude methods of digging enabled them to obtain it from the placers only close to stream cuttings, and at present larger pieces seem to be relatively rare. An interesting fact in connection with the native use of copper is that the placer deposits, which will be described below, are situated in gulches and valleys which were up to very recent time occupied by glaciers. As the glaciers gradually retreated they would leave the gravels uncovered and make the copper contained in them accessible. The time can not have been far distant when these valleys were filled with ice down to the main river valleys, and the copper contained in them can not have been in use by the natives more than a few centuries at most.

RAINY HOLLOW COPPER DEPOSITS.

On the accompanying route map (Pl. XL) three copper belts are located. The most easterly of these is 10 miles from Pleasant Camp, at what is called Rainy Hollow. At this locality, which is about 3 miles off the Dalton trail, near the head of Klehini River,[2] a copper vein was discovered late in the summer or early in the fall of 1898. At the time of my visit much of this region was deeply buried in snow, and there was no opportunity for detailed investigations. The belt lies close to the contact of the Coast Range granite and the sedimentary rocks. The sedimentary rocks are quartz-schists, often calcareous, striking about N. 60° E. and dipping very steeply southeast.[3]

The "Discovery" claim consists of two different veins, 2 feet and

[1] Dawson: Geol. Surv. Canada, Report of Progress, 1878–79.

[2] This region is included in the Cassiar Mountain district of British Columbia. The name "Copper Blow division" has been suggested, but I trust that it has not yet been accepted by the Canadian authorities.

[3] Mr. J. P. Jarvis, of Bennett, British Columbia, who had opportunity to study this region after the snow left the ground, says that on the Montana (the Discovery claim) there are a number of stringers of bornite embracing a zone of 300 feet in the slates and calcitic rocks. Mr. Jarvis also reports large deposits of zinc and lead from the same region. These, he states, occur in a belt about 3 miles long, running parallel to a belt of granite. The ore is said to run 33 per cent lead, 22 per cent zinc, and a little copper. Some specimens sent to me showed zinc blende and galena with a calcite gangue.

18 inches in width. The copper minerals are bornite, chalcopyrite, and malachite. The wall rock is a hornstone, which seems to have been silicified at the time of the intrusion of the copper-bearing solutions, and probably contains more or less copper-bearing minerals. The assays of copper ores from this region which were shown me by prospectors run from 20 to 55 per cent copper. From none of them, however, could I get definite information as to whether they were average samples. My visit to this locality was simply the utilization of a day in which we had to rest our horses, and the observations were very limited. From talking to several prospectors who had been in the region for some time and from examining the specimens, I gathered that there were other veins of relatively greater importance than the Discovery veins. The general appearance of the rocks, so far as my observation goes, is that a great deal of mineralization has taken place. Quartz veins carrying copper minerals are not uncommon in the metamorphic slates and schists exposed along the Upper Klehini River.

While my own investigations can not lead to any definite conclusions, yet I would regard the region as one worthy of attention by those seeking copper. It is easily accessible from tide water, being only some 50 miles from a good harbor, and could be easily reached by a railroad up the Klehini River, the highest point which would have to be crossed being about 2,000 feet in elevation.

This mineral belt has not been traced west of Rainy Hollow. Tyrrell, however, reports some copper pyrites bearing quartz from near Glacier camp, about 15 miles west, on the Dalton trail.[1] In the débris brought down by the O'Connor Glacier I observed much mineralized quartz carrying both iron and copper pyrite, and with it numerous fragments of white crystalline limestone as well as a variety of igneous intrusives. As the Rainy Hollow mineral deposits seem to be the result of contact phenomena between calcareous sediments and igneous rocks, the westward extension of the contact would seem worthy of investigation.

KLETSAN COPPER DEPOSITS.[2]

Kletsan Creek,[3] from which this deposit takes its name, is an unimportant tributary of the Upper White River, which joins the latter stream about 5 miles above the international boundary (see Pl. L). This stream rises in a glacier which occupies the north slope of Mount Natazhat, a peak of the northern portion of the St. Elias Range. These copper deposits have long been known to the natives, and seem to have been the source of much of the copper which is in circulation among the Alaskan Indians. The marvelous tales told by the Indians living

[1] Summary Report, 1898, p. 46, Geol. Surv. Canada.
[2] See Pl. L.
[3] Kletsan is the White River Indian word for copper.

adjacent to this region of the wonderful "copper mountain" are important contributions to the earliest works of fiction concerning Alaska.

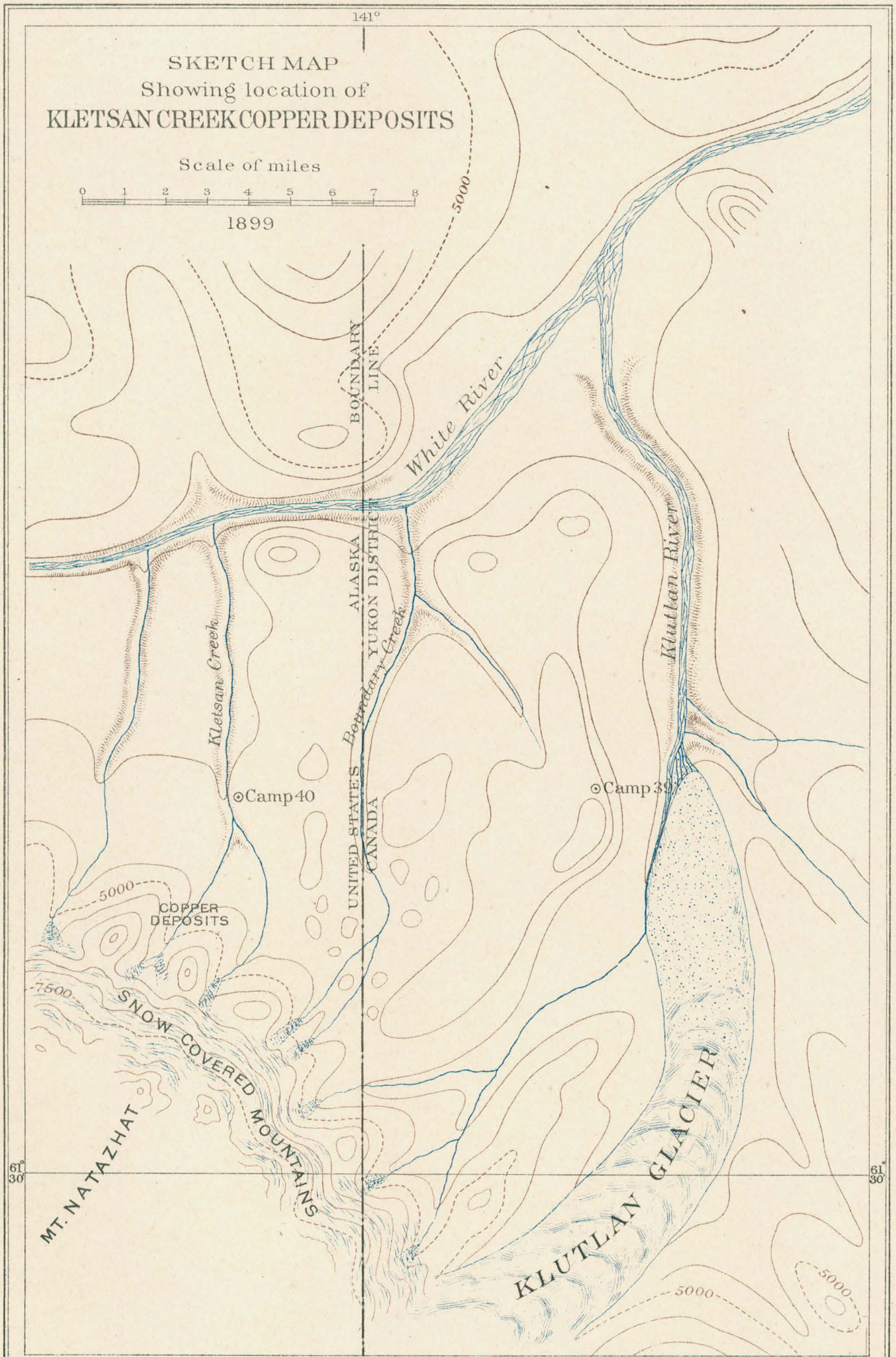
Though stories of these rich copper deposits had long been known to the traders and pioneers of Alaska, the region was so inaccessible that no attempt had ever been made to visit the copper deposits up to 1891. In that year Dr. Hayes, in company with Lieutenant Schwatka, made a trip from Fort Selkirk to Skolai Pass, before referred to.[1] In the course of this trip they were taken by the Indians to the copper deposits of Kletsan Creek.[2] In 1898 Mr. Jack Dalton, accompanied by Mr. Henry Bratnober, visited Kletsan Creek and procured samples of the native copper from the placer deposits.

The mountains lying to the south of Kletsan Creek are rugged and snow covered, the highest peaks probably reaching an elevation of 15,000 feet. The streams all have glacial sources, and in their upper courses flow through narrow rock-cut valleys. After leaving the base of the mountains they enter a broad gravel-filled area in which they have incised deep channels. In general, this upland consists of a series of more or less well-defined benches interrupted by numerous small lakes and undrained depressions. These are, in part, of glacial origin, but are also, in part, due to the obstruction of the minor drainage caused by the deposition of a large amount of white volcanic ash, a description of which has already been given. The talus slope of the mountains is connected with the upland by a gently sloping plain which owes its origin to a series of fan deltas formed by the streams that flow down the mountain gullies, the smaller ones only during the periods of rain.

The geology of the region, so far as studied, is not very complex. Close to where the creek leaves its rocky floor there is exposed a belt of white crystalline limestone containing numerous fossils, which show it to be of Carboniferous age. Above the limestone are found a series of carbonaceous schists and shales, which sometimes approach an impure coal in character. Both the limestone and the shales are cut by dioritic and diabasic rocks, which are exposed along the creek in large areas. The diorites seem to be the older intrusions, and are in turn cut by diabases. As far as determined from the talus and stream gravels the mountains themselves are made up of effusive rocks, which overlie these unconformably. The Carboniferous rocks show great variety in strike and dip. In some places they lie nearly horizontal, and again they are sharply folded. The strikes vary from north and south to nearly east and west. The greenstones are jointed, but are not much sheared. The slates and limestones are locally faulted, but

[1] Nat. Geog. Mag., Vol. IV, 1892, pp. 1-45.

[2] Another party of prospectors, under the leadership of Mr. Emmons, is said to have visited this copper belt in 1898. Several other parties of prospectors who reached the White River by way of Skolai Pass may also have visited the deposit.



JULIUS BIEN & CO. LITH. N.Y.

usually the dips do not exceed 20° and 30°. Near the contact with the greenstone the limestone is much altered, and the bedding planes are obscure.

The placer copper deposits (all native) are contained in stream benches that owe their existence to rock barriers through which the streams have now cut their courses. The placer copper, as far as observed, is confined to a distance of about half a mile above the point where the creek leaves its rocky canyon. The placer copper is irregularly distributed on the bed rock in the crevices and also among the large bowlders. The nuggets found by the Indians who accompanied me seldom exceeded a few ounces in weight, though one was found which weighed 5 or 6 pounds, and another which I saw from the same region weighed 8 or 10 pounds. The Indians dig the copper with caribou horns, and by this primitive method of mining must confine their efforts to the recent stream cuttings.

As far as the limited time would permit a careful search was made for evidence as to the source of this native copper. An examination of the greenstones showed them to be traversed by an irregular system of joints, and calcite veins were observed which followed these joints. A careful examination showed that some of these veins carried native copper. These copper-bearing veins were found close to the contact with the limestones. Calcite veins were also found in the white crystal line limestone near the contact with the greenstones. A superficial examination of the greenstones showed that they are of a dioritic character and are cut by a series of aphanitic dikes which are provisionally classed as diabases. The presence of amygdaloidal greenstones (probably andesites) and some tufas among the stream gravels suggest that these basic intrusives may be the feeders or apophyses of outpourings of volcanic rocks. No other copper minerals except secondary malachite were found during the day spent in investigating the deposits. In the western extension of the copper belt amygdaloidal greenstones carrying amygdules of copper pyrite and various gangue minerals are not uncommon. To the east the Kletsan copper belt was traced only to the vicinity of the international boundary. Its eastern extension beyond this point, if it exists, is to be sought north of our route of travel. To the west the same zone seems to extend to the Upper White River. The streams entering the Upper White River flow from the south. As far as examined all carry copper colors, and the gravels are similar in character to the rocks of Kletsan Creek.

TANANA-NABESNA COPPER DEPOSITS.

A third belt of copper deposits was found along the route of travel between the Tanana and Nabesna. The region between the two belts is occupied by the young volcanic series, so that if the copper zone is present it is buried under these younger rocks. In this belt the evidence of the presence of copper was the same association of rocks as on Kletsan Creek and the presence of copper colors in the streams. Copper pyrite was found in the amygdaloidal greenstones, but not veins of native copper, as at Kletsan Creek. I am convinced that this is an extension of the same copper belt and that by further search copper deposits will be found. Native copper nuggets were brought to us by Indians who claimed to have found them in the region between the Tanana and the Nabesna. My investigations did not extend west of the Nabesna River, but I was informed by prospectors that "copper float" had been found in the Mentasta Mountains and also near the northeastern limit of the Alaskan Range.

DEVELOPMENT OF COPPER.

The question of the commercial value of these copper deposits is one that could not be settled in a hasty reconnaissance. The two copper belts are each about 40 miles long, with possibilities of their extending in both an easterly and westerly direction. As to the size and depth of veins which may be found no opinion can be given, and it remains a question for future investigation. Such few facts as were collected in regard to the origin of the copper do not lead to the conclusion that the deposits would be of a superficial character. They are essentially contact phenomena. If a railway is ever built into the region it will naturally be constructed from Valdes, which is 200 miles away and is the nearest harbor. Such a railway might also give access to the reported copper deposits of the Chitina River. In any event I am of the opinion that this upper region is one that is worthy of careful investigation by the prospector and the capitalist.

COAL.

Coal has been reported from the region of the Upper White and Tanana rivers, but during our reconnaissance of the past season we saw no beds of coal which would be of commercial value. At a number of places carbonaceous shales of Carboniferous age were found, but none of these were sufficiently pure to use for fuel. One of these was about 10 miles west of the Kershaw River, near our route of travel. At this locality beds of carbonaceous material some 20 or 30 feet in thickness was exposed. Much of it had been altered to graphite by dynamic metamorphism. Near the upper end of Lake Kluane similar beds were found. On Kletsan Creek carbonaceous shales containing a little bituminous coal were found, but the coal was too impure to have any fuel value. The productive coals of Alaska have thus far been found in younger beds, and so far as known no coals of value have been found in the Carboniferous of this part of the continent. The outlook for coal is not encouraging, but should the region ever be developed it is possible that locally some of the carbonaceous beds might have fuel value.

The coals of the Upper Yukon have been described by Mr. Spurr and others. They are chiefly lignites of Tertiary age. Those that are accessible have been considerably mined for use on the Yukon River steamers. On the South Fork of Fortymile River considerable coal débris was found among the stream gravels. This was of a lignitic character, similar to that of the other Tertiary coals, and presumably the coal beds outcrop somewhere in the upper part of the drainage basin of the South Fork.

ROUTES AND METHODS OF TRAVELING.

The conditions of traveling in this region are similar to those which have so often been described elsewhere in Alaska. Probably the easiest journeys are made in winter when sledding is possible, with the use of dogs for draft animals. It is necessary to supply dog food either by carrying it along, which limits the length of the journey from the base of supplies, or by procuring dried fish, which, as a rule, can be had only at the Indian villages. Dogs are also used by the Indians in summer for carrying packs. Reindeer can probably be utilized in the uplands, where the reindeer moss is to be found. In the larger river valleys, as far as my observations go, the moss is not abundant, and the reindeer used for river trips would have to seek the uplands for food. The utility of reindeers as draft animals has been well demonstrated elsewhere in Alaska, and they have the advantage over dogs in that they find their own food. Up to the present time they have not been given a fair test as pack animals for summer use, but it seems possible that they may be better adapted for this purpose in this region than the horse or mule.

In summer supplies are transported by back-packing, by pack animals, or in boats. By the more primitive method of back-packing journeys are usually limited to three weeks, as this is the longest period for which the average man can carry provisions besides his blankets, etc.

Horses can be used to advantage from about the middle of June to the first of September. Horses are preferable to mules because of the large amount of soft ground which has to be crossed. Our experience teaches us that "sawbucks" are better than "aparejos," as the pack is less liable to slip off. In choosing a route for a pack train it is advisable to keep at as high an elevation as possible, thus to avoid the swamps and thick timber of the lowland. We found the best grass above timber line.

A party making a trip in this region which involves crossing any of the larger rivers should carry a folding boat or the equipment for constructing one. We used a heavy, waterproofed canvas which we stretched over a framework built by the use of a few simple tools.

Not much of the region is favorable for boating. Most of the larger rivers can be descended in boats at certain times in the year. Both the White and the Tatshenshini have been run in boats built by prospectors from whipsawed lumber. The Upper Tanana below the gorge, as well as the Nabesna, are favorable for the use of small boats, as are also the large lakes.

DALTON TRAIL.[1]

This trail leaves the coast at Pyramid Harbor, situated near the head of Chilkat Inlet, where the depth of water is sufficient for any seagoing vessel. In 1899 no wharf existed and freight was taken ashore by lighters.

The trail from Pyramid Harbor to Dalton House, in the interior, has been described in the itinerary. I will add that the hardest climb of the whole length of the trail is about 40 miles from the coast, near the police post. Here the crossing of a high spur necessitates a climb of 1,000 feet, which could be avoided by constructing a trail up the Klehini Valley. At Dalton House, which is about 100 miles from the coast, the trail turns northward, keeping to the east of Lake Dezadeash, and continues down the Kaskawulsh River, which drains the lake, to where this river makes its right-angled bend to the coast. It then crosses to the headwaters of Mendenhall River and thence continues to the Nordenskiold, which it follows down to the Lewes River.[2] The Dalton trail proper ends at the mouth of the Nordenskiold, but there is said to be a route all the way in to Dawson which has been followed by cattlemen with beef herds.

The exploration of this route for a trail, and its subsequent establishment, is due to the indomitable energy and perseverance of Mr. Jack Dalton. Mr. Dalton has done more than any other man for the exploration and development of this region.

The trail usually opens between the middle of June and the first of July. In the fall it can be used until about the middle of September. A permit having been granted by the Secretary of the Interior, the Alaskan portion of the trail is now a toll route. Below Pleasant Camp much money has been spent on the trail in road cutting, bridge building, etc.

ROUTES TO THE UPPER WHITE AND THE UPPER TANANA.[1]

The route followed by our party to the Tanana River is entirely feasible for a pack trail. The chief obstacles are the crossing of the

---

[1] See Pl. XL.

[2] Many maps show the Dalton trail leading to Fort Selkirk, and in a previous publication I fell into the same blunder. The Dawson Range intervening makes such a route impracticable for pack trains. The Indians, however, are said to have a trail across this range.

large rivers. Only in the Nabesna and Tanana valleys did we have to do much trail cutting. The following table of distances has been compiled from our map:

Table of distances along route of expedition from Pyramid Harbor to Eagle City.

	Pyramid Harbor.	Pleasant Camp.	Dalton House.	Kaskawulsh River.	South end of Lake Kluane.	Donjek River.	Kletsan Creek.	Head of White River.	Tanana Glacier.	Nabesna River.	Tanana River at mouth of Tetling River.	Franklin Gulch.	Steele Creek.	Eagle City.
Pyramid Harbor	.....	40	95	130	185	250	295	210	340	375	430	520	530	580
Pleasant Camp	40	.....	55	95	145	210	255	170	300	335	390	480	490	540
Dalton House	95	55	.....	45	90	155	200	115	245	280	335	425	435	485
Kaskawulsh River	130	95	45	.....	45	110	155	170	200	235	290	380	390	440
South end of Lake Kluane	185	145	90	45	.....	65	110	125	155	190	245	335	345	395
Donjek River	250	210	155	110	65	.....	45	60	90	125	180	260	280	330
Kletsan Creek	295	255	200	155	110	45	.....	15	45	80	135	215	235	285
Head of White River	210	170	115	170	125	60	15	.....	30	65	120	200	220	270
Tanana Glacier	340	300	245	200	155	90	45	30	.....	35	90	170	190	240
Nabesna River	375	335	280	235	190	125	80	65	35	.....	55	135	155	205
Tanana River at mouth of Tetling River	430	390	335	290	245	180	135	120	90	55	.....	80	100	150
Franklin Gulch	520	480	425	380	335	260	215	200	170	135	80	.....	20	70
Steele Creek	530	490	435	390	345	280	235	220	190	155	100	20	.....	50
Eagle City	580	540	485	440	395	330	285	270	240	205	150	70	50	....

A party intending to reach the Tanana or White from Eagle City would do well to take the Mentasta Pass trail from Franklin Gulch in the Fortymile Basin and reach the Tanana by way of the Khiltat. After crossing the Tanana it should make its way in a southeasterly direction and strike our trail near Tetling, or, what would probably be easier, follow the Mentasta trail to the Copper and then reach our trail on the Nabesna by the Batzulnetas trail. By this latter route it would be about 225 miles from Eagle City to the Nabesna. From Fort Selkirk the overland route, which is said to be an old Indian trail, used by Schwatka and Hayes, is passable for pack animals. By this route it is about 175 miles to the Klutlan Glacier, and the Donjek is the only river of considerable size which would have to be crossed. From the mouth of the Nordenskiold, on the Lewes, a route exists to the White by way of the Nisling Valley. Mr. J. B. Tyrrell's explorations of this route have already been referred to. On the accompanying map this route is continued across the White to the Tanana. This is entirely feasible except for the crossing of the White, which would be difficult. By descending the river to near the mouth of the Klotassin the crossing could probably be accomplished. The distance from the Nordenskiold to the mouth of the Nisling is about 175 miles.

The shortest and probably the best route to the head of the Tanana or White is the Copper River route, which leaves the coast at Valdes, on Prince William Sound. From this point a trail is now under construction by engineers of the United States Army, which is to avoid crossing the glacier. This proposed trail is to keep east of the Valdes Glacier and reach the Copper River at Copper Center, at the mouth of the Klutena. The rivers near the coast are said to have already been bridged, and the other streams, as the Konsina, will be crossed near their headwaters and will offer no serious obstacles. As the trail reaches the Copper on the south side of the Klutena, and as the former river is usually crossed above the Klutena, the latter river will have to be crossed, which is no easy matter. It will be necessary to use boats in crossing both the Copper and the Klutena. After crossing the Copper the so-called Millard trail is followed to the mouth of the Slana; a turn to the eastward is then made to Batzulnetas, from which point a crossing can be made to the Nabesna, or across the Suslota Pass to Tetling. The distance from Valdes to the Nabesna by this route is about 200 miles.

One of the routes into the interior which was tried during the Klondike excitement of 1898 and 1899 crossed from Disenchantment Bay, which is the upper end of Yakutat Bay, to the Alsek, and thence extended up that river and its tributaries. As a route into the interior it seems to have been a lamentable failure. Over 60 miles of glacier had to be crossed to the Alsek, and when that river was reached it was found to be very turbulent and exceedingly dangerous to ascend. There was, moreover, an absence of fuel on the glacier route, and only stunted alder on the Alsek. Some 300 prospectors are said to have started inland by this route, but probably not over 20 reached Dalton House, and those only after eighteen months of the hardest kind of toil and exposure. Several deaths due to exposure or to starvation have been reported from this region.

RAILWAY ROUTES.

Should the copper deposits of the Upper White and Tanana prove to be of sufficient extent to pay for a railway to them, the Copper River route would undoubtedly be chosen. Valdes, the natural terminus of such a railway, has an excellent harbor, which is open the entire year. A high divide would have to be crossed between Valdes and the Copper River. The next difficulty would be the crossing of the Copper River. The divides between the Nabesna and Copper and the Tanana and Copper is not over 3,000 feet.

The route from Pyramid Harbor is one along which a railway could easily be built, except for the bridging of the several large rivers which must be crossed in reaching the White. The Alsek Valley may also offer a feasible railway route, but as there is no harbor at the mouth of the river it will probably never be considered.

TIMBER.

Having had neither the time for collecting nor the means of transporting botanical specimens, I must confine myself to a few general notes on the timber. The timber of the coast region has been frequently described.[1] The trees are of good size and abundant. In the Porcupine gold district the development of the placers is more or less hampered by the abundant vegetation, the roots of the trees often striking very deep. Along Lynn Canal there is very little timber above an elevation of 3,000 feet. Between Rainy Hollow, on the upper Klehini, and the Tatshenshini River the Dalton trail is above timber line for much of the distance. North and west of Dalton House the timber line gradually decreases from about 4,500 to about 4,200 feet, varying somewhat according to local conditions. A stunted growth of willow and alder is still found above this up to an elevation of about 5,500 to 6,000 feet. According to the statement of prospectors there are no trees except alder and willow on the Alsek, the first spruce forest being reached about 15 or 20 miles above the junction of the Kaskawulsh and Tatshenshini. The larger valleys, like those of the two forks of the Alsek and of the White and Tanana, are heavily wooded. The Tanana is especially noted for its large trees, which are found up to 18 inches and 2 feet in diameter. The trees of the interior include several varieties of willow, alder, white birch, aspen, cottonwood, and spruce.[2] The spruce has the widest distribution of the trees valuable to the prospector.

GAME.

The large game of this region includes bear of several species, moose, caribou (woodland), mountain goats, bighorns, wolves, and wolverines. The Indians still trap mink, beaver, and some foxes, though the fur-bearing animals are becoming relatively scarce. The skins of moose and caribou are used extensively by the Indians for the manufacture of clothing and other articles. The natives also depend on these animals in a very large measure for their food supply. Some silver-gray foxes are caught, seven skins having been shown to me at Dalton House. Wolf and wolverine skins are still in use among the Indians, as are bear skins. In winter the Indians kill the bighorn extensively, for at that time the cold and the deep snow drive these animals from the mountain tops, which they frequent in summer.

[1] Those interested in this subject are referred to the botanical notes of Dr. Dawson, op. cit., pp. 186–190.

[2] These names are used in a popular sense as they are commonly accepted in Alaska, no collections having been made for determination.

Moose and the larger bears are found, more especially along the valleys of the rivers and lakes. The bears have not been definitely determined by naturalists, but are classed by the prospectors as grizzly, silver tip, brown, and black bears.

Caribou inhabit the regions at and above timber line. They are migratory, and in some years are very abundant, while in others they are almost entirely wanting. While game is usually fairly abundant in the more inaccessible portions of this region, yet it would be unwise for a party to depend on it for their food supply. Our experience shows that in some seasons game is exceedingly difficult to find. Wild fowl are very abundant along some of the larger rivers. Ptarmigan and grouse are usually plentiful at and above timber line. Salmon ascend the larger rivers except where there are rock barriers.

CLIMATE.

The meteorological data collected by our party are of too fragmentary a character and are distributed over too wide an area to be worth publishing. Climatic records of the coast region of Alaska have long been made, and authentic data are now available in regard to the interior.

The Lynn Canal region is damp and has a comparatively mild climate. It is, however, colder than other parts of southeastern Alaska which are more directly subjected to the influence of the Japanese current. In the Chilkat Basin there is a heavy snowfall, which is usually all gone below the snow line by the 1st of July.

The interior region is much drier and colder. The snowfall is comparatively light, but by spring there is considerable accumulation. I was informed that at Dalton House most of the snow disappears early in June.

Before crossing the divide, about the 21st of June, we had considerable rainfall. Clear weather prevailed until toward the end of July. From the 1st of August until we reached Eagle City we had many rainy and cloudy days, though the aggregate rainfall was not great.

INHABITANTS.

NATIVES.

We saw very few natives during our journey, and are able, therefore, to add no new facts concerning them. Those of Lynn Canal and Yakutat Bay, which have been frequently described, belong to the Thlinkit stock, which includes most of the Indians of southeastern Alaska. Those of Lynn Canal belong to two tribes—the Chilkats and the Chilkoots. They are semicivilized and live in well-constructed houses in villages often of considerable size. They have long been known for their skill in weaving blankets and in certain other handicrafts. I have seen very creditable pieces of silver jewelry made by these Indians. They are usually thrifty and prosperous. During the long period when they acted as middlemen between the white traders of the coast and the interior or "Stick"[1] Indians their livelihood was obtained chiefly by trade. Up to the time when the Hudson Bay Company established Fort Selkirk as a trading post, in 1847, they enjoyed a monopoly of the trade of the interior Indians. This monopoly they jealously guarded, as is shown by their raiding and burning Fort Selkirk in 1852.[2] Their trade with the interior Indians has almost disappeared, and they now earn a livelihood by catching salmon for the canneries, and also drive a lucrative trade in the curios which they manufacture and dispose of at good prices to the many tourists who visit southeastern Alaska every year.

The Chilkats are said to have waged a successful war with the interior Indians at a time not long distant and brought them to semi-subjugation. It is certain that the interior Indians stand in awe of those of Lynn Canal and will not visit the coast unless invited to do so by the coast Indians or unless they feel sure of the protection of white men. We saw several villages and houses of Chilkats along the river and inlet bearing the same name. Klukwan, at the mouth of the Klehini, on the Chilkat River, is their most interior settlement.

The interior Indians of the region visited by us belong to Athabascan stock and may be divided into three geographical groups—those of the Alsek Basin, who are subjects of Canada; those of the White River Basin, who live largely in Canadian territory, and the Tanana Indians, who are on the Alaskan side of the line.

The only permanent place of habitation that we saw after leaving the coast Indians was the village of Neskatatwen, near Dalton House, and therefore in the Alsek Basin. Here the Indians seem prosperous and live in substantial houses. They make their living by hunting, trapping, and salmon fishing. Closely related to these Indians are those of the village of Hutshi, lying about 100 miles north of our route of travel. Indians from this district visited our camp on the Kaskawulsh.

Of the White River Indians we saw no permanent habitations. While we were camped near Kletsan Creek a party of Indians visited us who claimed to be from Lake Kluane, but we saw no houses on the lake. Dr. Hayes[3] reported small Indian settlements on the Nisling and Kluane rivers. On the upper White we met a band of about 20 Indians, but they claimed to have come from the Copper River and were evidently out on a hunting expedition. Nandles, Tetling, and Khiltat are the most important settlements of the upper Tanana. The Indians of the upper Tanana have easy communication with

[1] This word belongs to the Chinook jargon, long used for trading purposes along the coast.

[2] An exploration in Yukon district and British Columbia, by Geo. M. Dawson: Ann. Rept. Geol. Surv. Canada, 1887–88, p. 139B.

[3] Nat. Geog. Mag., Vol. IV, p. 123.

those of the upper Copper River. The route which we followed to the White is said to be one much used by the Chilkats in their trading expeditions into the interior. In any event it is certain that the interior Indians were first supplied with the products of civilization by way of Lynn Canal. The Tanana Indians have been described in a previous report, already cited. We saw nothing of the Indians of the Fortymile region. Their chief village is said to be Kechumstuk, which is on the Tanana trail, near the head of the South Fork of Fortymile.

WHITES.

In the region explored by our party there were practically no white settlements except near the coast. Pyramid Harbor consists of a few houses and a canning factory. The latter in summer employs 50 or 60 white men, but in winter the place is practically abandoned. Chilkat, which lies on the other side of the inlet from Pyramid Harbor, has a deserted canning factory and a few houses, with one white family. Haines,[1] which is on the other side of the neck of land separating Chilkoot and Chilkat inlets, is a settlement of considerable size. At this place there are a mission, several stores, hotels, etc. Steamers daily make the trip to Skagway and return from this point. Many of the sound steamers running to Skagway also stop at Haines. Haines is connected with Chilkat by a good wagon road, and a ferry crosses from the latter point to Pyramid Harbor. All three of these places are United States post-offices. They depend for their development largely on the productiveness of the Porcupine gold district, which is about 30 miles inland.

After leaving the coast at Pyramid Harbor we passed several small settlements, some of which will probably have more or less permanency. At Walkerville were one or two buildings and 15 or 20 tents. Sunrise included a single log building. Porcupine City, near the mouth of Porcupine Creek, has several substantial buildings, including two stores and a sawmill. Prospectors' camps are also to be found along the entire length of the creek.

At Pleasant Camp,[2] which is beautifully situated on a bluff overlooking the river, are one of Dalton's trading posts and a northwest mounted-police post. The latter at the time of our visit included one officer and seven privates. A number of substantial buildings have been erected, and the site is probably one of the finest in the entire region.

Going inland along the Dalton trail we found a number of prospectors' camps in and near Rainy Hollow. These were then only temporary structures, but should the copper prove to have commercial value this will undoubtedly become an important place. Beyond

[1] This was formerly known as Haines's Mission.

[2] See Pl. XLI, A.

Rainy Hollow until Dalton House is reached there are no white settlements of any kind. At Dalton House is another trading post belonging to Mr. Dalton and in charge of a white man. There are also two members of the Canadian mounted police stationed there. The Indian village near at hand has already been referred to. There is said to be another trading post in charge of a white trader near Hutshi.

Between Dalton House, in the Fortymile Basin, and Franklin Gulch we saw no white settlements whatever, though the Indians told us that the United States Army had established a post at Mentasta Pass. In the Fortymile Basin there are a great many white men and several settlements of considerable size. At Franklin Gulch there are 15 or 20 substantial log cabins. Since the rush to Wade Creek, already referred to, a great many prospectors have come into this part of Fortymile Basin, and their cabins can be found in many gulches. On the lower Fortymile we passed a number of log houses, the largest settlement being at the international boundary, where there is now a United States custom office, a hotel, and a trading post.

Fortymile Post, at the mouth of the river of the same name, is a village of considerable size. The Canadian police headquarters, known as Fort Cudahy, is a short distance below, on the Yukon. Eagle City, some 50 miles below, promises to be the most important settement on the Alaskan side of the line on the upper Yukon. The site is well chosen and is on the banks of the Yukon, just below the mouth of American Creek. The sanitary conditions are much more favorable than at most of the mining camps on the Yukon. The various trading-post companies have put up substantial stores and warehouses, and the Government has erected large barracks for the company of soldiers now stationed there. The Nome rush of 1899 retarded the development of Eagle City very much, and, like most of the other towns on the Yukon, it for a time became almost deserted except for the Government officials and the agents of the larger trading companies.

A RECONNAISSANCE OF THE CHITINA RIVER AND THE SKOLAI MOUNTAINS, ALASKA

BY

OSCAR ROHN

CONTENTS.

	Page.
Introduction	399
Previous exploration	400
Work of explorers	400
Work of prospectors	401
Alaska Exploring Expedition No. 2	402
Discovery of the new route	403
Object of the expedition	403
Plans and preparations	404
Itinerary	405
Valdez to the Chitina	405
Chitina to the Nizina Glacier	406
Over the Nizina and Tanana glaciers to Copper River	407
General features	408
Topography	408
Valdes and the coast mountains	408
Copper River Valley	408
Chitina River Valley	409
Nizina River	409
The coast mountains south of the Chitina River	410
Wrangell Mountains	410
Climate and seasons	412
Timber and vegetation	414
Animal life	415
Trails	415
Tonsina and Lower Copper River	415
To the Kotsina River	416
Along the Chitina River	416
Skolai Pass	417
Upper Copper River Valley	417
From the Copper to the Nabesna and Tanana	417
Pack trains	418
Geology	418
Preliminary statement	418
Valdes to the Tonsina River	419
The Kotsina section	420
From the Chitina River to Kennicott Glacier	422
The Nizina-Tanana section	425
General relations	425
Nikolai greenstone	426
Chitistone limestone	426
McCarthy Creek shales	426
Faulting and folding in Chitistone limestone and McCarthy Creek shales	427
Other rocks	427

	Page.
Geology—Continued.	
Basic volcanic rocks	429
Acid igneous rocks	430
Relative age and probable correlation	431
Table of provisional correlations	433
Probable structure of the area	434
General structure	435
Mineral prospects	436
Gold	436
Copper	437
Appendix	439

LLUSTRATIONS.

		Page
PLATE LI.	Outline map of Alaska	400
LII.	Geologic map of the Wrangell Mountains area	404
LIII.	Summit of the Nizina-Tanana Glacier, looking west	406
LIV.	Summit of the Nizina-Tanana Glacier, looking east	408
LV.	Foot of the Tanana Glacier	410
LVI.	Crevasses in the Tanana Glacier	412
LVII.	Mountains south of Kennicott Pass	424
LVIII.	View of Kennicott Glacier	426
LIX.	*A*, Folding in Chitistone limestone; *B*, Amphitheater form of erosion	428

A RECONNAISSANCE OF THE CHITINA RIVER AND THE SKOLAI MOUNTAINS, ALASKA.

By Oscar Rohn.

INTRODUCTION.

The following report is based upon field work done by me during the season of 1899, while I was in charge of a detachment of the Copper River Military Exploring Expedition. This expedition, sent out by direction of Assistant Secretary of War G. D. Meiklejohn, was commanded by Capt. W. R. Abercrombie, Second United States Infantry. The object of the subexpedition in my charge was to explore, for the War Department, the unknown area south and east of the Wrangell Mountains, and this report is prepared for the United States Geological Survey by permission of the Assistant Secretary of War, to supplement an earlier and less complete report to the War Department.

I wish to acknowledge my indebtedness to the Director of the Geological Survey for the opportunity to make this report, and to the Assistant Secretary of War for permission to do so. I am also particularly indebted to Professor Van Hise, to Mr. Willis, and to Mr. Spurr for aid in preparing the manuscript, and to Mr. Goode and Mr. Peters for help in preparing maps. Special recognition is here due to Mr. Arthur H. McNeer, the young man who consented to continue with me over the Nizina Glacier when the members of the party were unwilling to do so, and to whom I am, therefore, indebted for not having to abandon the trip at the foot of the Nizina Glacier.

The area covered by this report is attracting attention on account of the fact that it affords an opportunity for reaching the interior of Alaska from a good port by a route entirely on American soil, and because it gives promise of containing mineral wealth. The route from Valdes to the interior is indicated in red on the general map of Alaska (Pl. LI) which accompanies this report. On this is also indicated the area included in the detailed map (Pl. LII).

PREVIOUS EXPLORATION.

WORK OF EXPLORERS.

Prince William Sound, formerly known as Chugach Gulf, was discovered by Captain Cook in 1778. Soon afterwards it was visited by a number of English, Spanish, and Russian explorers, among whom were Fidalgo, Vancouver, Quadra, and Nagaief. Copper River was first seen by Nagaief in 1781, and first ascended for a short distance by Bazanof in 1803.[1] The exploration of the stream was next undertaken by a party of the Russian-American Company, who in 1843 ascended it for a short distance for the purpose of trading with the natives,[2] and five years later Serebrennikof, with a party of Russian explorers, succeeded in reaching a point above the mouth of the Tazlina River, where, however, he and his entire party were massacred by the natives.[3] Nothing was done from this time until 1882, when C. G. Holt, a trader in the employ of the Alaska Commercial Company, reached Taral. Two years later Captain Abercrombie, of the United States Army, made an effort to ascend the river, but did not succeed in getting farther than Miles Glacier.[4]

In 1885, the year following Captain Abercombie's attempt to ascend the river, Lieut. Henry T. Allen, of the United States Army, made one of the most remarkable exploration trips recorded in Alaskan history.[5] He ascended the Copper to Taral. From here he reached the Nikolai house, on the Chitina, by portage, and returned down the Chitina by boat. He then made his way up the Copper to Batzulnetas. And from here, crossing the Mentasta Mountains to the Tanana River by way of Suslota Pass, he descended the river to the Yukon. Though he and his party practically lived off the country and suffered great privations and hardships, he was not content with his great success, but ascended the Koyukuk for a distance of several hundred miles before returning home by way of the Yukon and St. Michael.

To Lieutenant Allen we are indebted for the first reliable maps and information regarding the Copper, Chitina, and Tanana rivers, and the group of mountains surrounding the active volcano known as Mount Wrangell. In 1898 a party of the United States Geological Survey, in charge of Mr. W. J. Peters, accompanied by Mr. A. H. Brooks as geologist,[6] explored and mapped the Tanana River from a point where it leaves the mountains to its confluence with the Yukon.

In 1891 Lieut. Frederick Schwatka and Dr. C. Willard Hayes[7]

[1] Alaska and its Resources, by W. H. Dall, pp. 317-321.
[2] Bancroft's History of Alaska, p. 526.
[3] Alaska and its Resources, by W. H. Dall, p. 272.
[4] Reconnaissance in Alaska, Lieut. H. T. Allen, 1885, p. 23.
[5] Op. cit.
[6] Explorations in Alaska in 1898; U. S. Geol. Survey, p. 64.
[7] An expedition through the Yukon district, by C. W. Hayes: Nat. Geog. Mag., May 15, 1892, Vol. IV p. 120-127.

JULIUS BIEN & CO. LITH. N.Y.

entered the Chitina Valley through the headwaters of the White River, by way of the Skolai Pass, which they discovered and named. Reaching the headwaters of the Nizina River, they built a boat in which they ran down the Nizina to the Chitina, then down the Chitina to the Copper, and along this to the coast. Considering the difficulties which both Lieutenant Allen and Dr. Hayes encountered, their maps and observations are remarkably accurate, though they are, of course, restricted to the immediate vicinity of the respective routes traveled.

WORK OF PROSPECTORS.

The general rush to Alaska in the spring of 1898, due to the Klondike discoveries of the previous year, resulted in the landing of between 4,000 and 5,000 prospectors with their outfits at the head of Valdes Bay during the months of March, April, and May of that year. A route was supposed to exist from here to a point on the Copper River above the rapids and canyons reported by Lieutenant Allen, but no exploration of this route had ever been recorded, and no information regarding it could be obtained.

The general impression among these adventurers, that the interior was a great field of treasure and that beyond reaching it little else was needed to enable them to gather a fortune, spurred them into attempting to cross the glacier that occupies the only break in the mountains surrounding Valdes which seemed to give promise of leading from the bay into the interior. This, subsequent developments proved it to do, but the difficulties which it presented were very great. With the thermometer at 40° to 50° below zero, in the fierce storms which only polar glaciers can give birth to, and with fuel at $1 a pound, outfits were sledded over a course that in places required hoisting by means of rope and tackle.

Beyond this glacier, which is now known as the Valdes Glacier, a swift and powerful stream, which proved to be that named by Lieutenant Allen the Klutena, was found to lead in a general northeasterly direction to the Copper River, and by carrying their goods down this in boats the more fortunate reached Copper River. Many of those who reached Valdes never landed; many more turned back disheartened at the glacier; others succeeded in crossing the glacier only to lose their outfits in the swift and treacherous waters of the Klutena, and only a minor part of the crowd that landed ever got far beyond the mouth of the Klutena, where a winter camp sprung up which was called Copper Center. Nearly all of those who went beyond Copper Center were headed for the Yukon by way of the Mentasta Pass and the Fortymile River. Mentasta Pass was reached by two general routes—one by "tracking" or "cordelling" boats up the Copper River, the other by an overland route leading from Copper Center along the foot of Mount Drum to the mouth of the Slana, known as the Millard trail. At the mouth of the Slana the two routes converged and, following along the eastern bank of this stream, led to Mentasta Pass. A number of parties made this trip and the routes were well established. One party even made the trip to the Yukon and return in the course of the season.

The major portion of each man's time was spent in traveling and transporting goods, and, considering the number of men who reached the interior, comparatively little prospecting was done. Such as was done was confined to the immediate vicinity of the routes named and to the Copper River from Copper Center to the coast. The short streams tributary to the Copper heading in the Wrangell Mountains were explored to some extent, but the Chitina was ascended only a very short distance. All of the mineral prospects discovered by the season's work were practically confined to those of Quartz Creek, a southern tributary of the Tonsina. This was discovered in August, but was not reported until later in the season, when a general stampede for the area occurred.

The discouraging prospects led many to leave the country at the approach of winter. Some returned over the glacier to Valdes, but more went down the Copper River to the coast in boats. Of those who had sufficient provisions and were determined to explore farther the greater number wintered at Copper Center, at Quartz Creek, and at Valdes. A few were scattered in isolated camps along the Klutena and along the Copper River below Copper Center.

ALASKA EXPLORING EXPEDITION NO. 2.

The War Department, in an endeavor to find an all-American route to the interior of Alaska, put three parties in the field in the spring of 1898; one at Cook Inlet, one at Prince William Sound, and a third at Lynn Canal. The Prince William Sound expedition was in charge of Capt. W. R. Abercrombie, United States Army. It landed at Valdes in April, and spent the earlier part of the season examining the coast of Prince William Sound and the different bays or fjords adjacent to it. In August a start was made for the interior. A detachment of the expedition in charge of Mr. F. C. Schrader,[1] a member of the United States Geological Survey, detailed with the expedition, crossed the glacier with a pack train and reached Copper Center by the then well-established trail along the Klutena River. Here the party divided, one detachment, under Lieutenant Lowe, going northward to Mentasta Pass and finally reaching Fortymile; and the other, in charge of Mr. Schrader, going down the Copper River. Taral was reached with the horses. These were then abandoned and

[1] A reconnaissance of a part of Prince William Sound and the Copper River district, Alaska, by F. C. Schrader: Twentieth Annual Rept. U. S. Geol. Survey, Pt. VII, pp. 321–423.

the journey was continued by boat to the mouth of the Tasnuna. From here, by back-packing up the valley of the Tasnuna, Mr. Schrader succeeded in reaching the valley of the Lowe River, and along this he made his way back to Valdes.

The year's work showed that beyond the coast mountains the country is open and affords splendid opportunities for the construction of pack trails and railroads; but that, unless a way of avoiding all glaciers could be found through the coast mountains, a general route from Valdes to the interior was not feasible.

DISCOVERY OF THE NEW ROUTE.

The finding of placer prospects attracted prospectors from the Klutena River to Quartz Creek. From here they worked over a low divide into the valley of the Kanata. Finding a few colors of gold in the gravels of this, they followed it to its confluence with the Chena, and worked up along the banks of the latter for a distance of 12 to 15 miles. The route from this point to Valdes being very circuitous, a man named Johnson who, with a companion, made monthly trips with the mail from Valdes to the various camps, attempted to find a more direct one. He made several attempts to find his way from the Chena out to Valdes, in one of which his companion perished from freezing. Johnson, however, persevered and finally succeeded in reaching the Lowe River Valley by way of what is now called the Lowe River divide. This was the final step that completed the all-important route through the coast mountains and made possible what now promises to be the gateway to the interior.

When Captain Abercrombie's expedition landed in the spring of 1899, Johnson's discovery had become generally known, and several parties of prospectors who had landed early in the season were already at the summit of Lowe River divide, bound for Quartz Creek with their season's supplies.

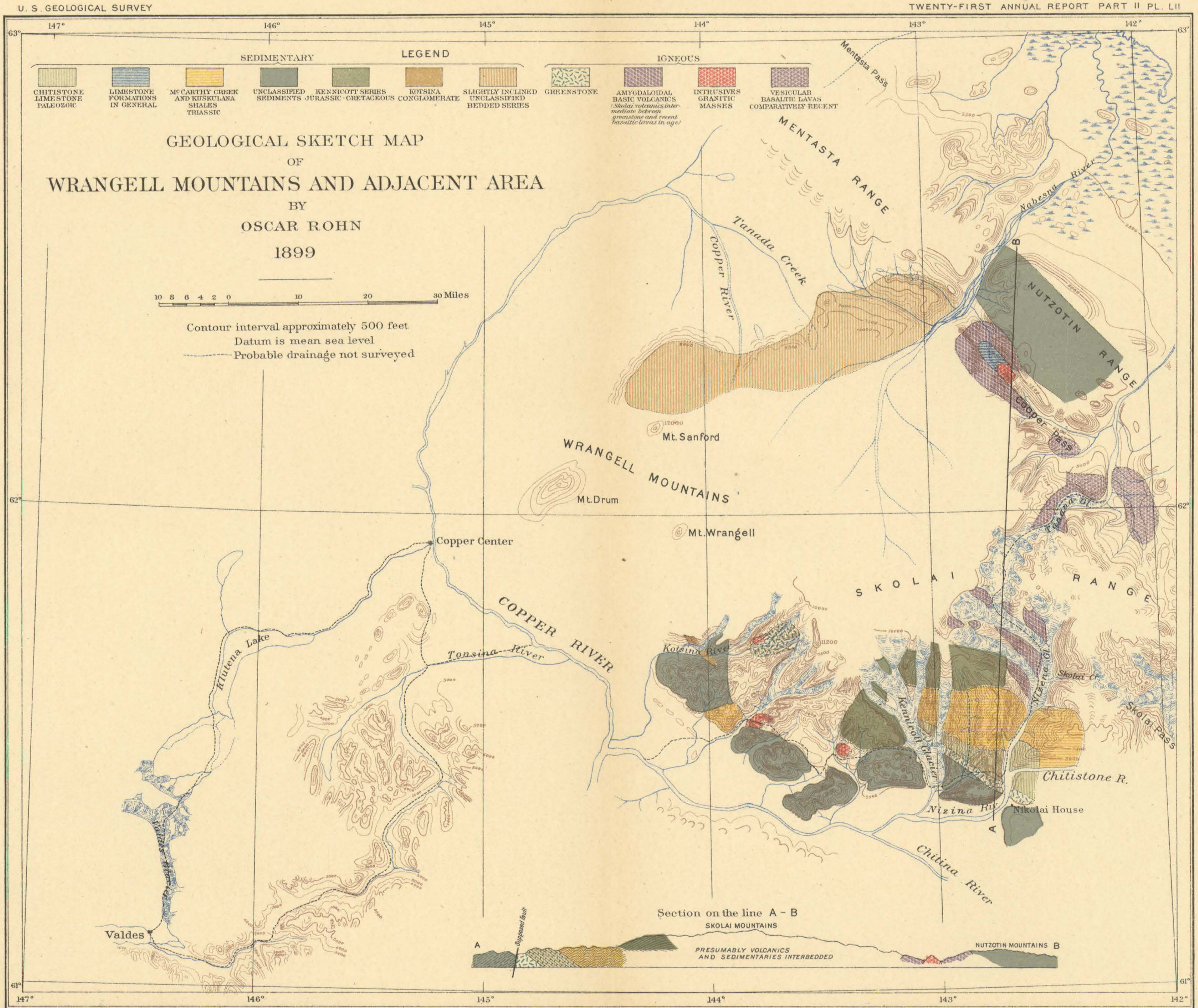
OBJECT OF THE EXPEDITION.

No satisfactory placer prospects having been found in 1898, the mountainous region east of Copper River attracted the attention of those prospectors who remained through the winter, as affording the most favorable field for further work. Copper deposits were known to exist somewhere in this area by the fact that the natives repeatedly brought specimens of this metal to the trading stations on both the coast and the Yukon, and to these deposits the attention of prospectors was drawn by the opening of copper claims on Prince William Sound during the previous year. The explorations of Lieutenant Allen and Dr. Hayes showed that the area is exceedingly rugged and difficult of access, and that it forms the divides between four great streams. But beyond this nothing was known of it. Under these conditions it was most important to the work of the prospectors and the development of the area, and of much interest from a geographic and scientific standpoint, that the area should be explored and mapped, and its true nature and accessibility be determined. To undertake this work, a detachment of the expedition was detailed by Captain Abercrombie and put in my charge. The plan decided upon was to work up the valley of the Chitina with a pack train, and, if possible, to cross to the headwaters of the Copper. If it was found impossible to proceed with the horses, they were to be left, the trip to be continued by back-packing or sledding. Upon reaching navigable waters on the Copper River it was intended to build rafts or canoes, and by means of these to run down Copper River to Copper Center.

PLANS AND PREPARATIONS.

The general experience of Alaskan explorers has shown that, as a rule, each member of a party must carry his own provisions, and that increasing the number of men in a party is merely increasing the amount of provisions necessary and adding to the difficulties. The area to be explored was known to be very rugged and forbidding, and one in which back-packing would probably have to be resorted to. It was therefore decided to select instruments for cartographic work and the necessary provisions and camp outfit with a view to the least weight and bulk that could possibly be made to serve the purpose. The party was accordingly restricted to four men. I was to take charge of both cartographic and scientific work; two packers, J. V. Place and H. H. Fitch, were to handle the pack train, and John Fohlin was to act as cook and camp man. The instrumental outfit for cartographic work consisted of a Johnson's improved traverse plane table with a small open-sight alidade, a small sextant with an artificial mirror horizon, an aneroid barometer, and two high-grade watches. In addition to a very light camp outfit, two 11-foot canvas folding canoes were carried to provide for crossing glacial streams. It was found that these were too small and that one larger boat would have been more serviceable. No provision was made for crossing glaciers, but fortunately we were able to secure two sleds at the Nikolai House.

Not being provided with the fuel and cooking arrangements ordinarily used in glacial work, we prepared as much bread and bacon as possible before starting over the glacier, and carried with us dry spruce timber with which to prepare a little coffee and oatmeal daily. Though this arrangement sufficed to carry us through, it did not fail to show us the inadvisability of undertaking an extended and uncertain glacial trip without suitable and adequate provision for preparing food on the way. It is, however, almost equally undesirable to carry coal oil and lamp stoves on a long overland trip when there is only a possibility


LEGEND
SEDIMENTARY
CHITISTONE LIMESTONE PALEOZOIC
LIMESTONE FORMATIONS IN GENERAL
McCARTHY CREEK AND KUSKULANA SHALES TRIASSIC
UNCLASSIFIED SEDIMENTS
KENNICOTT SERIES JURASSIC-CRETACEOUS
KOTSINA CONGLOMERATE
SLIGHTLY INCLINED UNCLASSIFIED BEDDED SERIES
IGNEOUS
GREENSTONE
AMYGDALOIDAL BASIC VOLCANICS (Skolai volcanics intermediate between greenstone and recent basaltic lavas in age)
INTRUSIVES GRANITIC MASSES
VESICULAR BASALTIC LAVAS COMPARATIVELY RECENT
GEOLOGICAL SKETCH MAP
OF
WRANGELL MOUNTAINS AND ADJACENT AREA
BY
OSCAR ROHN
1899
10 8 6 4 2 0 10 20 30 Miles
Contour interval approximately 500 feet
Datum is mean sea level
Probable drainage not surveyed
147° 146° 145° 144° 143° 142°
63° 62° 61°
Mentasta Pass
MENTASTA RANGE
Nabesna River
Tanada Creek
Copper River
NUTZOTIN RANGE
Copper Pass
Mt. Sanford
WRANGELL MOUNTAINS
Mt. Drum
Mt. Wrangell
Copper Center
COPPER RIVER
Tonsina River
Klutena Lake
SKOLAI RANGE
Kotsina River
Kennicott Glacier
Nizina Gl.
Skolai Cr.
Skolai Pass
Chitistone R.
Nizina River
Nikolai House
Chitina River
Valdes
A
B
Section on the line A - B
SKOLAI MOUNTAINS
Suspected fault
PRESUMABLY VOLCANICS AND SEDIMENTARIES INTERBEDDED
NUTZOTIN MOUNTAINS

that there will be occasion to use them. This can be avoided by providing a small folding sheet-iron charcoal pot. Charcoal being very light, sufficient for a considerable time in an ice or timberless area could be carried, and this could be readily prepared at the point of beginning such part of the trip.

ITINERARY.

The new route to the interior, as has been explained, had been discovered and its practicability determined when Captain Abercrombie landed with his expedition in the spring of 1899. He therefore directed his attention at once to building a trail through Keystone Canyon, on Lowe River, about 12 miles above its mouth. The prospecting parties mentioned as having gone in earlier in the season had passed through the canyon on the ice. It was now, however, too late to do this, and the necessity of building a trail around the canyon delayed our start until the 18th of June. In the meantime the area about Valdes and the shore of the bay were carefully examined and mapped in detail, and a series of soundings were made in the bay.

VALDES TO THE CHITINA.[1]

In company with a detachment of the Copper River Exploring Expedition conveying the United States mail inspector from Valdes to Eagle City, on the Yukon, and the United States mail contractor and several parties of prospectors, we left Valdes on the 18th of June. The first day's route lay along the north bank of Lowe River to Keystone Canyon. This, a deep, rocky gorge by which Lowe River breaks through the mountains, was passed by way of the new trail, just built. Beyond Keystone Canyon the course lay up the north side of the Upper Lowe River Valley, a distance of about 7 miles, to Lowe River divide, which was crossed at an altitude of 2,600 feet. From here a journey of about 7 miles in a general northeasterly direction took us to the Chena River. Thus far we had traveled over a trail prepared by prospectors who, as has been said, came in earlier in the season. These we found encamped at the head of the Chena River awaiting our arrival, and from here on it became necessary to pick and prepare a trail suitable for further progress. In this I was assisted by Mr. R. F. McClellan, who was in charge of a large prospecting party.

After following the valley of the Chena as best we could for a distance of about 15 miles to its confluence with the Kanata, we proceeded up the right bank of the latter stream, and by way of a divide known as the "Drop" we reached Quartz Creek, which we followed to its mouth at the foot of Tonsina Lake. From here part of the outfit was taken to Copper Center by way of the Klutena River, arrangements being made to have it brought down Copper River by boat. While this was being done, the trail leading from Tonsina Lake to the Copper

[1] This name has been spelled in various ways. For Alaskan names see pp. 487–509 of this report.

River was cut out and marked, so that by way of it the pack train could be taken to Copper River on its return to Tonsina Lake. Copper River was crossed a little above the mouth of the Tonsina. From here the outfit was carried to the mouth of the Chitina in boats, and the horses were driven down the river along the eastern bank.

While the relay trips of the pack train necessary to bring the outfit to the Copper River were being made, a side trip of ten days was made up the Kotsina River by way of the trail from Copper River.

CHITINA TO THE NIZINA GLACIER.

From the mouth of the Chitina, which we reached on July 21, we followed an old Indian trail leading along the northern side of the river. This trail was very old and very little used, but having secured an Indian guide acquainted with it, we had no difficulty in following it. It led us directly to the mountains, and up into these along the western bank of the Kuskulana River for a distance of 5 or 6 miles. Then crossing the river near the foot of the glacier, we entered a narrow, transverse gulch leading away from it into the mountains eastward. After rising rather steeply for some time, this gulch opened out into a broad valley, which we followed in a general southeasterly direction for about 15 miles. Here we encountered the second stream of considerable size, known as the Lachina. The Indian trail leads off southward at this point, and we decided to abandon it and attempt to continue through a narrow valley leading eastward through the mountains. This valley, which is transverse to the general drainage of the area, was found to lead out upon a large glacier for which I propose the name of Kennicott Glacier.[1] This glacier being too rough to cross with the pack train, it was necessary to work around the foot of it for a distance of about 8 or 10 miles. Beyond this the valley of a small stream opening into the glacial valley enabled us to continue in a general northeasterly direction, and finally, after crossing a mountain range at an altitude of 6,500 feet and after descending 4,000 feet on a very steep and difficult slope, we succeeded in reaching the valley of the Nizina River.

We were traveling along the southern side of a very high range of mountains extending eastward from Mount Blackburn. We had thus far been unable to find any opportunity to cross. On the Nizina, however, we found the lowest divide yet seen, and, while it was occupied by a large glacier, it seemed to offer the only opportunity of crossing, and we decided to attempt to cross here. We continued up the valley of the Nizina to a point about 3 miles above the foot of the glacier. Dr. Hayes,[2] who first saw this glacier, regards the Nizina

[1] Named in honor of Robert Kennicott, a pioneer in Alaskan exploration, who, as director of the scientific corps of the Western Union Telegraph Expedition in 1865, established the identity of the Kwikpak of the Russians and the Yukon of the English, and who sacrificed his life in the undertaking.

[2] Op. cit.

SUMMIT OF THE NIZINA-TANANA GLACIER, LOOKING WEST.

River as heading in Russell Glacier and crowded out of its course by this, which he calls a great triple glacier. It will be referred to as the Nizina Glacier.

OVER THE NIZINA AND TANANA GLACIERS TO COPPER RIVER.

Finding it impossible to proceed farther with the horses, the party was divided, I and Mr. A. H. McNeer[1] continuing over the glacier, while the remainder of the party returned to Valdes with the pack train.

The glacier would be difficult to cross at any time, but at this season of the year it was especially so. By exercising all possible care and awaiting our opportunity, we succeeded in making our way over the summit, and at the end of fifteen days reached the foot, on the opposite side. The summit was found to be over 8,000 feet above the sea, and the length of the glacier from foot to foot along the route which we traveled was about 47 miles.

During the trip over the glacier the storms which are almost constant on the summit at that time of the year, the difficulties of traversing glacial ice, and snow-blindness absorbed our attention and left us no time to speculate on what drainage we were reaching. When, however, the glacier had been crossed, the latter became the all-absorbing question. After following the stream which headed in the glacier for a distance of 12 or 15 miles in a northeasterly direction, and finding that it led out of the mountains in a direction almost due east, we became convinced that it was the Tanana River, and we decided to make a portage through a gap in the mountains to the west, by which we hoped to reach what we felt sure was a branch of Copper River. At the end of a seven-days' packing trip we reached a large river, which, however, proved to be merely a branch of the Tanana, called by the natives Nabesna.

The lower Nabesna and its confluence with the Tanana are indicated on Mr. Peters's map of 1898. But it is here shown to head on the eastern side of the range, which we found it to break through.

On the mountain at the foot of the Tanana Glacier we found two stone cairns, and on the river bottoms some miles below we found horse tracks. At the time, we supposed these to have been left by prospecting parties who had started for this area in the spring with pack trains. Since returning, however, we find that the cairns are monuments left by the Peters party of the United States Geological Survey, who passed through this valley some weeks before us. We followed the tracks of this party through the pass to the Nabesna and found them to lead down the banks of this stream. We find also that a prospecting party in charge of Mr. Cooper went through the pass

[1] McNeer was a member of a prospecting party which followed the expedition, and was engaged for this part of the work on account of the difficulty of getting any of the regular members of the party to undertake it.

from the Nabesna to the Tanana earlier in the season, on its way from Copper Center to the Upper Yukon.

The season being so far advanced that ice was rapidly forming in the streams, and our provisions being reduced to less than ten days' rations, we decided to build rafts and make our way down the Nabesna and Tanana with all possible haste. Before proceeding down the Nabesna very far, however, we met natives, from whom we learned that a portage of five or six days led to the headwaters of the Copper River. Securing these natives as guides and packers, we made our way overland to Batzulnetas, on Copper River, which was reached on the 2d day of October. After rafting down Copper River for some miles we found a boat on the bank. Launching this, we made our way to the mouth of the Chislechina, where we delayed for three days in order to make a side trip for some distance up this stream. We then continued down Copper River to Copper Center, which was reached on the night of October 10. After a delay of some days at Copper Center, we proceeded in a direction almost due south for a distance of 20 miles to the Tonsina River, and from here, by way of the new military road, we reached Valdes on the 27th of October.

GENERAL FEATURES.

TOPOGRAPHY.

Valdes and the coast mountains.—The country about Valdes consists of a series of rugged, sawtooth ranges, with a general east-and-west axis, separated by narrow valleys. A partial submergence of this area gave rise to a series of deep, narrow bays or fjords, bordering the coast of Prince William Sound. The northernmost of these is Port Valdes. The trans-Alaskan military road from Valdes to the interior crosses three of these ranges—the first by way of Keystone Canyon, a deep, perpendicular-walled gorge, by which Lowe River breaks through the range; the second by a pass known as the Lowe River divide; and the third by way of the transverse valley occupied by the Kanata River.

Along the coast the valleys are very deep and narrow, and the mountains are very jagged and sharp peaked, but northward, particularly beyond the Chena, the valleys become more open and the mountain outlines become less jagged and more regular and rounded. The average elevation is perhaps 6,000 feet. On the coastward side are many small glaciers and nevé fields, but toward the interior border of the range these disappear entirely.

Copper River Valley.—The southern side of the Tonsina Valley marks the northern border of the Coast Range and the beginning of a wide, flat valley, composed of a great thickness of glacial gravel and silt deposits. This valley extends northward to the Mentasta Mountains and westward to the divide separating it from the Cook Inlet drain-

SUMMIT OF THE NIZINA-TANANA GLACIER, LOOKING EAST.

The left of Pl. LIV overlaps the right of Pl. LIII, and forms with it a continuous view from west to north to east. The valley at the left of Pl LIV is that of the Tanana Glacier, and the mountains to the left of this valley, again seen at the right of Pl. LIII, show the peculiar jagged outline which characterizes the basaltic volcanics of this area. The mountains on opposite sides of the valley (seen at the right in Pl. LIV) show how their northern slopes are covered with thick snowcaps, while their southern slopes are bare.

age, while on the eastern side it is bounded by the Wrangell Mountains. Through it Copper River has cut a gorge attaining at times a depth of 500 feet and a width of a mile or more. Its tributaries join it through corresponding lateral gorges. The gradient due to this cutting, added to the already high gradient of the valley, makes these streams exceedingly swift and torrential. They are further made dangerous and unfit for boating by the fact that the glacial drift of which the valley is composed contains beds of huge bowlders, which are left in the river bottoms as the finer material is washed away. The bed of the Copper River is in places, notably above the mouth of the Tazlina River, full of these bowlders. Copper River leaves this valley by following the border of the coast mountains for some distance southeastward and then breaking through them in a deep, narrow valley, at the head of which is Woods Canyon.

Chitina River Valley.—Just above Woods Canyon the Copper River is joined from the east by the Chitina, a river of about equal volume. The valley of the Chitina averages in width from 20 to 40 miles, and separates the coast mountains from the Wrangell group. The lower part of the Chitina Valley is unlike the Copper River basin, in that it is not deeply buried under glacial drift, and in that the surface is composed of a series of low, rounded domes of rock with innumerable bogs and lakelets between them. The Chitina follows the southern border of this valley, and its tributaries cut across it in gulches and canyons. The valley narrows to about 35 miles above the mouth of the river. Farther on, where the Chitina is joined by the Nizina, its great northern branch, the valley again widens. This upper valley is more heavily covered by glacial deposits and is better drained, presenting the appearance characteristic of the Copper River Valley. The main or central branch of the Chitina rises about due east from its confluence with the Nizina in a very high, snow-capped range of mountains. Some distance above the mouth of the Nizina the Chitina is joined by a branch from the south called by the natives the Tana. This is said to be extremely swift and full of rapids and cataracts, and rises far south toward the coast. Between the Tana and the Chitina several large lakes are seen.

Nizina River.—For a distance of 6 or 7 miles above its mouth the Nizina flows through a rock-walled canyon in a generally southwesterly direction. Just above the canyon it is joined from the north by a swift stream draining Kennicott Glacier. From the point where it leaves the mountains to the head of the canyon, a distance of about 15 miles, it flows through a gravel gorge in a general westerly direction. From the glacier in which it heads to the point where it leaves the mountains, a distance of from 15 to 20 miles, the stream breaks up into innumerable channels, which migrate back and forth on a flood plain sometimes 2 miles wide. This is hemmed in by high, often perpendicular, rock walls.

The Nikolai house, visited by Lieutenant Allen,[1] is just east of the great bend where the river leaves the mountain. About 5 miles above this the Nizena is joined from the east by a large tributary called the Chitistone. This rises in a series of glaciers flowing down the western side of the huge mountain range eastward.

The coast mountains south of the Chitina River.—The mountains south of the Chitina, as seen from the mountains north of its valley, present the appearance of a sea of rather uniformly high, closely nested peaks, or of a plateau from 5,000 to 6,000 feet high, dissected to a depth of from 1,000 to 2,000 feet by drainage lines. It is probable, however, that this appearance is somewhat deceptive, and that in reality this area consists of a series of ranges separated by drainage lines leading in a general westerly direction toward Copper River. This is made more probable by the fact that below the Tana the Chitina is joined by no important tributary from the south.

Wrangell Mountains.—North of the Chitina Valley, occupying the great bend in Copper River, is a group of four huge, isolated peaks joined by high, impassable ranges, the whole a desolate wilderness covered by heavy snow and névé fields, the source of innumerable glaciers which extend far out into the valleys of the foothills below. The central and highest peak, Mount Wrangell, an active volcano, is a huge, smooth, rounded dome, with several small cones rising from its surface. From one of these vapor rises continually, and periodically it sends out great puffs of steam, black with ashes. About 20 miles northwest of this is Mount Drum. From its southern side Mount Drum appears very jagged, and a large part of it is cut away by erosion, presenting, as has been suggested by Schrader, an appearance of a huge crater with one side blown off.[2] Its northern side, however, is affected very much less by erosion, and presents a rounded outline exactly like that of Mount Sanford, farther east. Both rise majestically above all else around them and present smooth, flowing outlines that may be due to the great thickness of snow that covers them. Mount Sanford is nowhere seen cut by erosion as is Mount Drum on its southern side. High ridges connect Mount Drum and Mount Sanford with Mount Wrangell; the area between them is drained by the Sanford River, which flows northeast into the Copper River. Mounts Drum and Sanford are supposed to be between 12,000 and 13,000 feet high. The northern and western slopes of Mount Drum merge into the plains of the Copper River Valley, but Mount Sanford is surrounded toward the north and east by a wide border of rough, jagged foothills.[3]

---

[1] Reconnaissance in Alaska, by Lieut. H. T. Allen, 1885.

[2] A reconnaissance of a part of Prince William Sound and the Copper River district, Alaska, by F. C. Schrader: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, p. 377.

[3] No mountain answering to the location and description of Mount Tillman of the older maps was seen by the writer.

FOOT OF THE TANANA GLACIER, SHOWING A PART OF THE SKOLAI RANGE.

The illustration brings out faintly a crumpling and plication in the surface moraines of the glacier at the great bend, which is strikingly like the plication of quartz veins in some of the ancient gneisses. The foot of the glacier tapers down gradually, presenting a smooth, rounded surface, almost free from moraine material.

Southeast from Mount Wrangell and some 25 to 30 miles distant from it is Mount Blackburn. This presents a rounded outline only at its very top, being cut deeply on all sides by erosion. The divide between Mount Drum and Mount Wrangell is an expanse of névé fields with isolated, jagged peaks projecting through it. This range continues with the same general character in a direction a little north of east from Mount Blackburn. Beyond Mount Regal, a peak about 25 miles from Mount Blackburn, the range is crossed by two breaks which are occupied by the Tanana-Nizina glaciers. Beyond these it turns southeastward and probably continues with the same general characteristics to its junction with the St. Elias Range.

From the foot of Mount Drum southward, bordering Mount Wrangell and Mount Blackburn, is a series of foothills, very rough and jagged in character, averaging from 5,000 to 7,000 feet in elevation, attaining around Mount Blackburn a maximum width of about 25 miles. These continue eastward as the northern border of the Chitina Valley.

The foothills east of Mount Sanford join those of Mount Wrangell and form a range with an average elevation of about 7,000 feet, which, in continuing in a northeasterly direction, joins the Mentasta Mountains and forms a divide between the Copper River Valley and that of the Nabesna. The Nabesna River is a great western branch of the Tanana, draining the entire area east of the Wrangell Mountains, which was formerly supposed to belong to the Copper River drainage. This river flows in a northeasterly direction and breaks directly through the Mentasta Range.

The very high Skolai Range, already described, terminates abruptly on its northern side in a depression about 20 miles wide, forming in its central portion the valley of the Upper Tanana River. Westward it contracts to a narrow pass and beyond this it forms the valley of the Upper Nabesna. To the north of this depression is a range of mountains from 7,000 to 8,000 feet high, with very jagged, irregular outlines—the Nutzotin Range[1]—which is in reality a direct southern continuation of the Mentasta Range. The Mentasta Range, which extends in a general southeast-northwest direction, forms, as is well known, the divide between the Tanana and Copper rivers. Toward the northwest this range increases in ruggedness and elevation, culminating in Mount Kimball and forming a part of the Great Alaskan Range. The south side of this is drained by the Chislechina, one of the largest western branches of the Copper River. Along the Upper Chislechina and along the southern border of the Mentasta Range is a series of low, rounded foothills, and to the west nothing could be seen but a continuation of the flat plains of the Copper River Valley.

[1] A reconnaissance in the Tanana and White river basins, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, Part VII, p. 446.

CLIMATE AND SEASONS.

Climatic conditions divide the Copper River district into two distinct provinces. Prince William Sound and the seaward side of the coast mountains have, owing to the influence of the Japan current, the moderate temperature and great humidity characteristic of the coast of southeastern Alaska. The winters are mild and the summers are cool. The temperature seldom falls much below zero, and varies within narrow limits, while the precipitation is very abundant and cloudy weather the rule rather than the exception. Beyond the coast mountains the climate resembles that of the Middle Yukon basin, which is characterized by extreme cold in winter and moderate heat in summer, and by dry, bright, and clear weather. The coast mountains along the Copper River Valley are not nearly so high as the St. Elias Mountains, farther east, and do not so effectually precipitate the moisture from the warm ocean winds. The moisture which thus reaches the interior gives rise to heavy precipitation, which produces great snow fields and glaciers in the Wrangell and Skolai mountains. The south sides of these present the heaviest glaciation found anywhere in the interior of Alaska. On the southern border of these mountains a rainy season was encountered during August and early September very much like that which prevails at this time annually on the Bering Sea plains and along the Lower Yukon and Kuskokwim Rivers. The manner in which the clouds constantly hung on the flanks of the Wrangell Mountains at this season, while the Chitina Valley was bright and clear, was very noticeable. The difference in snowfall between the southern and the northern side of the Wrangell Mountains was marked, but not to be compared with that on the opposite sides of the coast ranges.

Not the climate alone, but the seasons as well, are different on opposite sides of the coast mountains. In the coastal region the heavy snow does not finally disappear until late in the very short spring, which intervenes between the long winter and the very short summer, and when it does disappear vegetation springs up with marvelous rapidity. In the interior the very much lighter snowfall disappears much more rapidly, and the summer season opens from two to three weeks earlier than on the coast. Extremely local conditions, due not only to difference in elevation but to the angle of incidence of the sun's rays, have a marked effect upon the season. This is impressive at Valdes. In the early summer, while the snow is disappearing from the flood plains and bottom lands of the valley and the conditions here are those of March in New England, the southward-facing mountain side to the north of the valley will be clothed in green to a considerable elevation, with flowers in blossom and vegetation in full foliage, while the northward-facing mountain side to the south of the valley is in the depth of winter and covered with a thick mantle of snow extending almost to tide water.

CREVASSES IN THE TANANA GLACIER.

As the length and progress of the season is of much interest to prospectors and explorers contemplating work in the interior, a few of the leading features of the season of 1899 are appended to serve as a guide.

When the Copper River Exploring Expedition landed on the 22d day of April, the tide-water plains about Valdes were covered with from 4 to 6 feet of snow, and between the 22d and 24th of April there was an additional snowfall of about 18 inches. It was thawing daily, however, and by the 15th of May the snow was rapidly disappearing from the gravel flats. By the 1st of June it was receding up the mountain sides and by the 15th of June the mountains were bare to the 4,000 or 5,000 foot level. The glacial streams draining Valdes Glacier and those tributary to Lowe River began to rise about June 10. Lowe River rose slowly from May 15 to June 15, then subsided somewhat to about July 10; then it again arose and was at its height about August 15. After this it began slowly subsiding.

We reached the Chitina River on the 15th of July, and at this time it was flooding from bank to bank and still rising. The highest water seen during the season was on July 28. When we reached the Nizina on August 20, the flooding season was past and the water had receded considerably. Up to August 1 the weather had been clear and bright, but at this time cloudy weather had set in with occasional showers, which became more and more marked and still continued when we left the Chitina Valley over the glacier to the north. The time when the snow line reached its maximum elevation was not accurately determined, but it was probably about August 10. On September 1, when we were crossing the glacier, the lower limit of snow on it was about 7,500 feet and was moving down rapidly from day to day. North of the glacier the snow line stood at 7,000 feet on September 10. The Tanana Glacier was at this time freezing up and the river issuing from it was rapidly drying. By September 18 the snow line at the head of the Tanana stood at about 6,000 feet. The weather was clear and cold, and ice was forming in the streams.

When we reached the Nabesna River on the 23d of September mush ice was running heavily in the main stream, and all the smaller channels were frozen over. On crossing the divide between the Nabesna and the Copper on September 29 the snow line extended below the 5,000-foot level; and on the divide, at an elevation of about 6,500 feet, the snow was 6 to 10 inches deep. Mush ice appeared in the Copper, at the mouth of the Slana, about September 25. When we reached Copper Center on October 10 the ice in the river was running so heavily that a boat could be managed only with the greatest difficulty. On the trip from Copper Center to Valdes, from October 18 to the 27, all small streams in the Copper River Valley were found frozen up. The Tonsina, which we crossed on the 21st, was frozen, except a narrow channel through the center. On the divide between the Tonsina and the Kanata, at an elevation of 4,000 feet, the snow was 1½ feet deep, and on the Lowe River divide, at an elevation of 2,600 feet, the snow was found over 3 feet deep on the 25th. The snow line reached tide water about November 1.

TIMBER AND VEGETATION.

Full descriptions of the different species of plants and animals found in the different parts of Alaska have been prepared by Dr. Dall and many other writers. These probably include most of the species found in the Copper River region, and no attempt to add to them can here be made. A few words regarding the distribution of those of economic importance, may, however, be useful.

The elevation of timber line varies considerably in different parts of the area. On the islands and coast of Prince William Sound it is about 2,000 feet. In the neighborhood of Valdes it is considerably less, while in the Chitina and Copper River basins it is between 3,000 and 3,500 feet, and on the Tanana and Upper Copper it is nearly 4,500 feet. The interior basins are well timbered except where burned over by the natives. This has been done on a very extensive scale, and a large amount of timber is annually destroyed by them. In places very fine timber is found. As a rule, however, especially at the higher altitudes, it is rather short and somewhat scrubby. The only timber of importance is spruce. Several kinds of poplar are found and the trees sometimes attain considerable size. They grow chiefly on old gravel bars and river bottoms. At higher elevations birch is occasionally found, but it is usually small and of little value. Willow and alder, usually as brush, though sometimes attaining a size that entitles them to be classed with trees, predominate along the upper margin of the timber belt.

Wherever the timber and the moss which usually covers the ground has been destroyed grass flourishes abundantly. Of this there are many different kinds, most of which are valuable for both hay and grazing, and are consequently of much economic importance in making possible the advantageous use of pack animals for transportation purposes.

Blueberries, black and red currants, cranberries, moss berries, and red salmon berries are found in great abundance. The red currant here found rivals in size and flavor the domestic currants of the States.

Among the many kinds and varieties of the most beautiful wild flowers which flourish everywhere in great abundance, probably the most conspicuous is the forget-me-not, which is found far above the timber line on the most barren mountains, often at the very edge of perpetual ice and snow.

ANIMAL LIFE.

According to the testimony of the natives and judging by the great number of antlers found, and the remains of traps or fences used by the natives for catching them, moose and caribou must have been very abundant in the country adjacent to the Wrangell Mountains. Now, however, they have either migrated elsewhere or become almost extinct, as only a very few are occasionally taken, on the northwestern border of the Copper River Valley. Bears are very numerous, but usually of the smaller brown and the black species. No indications were seen of the huge brown bears found on the Aleutian Peninsula. The animals now chiefly depended upon by the natives for food are mountain sheep and mountain goats. The sheep of the Wrangell Mountains differ considerably from those of the Rocky Mountains and differ somewhat also from the species found in the vicinity of Cook Inlet and the Upper Kuskokwim River. Hundreds of these animals were seen in flocks, at times, of as many as a dozen to twenty individuals. They are found, however, only at great heights, on craggy and inaccessible mountains and are usually most difficult to reach. Martens are trapped in considerable numbers, particularly by the Tanana natives, and beaver, though taken, seem not to be very numerous. Ground squirrels, which are so abundant in the western part of Alaska, do not seem to be very abundant here. Wolves and foxes, the latter including the black and silver-gray varieties, are taken by the natives.

Eagles and ravens are very common and are to be reckoned with in leaving fresh meat exposed anywhere away from camp. Brant, many different species of ducks, grouse, and ptarmigan are abundant and furnish the natives with important items of food.

Many different varieties of fish are found in the brooks and lakes. The salmon, however, is the one of most importance. These run up Copper River and its tributaries annually and furnish the natives with their only staple article of food. Every native has a "stick," or summer house, and salmon cache at some point along the river, where he lives during the summer season, catching and drying salmon, and to which he returns after the fall hunt, when the snow becomes too deep to travel. Salmon do not reach the Upper Tanana River, and the Tanana natives go to the Copper River to catch their year's supply. Halibut and cod are abundant in Prince William Sound and along the coast.

TRAILS.

Tonsina and Lower Copper River.—A good trail leads from Tonsina Lake eastward along the northern bank of the Tonsina River to a point on Copper River about 8 miles above the mouth of the Tonsina. This trail has been carefully marked and cut out and can easily be found. From a point where it reaches the upper edge of the Copper River gorge it connects with an old Indian trail leading along the Copper River bluffs to a point on the Copper about a mile above the mouth of the Tonsina. Here a number of bars divide the river into several narrow channels, making crossing easy for pack animals. Care must, however, be exercised to keep the animals well up toward the head of the bars, as the lower ends are often soft and composed of quicksand.

A trail leads from Copper Center down the western side of Copper River. This is, however, very irregular and most difficult to travel. From a point on the Copper River opposite the mouth of the Tonsina an Indian trail leads along the eastern bank of the Copper River for the greater part of the distance to the mouth of the Chitina. In places, particularly near Indian houses, this is very good, and in others it is almost impassable. With comparatively little work a trail could be made which, leading back from Copper River about opposite from the Tonsina, and keeping well back from the river valley to avoid the lateral draws, would lead in a general southeasterly direction into the Chitina Valley.

To the Kotsina River.—On the eastern side of Copper River about 5 or 6 miles below the mouth of the Tonsina is the winter house of a native known as Bellum. From here a trail leaves Copper River and leading almost due east reaches the Kotsina River at the point where it emerges from the mountains, a distance of about 10 to 12 miles. From here it leads up the northern side of the Kotsina River Valley for 8 or 10 miles more. This trail is entirely feasible for pack horses, and by means of these the headwaters of the Kotsina can be reached at any time except that of the highest floods.

Along the Chitina River.—The general route up the Chitina River is the Nikolai trail, leading from Taral over the mountains on the southerly side of the river to the Nikolai house on the Nizina. This is the trail followed by Lieutenant Allen in 1885. It is not feasible for pack train. An old Indian trail was found on the northerly side of the river leaving the bank about 8 miles above its mouth and running from here to the point where the Kuskulana River emerges from the mountains, and then following the Kuskulana it crosses the same near the foot of the glacier and leads in an easterly direction to the bend in the Lachina. This route is well marked out and can be traveled by pack train at almost any time of the year. From the Lachina eastward to the Nizina a trail was cut during the summer of 1899 which leads through several mountain passes and is rather difficult to follow. This may be the best route for reaching the Nizina during the time of high water, but at any other time a much better trail could easily be made which would lead down the Lachina to the foot of the mountains and along these to the foot of the Nizina, crossing the Kennicott River at the foot of Kennicott Glacier.

It is reported that the Indians formerly reached the coast at a point between Yakutat and Kyak by traveling up the southern branch of the Chitina, known by the natives as the Tana. This route involves crossing a glacier, and is not now used by the natives.

Skolai Pass.—A trail leading from the White River to the Chitina, by way of Skolai Pass, used by the natives and followed by Lieutenant Schwatka and Dr. Hayes, leaves the Nizena Valley at a point several miles above the foot of the glacier, where a valley free from glaciers joins it from the east. From the head of this valley a low gap leads to the headwaters of the White River over the foot of a glacier which Dr. Hayes has named Russell Glacier.[1] In winter the natives travel on Skolai Creek, but in the summer time, when the Nizina is flooding, they use a trail through the mountains leading to the Chitistone, and by way of this they reach the Nikolai house. This is probably the only route feasible for crossing from the Chitina to the White or Tanana. It is said to be not very difficult for traveling with a light pack, but it is quite impassable for the use of a pack train, or for railroad, or for transporting goods by any other means.

Upper Copper River Valley.—From Copper Center northward two general trails lead toward Mentasta Pass, one along the western bank of the Copper River, and the other in a more or less direct course from Copper Center to the mouth of the Slana along the foot of Mount Drum, the latter known as the Millard trail. The former probably affords the firmer footing, while the latter avoids crossing the western tributaries of the Copper. The trail leading from the mouth of the Slana to Mentasta Pass is well marked and easily followed. From the mouth of the Chestochena a good trail leads up the river along its western bank for a distance of 60 to 75 miles. From the mouth of the Slana the trail leads along the eastern bank of the Copper for a distance of about 10 miles to Batzulnetas.

From the Copper to the Nabesna and Tanana.—From Batzulnetas a good trail leads in a general southerly direction for a distance of about 10 miles, where it forks, leading by three different passes to the Nabesna River. These are all feasible for horse trails, and each is advantageous according to the point on the Nabesna that is to be reached. The western one, by way of Lake Tanada, was used by prospecting parties traveling with pack train during the season of 1899, and the central one was used as a sled route. The eastern one, however, is the most practicable and the easiest, particularly for reaching the trail from the Nabesna to the Tanana and White rivers. The western one, which was traveled by pack trains, is well marked up, but the others are difficult to follow and require guides.

[1] An expedition through the Yukon district, by C. W. Hayes: Nat. Geog. Mag., May 15, 1892.

The trail from the Nabesna to the Tanana leads to one of two passes. The northern one, the most direct and the one used by the natives, is not feasible for pack horses, while the one a little farther south is. This is the only part of the route that offers any difficulty whatever for railroading, but the difficulties are not such that they can not be readily overcome.

PACK TRAINS.

The military road and the network of trails found in the Copper River Valley make pack trains the only convenient and satisfactory means of transporting goods; they can be used to advantage from about the 10th of June to about the 10th of October, and they have been adopted almost exclusively by the prospectors now working in the country. If large quantities of goods are to be transported, this can in some cases be done to advantage by sledding with horses on the ice of the rivers during the months of February, March, and April.

The experience of the past year's work with different outfits prompts the following suggestions: A stocky Montana ranch horse weighing about 1,200 pounds, which had not been used as a harness horse and which had not been stable fed, was found to be the most satisfactory. Such horses were bought for about $40 and cost about an equal amount for transportation. A well-fitting double-cinch sawbuck saddle, without breeching or breastpad, with two heavy blankets under it, was found the most satisfactory. Saddlebags or panniers made of canvas well trimmed with leather are a great convenience and economy. These should be made just long and wide enough to accommodate a 50-pound sack of flour and should be in depth a little less than twice their width. They should be fitted with straps by which to hang them to the saddle horn. All goods should be packed in sacks and all forms of boxes carefully avoided. A very useful precaution is to have a couple of cans of baking powder well buried in each sack of flour. Pack covers made of strong canvas about 7 feet square are very useful, and a farrier's kit, with a sufficient supply of horseshoes finished and ready for the horses' feet, must under no circumstances be omitted. Two men can handle twelve horses without much difficulty, but to do so to advantage they should be allowed one saddle horse. Such horses as above mentioned will readily carry 200 pounds each.

GEOLOGY.

PRELIMINARY STATEMENT.

In exploration, where ignorance of the difficulties and obstacles to be met and overcome makes it necessary to proceed as rapidly as possible and to avoid every form of delay, geological observations must necessarily be brief and fragmentary. This was particularly true of the trip on which this report is based. It was undertaken for the War Department with the primary object of doing topographic work. In addition to topographic work it was necessary to pilot a pack train through a difficult and unknown country, and later to continue by back-packing under great pressure. Therefore the geologic notes necessarily consist of general observations obtained incidentally and the specimens consist of such as could conveniently be picked up along the route. In a practically unknown area even such information as that gathered is useful as a guide to prospectors and to further work in the area. This being the case, the following report is warranted even if the work upon which it is based was very fragmentary.

VALDES TO THE TONSINA RIVER.

The rocks of the area about Valdes and along Lowe River have been examined and described by Schrader.[1] These consist of a series of interbedded quartzites, arkoses, slates, and shales, and occasionally some mica-schist. The rocks are very much faulted and folded. The strike is generally about east and west and the dip steeply north. The dip is rather uniform, and if the valleys between the ranges present a continuation of the series as represented in the bordering ranges the series must be very thick. It seems more probable, however, that these valleys represent either fault planes or the reverse limbs of folds, so that the ranges present a repetition of the series rather than a continuation of the same.

Northward along the valley of the Kanata these rocks are replaced by a series of micaceous and hornblende green schists. Whether these are of sedimentary or of igneous origin could not be determined. They are very much metamorphosed and closely laminated and plicated, and the series as a whole is closely folded. The effect of this change in the nature of the rock upon the topography is very marked. The jagged aspect characteristic of the Valdes series entirely disappears and is replaced by rounded and irregular outlines. No general strike and dip could be made out.

At the head of Quartz Creek these schistose rocks give way to a series of quartzites, shales, slates, and limestones. The latter series has suffered much deformation, but the accommodation has been largely by fracture and faulting, and the filling by underground circulation of the openings thus formed has given rise to a series of calcitic and quartzitic veinlets, which are so numerous that they make up a very considerable part of the rock. The contact between this series and the schistose rock southward was not seen. Various forms of acid intrusive dike rocks are common in this series, and northward become more abundant.

[1] A reconnaissance of a part of Prince William Sound and the Copper River district, Alaska, by F. C. Schrader: Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, pp. 341-423.

On the divide bordering the Tonsina Valley on the south were found the first traces of the great gravel deposits which characterize the Copper River Valley and the river valleys of the interior of Alaska generally.

Northward from the Tonsina and between it and the Klutena is a group of irregular rounded mountains 3,000 to 4,000 feet high, which, so far as examined, were found to consist mostly of volcanic rocks.

THE KOTSINA SECTION.

The Kotsina River is joined from the north by three principal tributaries. Having been unable to learn the native names for these, I will refer to them as the first, second, and third tributaries, the first being the one nearest the head of the stream, and the second and third those entering successively downstream.

At the head of the Kotsina River, a few miles west of Mount Blackburn, is found a series of bedded volcanics. The bedding in these is at times so regular and so marked that at a little distance they can hardly be regarded as of other than sedimentary origin. They are, however, basic crystalline volcanics, and resemble in a marked degree, both in appearance and in mode of occurrence, the Keweenawan diabases of Lake Superior. The main portion of each bed is massive and the edges are usually amygdaloidal. These rocks vary in color from green to brown, red, and gray. In texture they are fine-grained to aphanitic. The amygdules in the vesicular portions of the beds are usually filled with either calcite, epidote, or a green chloritic substance, and not infrequently with quartz. In the thin section these rocks are found to be composed essentially of plagioclase and pyroxene. The plagioclase is usually in the form of lath-shaped crystals with the augite filling interspaces. Olivine is usually though not always present. When present it is always more or less altered, in some cases to a green chloritic substance, in others to a reddish-brown ferrite. Pyrite, and in some cases what may be magnetite, seems to result from the alteration of the olivine. Pyrite is nearly always present in these rocks and at times is a very important constituent. All of the sections examined show the presence of some unindividualized base, and in the finer-grained aphanitic types this is at times very abundant.

The regular horizontal bedding in these rocks was observed on both sides of the river near the foot of the glacier in which it heads. In proceeding down the river this bedding becomes more and more inclined, dipping to the southwest. At a distance of about 3 miles from the foot of the glacier it disappears entirely.

The first tributary, which joins the river about 2 miles below the foot of the glacier, was followed for a distance of 4 miles to the glacier in which it heads. Throughout this distance it flows through a canyon, the perpendicular walls of which are composed of the basic volcanics above described. In this canyon, however, they are very much cut and disturbed by both basic and acid intrusives, and in places they are very much decomposed. Near the foot of the glacier was found a mass of diabase, seemingly an irregular dike, which was so thoroughly impregnated with iron pyrite that this mineral made up a very considerable part of the rock. This dike could be traced northward along the western side of the valley by the red stain which the decomposition of the pyrite imparted to its surface. Both large and small dikes of acid volcanics were particularly numerous at this point.

The largest acid dikes are of a coarsely crystalline rock, which is composed essentially of feldspar and hornblende, and in which quartz is often present. Other smaller dikes are composed of rock probably quite similar chemically but less completely crystallized. Some of these consist practically of a groundmass containing isolated feldspar and hornblende crystals. Iron pyrite is a common impregnation in the acid as well as in the basic intrusives.

Among the moraine material found on this glacier were very fresh basaltic lavas. Some of these were highly scoriaceous and vesicular, and others compact and glassy. Two varieties of this were particularly conspicuous on account of their color—one a deep black and the other a bright red. Among these lavas were found bedded tuffs. Some parts of these are composed of very fine-grained material and others of course angular fragments, the whole having the appearance of being laid down under water.

About a mile below the confluence of the first tributary of the river is a mountain very conspicuous on account its smooth, regular outline. Examination showed this to be composed entirely of a granite-like rock essentially like the coarse dike rock found near the glacier on the first tributary. It is composed mainly of feldspar and hornblende, with a little quartz. The mass is seemingly an intrusive boss, and it is very probably the central mass, from which the dikes in the river to the east are offshoots. This mass is cut nearly at right angles by three series of joints, which cause it to disintegrate so readily that the sides of the mountain, from the summit to the base, are practically one talus slope. The outlines are very characteristic of these intrusive masses, a number of which are found in the mountains along the northern side of the Chitina Valley.

West of the granitic mass noted basic volcanics form the main mass of the mountains on both sides of the river for several miles. Here, however, they do not exhibit any regularity in bedding, and near the confluence of the second tributary they dip steeply under sedimentary rocks. These sedimentaries are much folded and fractured sandstones and shales, which are very much seamed by calcitic and quartzitic veinlets. The bedding is so disturbed and irregular that no general strike and dip could be made out.

Just below the confluence of the third tributary a very heavy bed of conglomerate appears, and this strikes in a direction nearly northwest to southeast, and dips southwestward at an angle of probably 30°. This conglomerate is characterized by a decidedly greenish color, which seemingly is due to material derived originally from the green volcanics. The pebbles are often very coarse and are always well rounded and waterworn. The rock is very compact and resistant, the matrix being almost as resistant to weathering as the pebbles. It is much fractured and jointed, but folding was nowhere observed in it. The appearance of this conglomerate is so characteristic that it can readily be recognized anywhere. Bowlders composed of it were found in the beds of several of the streams tributary to the Chitina from the north.

West of this conglomerate the river valley widens, and here the rocks could not be examined for lack of time. The more regular features of the mountain would tend to indicate a rather flat-lying series of sedimentary rocks.

Between the foot of the mountains and the Copper River is a series of low ridges trending in a general northwest-and-southeast direction. These are composed of basic volcanic rocks and are undoubtedly intrusive dikes. They turn the course of the Kotsina River far southward before it finally breaks through them in narrow canyons.

FROM THE CHITINA RIVER TO KENNICOTT GLACIER.

Rocks are exposed in many places along the Chitina River, in some cases forming high cliffs and occasionally barriers which extend out into the river. So far as examined these rock masses were composed of a greenish-black basic volcanic, sometimes banded with streaks of lighter-colored material. The valley of the lower Chitina is a rolling, hummocky area in which small lakes and low rounded rocky ridges are very numerous. The trend of these ridges is usually east and west, and the tributaries of the Chitina from the north break through them in deep, rocky canyons. The appearance in general is that typical of a glaciated area. One of the knolls rising above the river to a height of about 1,000 feet, just west of where the Kuskulana trail leaves the bank of the Chitina, was found to be made up of a fine-grained, very dark schist, probably containing both mica and hornblende. This was cut by large dikes of basic volcanic rock. Local magnetic attraction, which was found throughout the Chitina Valley, is here particularly marked, and is due here to the presence of this schist, which was shown by the fact that a fragment of it affected the needle of the compass.

The only ledge exposed along the trail to the mountains was about 4 miles from the Chitina River. This was a light-colored, impure limestone exactly like that found later north of the pass between the Lachina and the Kennicott Glacier and again on the top of the mountain east of McCarthy Creek. The exposure, however, was small, and it is not certain that the rock was here in place.

On entering the mountains along the valley of the Kuskulana, the first rocks observed were found in the bed of the first small creek joining the Kuskulana from the west. These are hard, ringing, highly silicified grits, shales, and slates, and some schists, all of which are much fractured and seamed in three or more directions by veinlets of quartz and calcite. On the second creek entering the Kuskulana from the west was found a bowlder of a dark-colored shale containing fossils which were referred by Dr. T. W. Stanton, of the United States Geological Survey, to a Triassic *Monotis*. Similar fossils were found at a number of places farther on. The dip and strike of the rock was not definitely determined. The general appearance in the distance gave the impression that they dipped southwestward with the strike nearly southeast and northwest.

Northward along the valley of the Kuskulana the outline of the mountains changes repeatedly, indicating decided differences in the nature and inclination of the rocks composing them. On either side of the pass by which we left the valley, which may be called Kuskulana Pass, are high peaks with smooth, regular outlines and few gulches, features characterizing the masses of granular igneous rock in the area. Several of these were seen farther north, and between them were jagged angular peaks showing marked bedding. This bedding is inclined sometimes in one direction and sometimes in another, and is nowhere sufficiently regular to indicate a definite strike and dip. Usually this bedding would indicate rocks of sedimentary origin. From its similarity, however, to the bedding in the volcanics at the head of the Kotsina River, but a few miles distant, it is quite possible that the rocks in which it is found here are also of volcanic origin; and the fact that the drift on the flood plain of the Kuskulana contains almost no sedimentary rock would seem to favor this view. This drift, however, is made up in large part of acid and intermediate volcanic dike rocks and contains comparatively little basic volcanic rock, which is probably due to the greater resistance of the acid rock and not to a greater abundance of the same. So also the absence of even less resistant sedimentary rock is not a potent argument that such rock is not found higher up on the stream.

On the eastern side of the granolitic peak south of Kuskulana Pass a contact was found between the granolite and an arkose or very impure sandstone. There being no conglomerate at the base of the sandstone, it is not clear whether the volcanic was intruded or the sandstone laid down upon it. The fossils collected from this sandstone were unfortunately lost on the way to Valdes. The granolite composing the mountains on either side of this pass contains considerable quartz, and the ferromagnesian mineral is almost exclusively hornblende.

The main drainage lines from the Kuskulana eastward trend approximately north and south. A second series of valleys, hardly less marked than these, trend southeast and northwest, and cut the ranges between them. These secondary valleys correspond in a general way to the strike of the rocks and probably represent a series of softer and less resistant rock or planes of weakness due to faulting or folding. One of these, a broad, open valley, begins at Kuskulana Pass and extends eastward where, as the valley of the Lower Lachina, it leads out into the valley of the Upper Chitina. The range of mountains between this and the Chitina Valley is divided by the valleys of Fitch and Dora creeks into three separate groups. These different groups present topographic outlines like those of the mountains west of the Kuskulana, of which they appear to form an eastern continuation. They probably represent the same series of shales and slates that were found along the first creeks west of the Kuskulana, and these may be conveniently referred to as the Kuskulana shales. At the western end of this transverse valley, on opposite sides of Kuskulana Pass, are the masses of granular igneous rocks that have been described. Several others similar to these were seen at various points along the valley, and a very prominent one was found just east of the Lachina. The rock composing this has a medium-grained gray groundmass, inclosing small needle-shaped phenocrysts of hornblende.

The range between the Lachina River and the Kennicott Glacier is cut by a narrow valley, which, leading out upon Kennicott Glacier, may be called Kennicott Pass. The rocks composing the mountains to the south of this are made up of shales, slates, arkoses, and probably some limestones, all much fractured and distorted and seamed by calcite veins. Reddish brown areas of interbedded volcanics are conspicuous on the northern slopes of these mountains, and intrusive dikes are numerous.

To the north of the pass, beyond a mass of granular igneous rock, the mountains are truncated and have a flat mesa top, the surface of which is an impure nodular limestone. The edge of this mesa, as exposed in the wall of an amphitheater at the head of a small valley, shows a section through a series of rather thin-bedded, light-colored sedimentary rocks dipping slightly southward.

In the bed of a small creek between Fohlin Creek and the Lachina, in Fohlin Creek, and at various points between this and the summit of Kennicott Pass, were found exposures of a light-gray, rather coarse-grained arkose, containing fossils which were recognized by Dr. Stanton as a Russian species of *Aucella*, and which were referred by him to the later Jurassic. Similar fossils were found in the small canyon just east of Kennicott Pass and again in the western lateral moraine of Kennicott Glacier. There can be little doubt that this arkose is a member of the series of the gray-bedded rocks north of the Kennicott Pass.

MOUNTAINS SOUTH OF KENNICOTT PASS.

The type of topography here illustrated characterizes the frontal ranges bordering the Chitina Valley on the north. The surface of the valley, shown in the center of the cut, has a gentle slope and at a distance appears like a mass of mud oozing out into the valley below. A closer examination shows its composition to be in no wise different from that of an ordinary talus slope. This apparent "flowage" in talus slopes was noticed in a number of places, and seems to be due to the presence of small local glaciers or patches of névé in the amphitheaters from which these talus slopes descend. They are, therefore, rather moraines than talus slopes.

The moraine on the western edge of Kennicott Glacier also contains pebbles of a dark-colored shale, in one of which was found a specimen of *Monotis* exactly like that found in the Kuskulana shales, thus indicating that these rocks occur higher up on the glacier. A light-colored brecciated acid volcanic, very heavily impregnated with iron pyrite, was very abundant in this moraine.

THE NIZINA-TANANA SECTION.

General relations.—The valley of the Kennicott Glacier represents a geological break, the rocks to the east of which are exposed in a series of parallel ridges tending approximately north and south and cutting the strike of the rocks at considerable angles. The first of these ridges is between Kennicott Glacier and Root Glacier, its eastern tributary, the second between this and McCarthy Creek, and the third between McCarthy Creek and the Nizina River.

The most conspicuous geologic feature of this area is a great limestone bed 500 feet or more thick, overlying a series of greenstones. This was first seen in a rather prominent peak at the foot of the spur between Kennicott and Root glaciers, where the contact between the two is so prominent that it may be distinctly seen in Pl. LVIII, which is from a photograph taken on a mountain west of the glacier. The limestone here dips uniformly northward at an angle of about 30° and the strike is about northwest and southeast. This general strike persists across each of the ranges eastward as far as seen. The limestone is exposed at the junction of the Nizina and Chitistone rivers, and will therefore be referred to as the Chitistone limestone. The greenstone contains the Nikolai copper vein and will be called the Nikolai greenstone.

To the south of the greenstone exposure each of the ridges is cut by a decided topographic break. This is particularly marked in the mountains east of the Nizina, where it constitutes the valley of the stream on which the Nikolai House is situated. The mountains south of these breaks in the several ranges lie in a nearly direct line with the mountains just west of Kennicott Glacier and south of Kennicott Pass. This and the fact that all of these mountains present strikingly uniform topographic features make it probable that they all represent outcrops of the same general rock series. These have been described as consisting of arkoses, shales, slates, and limestones, usually very dark in color and much fractured and seamed by calcite veins. They appear to be highly inclined, dipping southward, and are everywhere much intruded by acid volcanics, both as interbedded and as dike masses. The topography which characterizes these mountains is of the angular, jagged, sawtooth type, not unlike that of the mountains at Valdes and Lowe River, and strikingly similar to that of the Nutzotin Mountains at the head of the Tanana River.

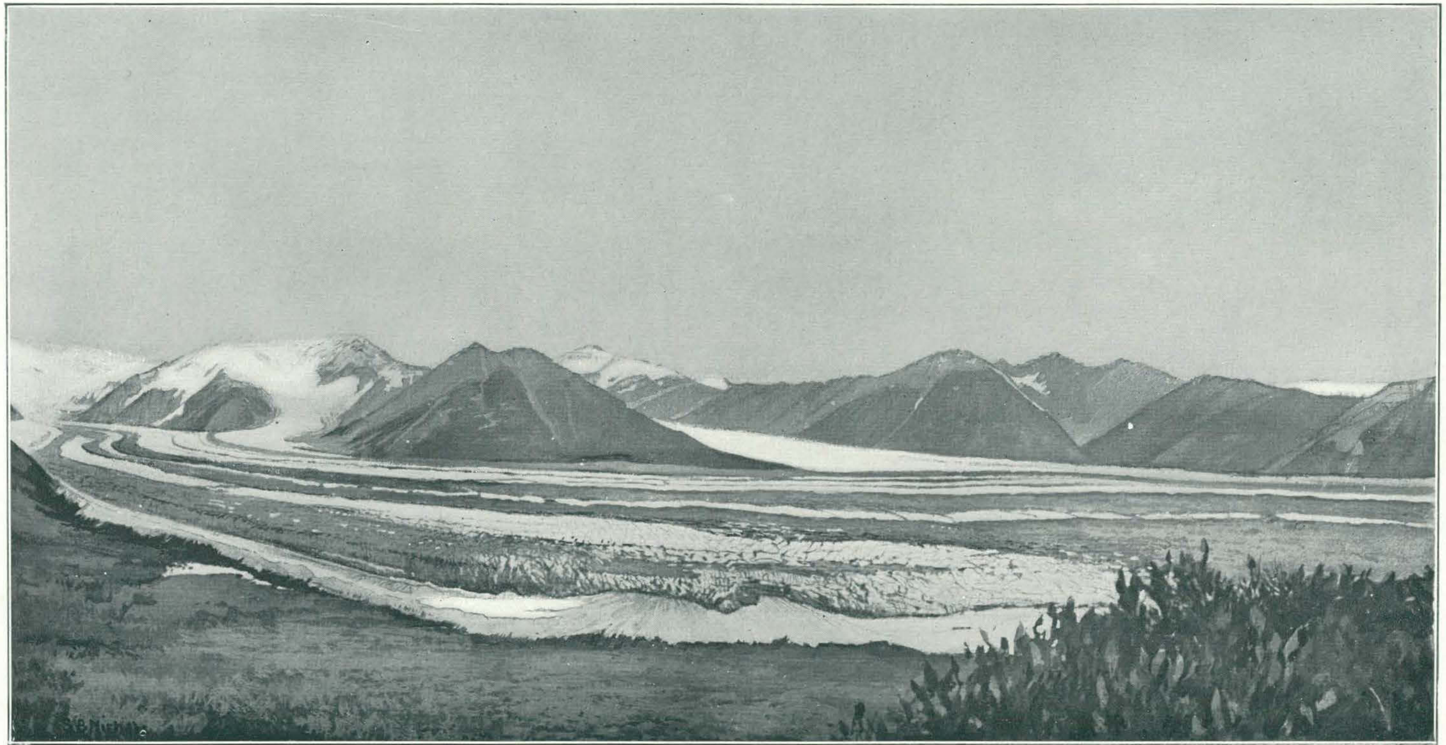
Nikolai greenstone.—This is a series of ancient basic volcanics. Though in general having the appearance of extrusive flows and being in some places massive and in others somewhat amygdaloidal, no regularity in bedding was anywhere observed.

In the hand specimen these rocks are characterized by a predominating green color, though at times they are somewhat reddish. Irregular spots of lighter green color are very common. In structure they are usually ophitic and in texture are coarse-grained. None of the fine-grained aphanitic phases common in the later diabases were seen. Under the microscope these rocks are found to be made up essentially of feldspar, pyroxene, olivine, some magnetite, and alteration products. The feldspar is often present in large phenocrysts, several of which are usually associated in an irregular aggregate, and these cause the spots or mottlings of lighter material noted in the hand specimen. The feldspars are generally lath-shaped, and are always much saussuritized. The pyroxene fills the interspaces between the feldspars and incloses small individuals of olivine, which are sometimes well crystallized and very abundant. The olivine is always more or less altered. In its first stages it is merely crossed by rifts and bands of a reddish-brown decomposition product, and in its final stage there is nothing left but the outline to indicate its presence.

Chitistone limestone.—This consists of a massive bed of limestone 500 or more feet thick. It weathers gray, but on the fresh surface is of a uniform dark chocolate-brown color. In texture it is exceedingly dense and aphanitic, resembling in this respect a quartzite. While usually massive it is often brecciated, in which case the fractures are filled by coarsely crystalline calcite veins. None of this rock containing fossils was found in place. In the thin section this rock is found to be made up of rounded areas of exceedingly fine-grained material surrounded by material of the same kind, somewhat more coarsely crystalline. Sometimes areas of the finer and coarser material are arranged in concentric circles, or a ring of the finer grained material will surround an area of the coarser. Sometimes these areas are linked together in a manner strongly suggestive of organic remains.

The contact between this limestone and the underlying greenstone was examined in only one or two places, and where examined it was sharp and no traces of any conglomerate or fragmental rocks were found. The examination was not, however, sufficiently extensive to be conclusive on this point.

McCarthy Creek shales.—Overlying the limestone formation and extending northward for a distance of 6 or 8 miles is a series of soft, black, highly fissile shales and slates. These are typically exposed on McCarthy Creek and may be called the McCarthy Creek



VIEW OF KENNICOTT GLACIER.

The glacier cuts across the foot of a lateral valley facing it, with an ice wall in places several hundred feet high. In the mountain between the main glacier and its eastern tributary the contact between the Nikolai greenstone and the overlying Chitistone limestone is very marked, and it may be distinctly traced in the mountain to the east. It is in this greenstone near the contact that the Nikolai copper vein is found, just west of the Nizina River.

shales. The contact between this series and the underlying limestone was nowhere carefully examined. In the Nizina exposure, however, it was sufficiently sharp and distinct to be readily seen at a distance.

Faulting and folding in Chitistone limestone and McCarthy Creek shales.—The Chitistone limestone, where first seen in the spur between Kennicott and Root glaciers and in the ridge between Kennicott Glacier and McCarthy Creek, presents a uniform dip northward of about 30°. In the eastern wall of McCarthy Creek, however, the dip of the limestone is less, and in the range to the east of this the contact between it and the greenstone is very irregular, suggesting marked displacement, principally by faulting.

Owing to the flattening of the dip and the deformation of the bed its most extensive exposure is found on the Nizina River. Here it forms vertical cliffs in the western wall of the canyon for a distance of several miles. These cliffs are in places 2,000 feet high. The great thickness of the bed is here due to marked faulting, folding, and buckling. Deformation has evidently been due to lateral compression, and the development of thrust faults from overfolds is beautifully illustrated, and has already been described by Dr. Hayes.[1] The massive bed of limestone is bent into a short overfold which is sheered off smoothly along the reverse limb and one part thrust far over upon the other (see Pl. LIX, *A*). Other faults have been developed with little or no preliminary folding. The faulting of the limestone is in some cases seen to extend directly into the underlying greenstone.

Eastward from the Nizina Canyon the contact between the limestone and the greenstone is found in the mountain just south of the Chitistone. Here the limestone dips northward, but in the mountain north of the Chitistone the limestone bed dips southward and forms a capping on a flat-topped mountain. It here ends northward in a precipitous bluff which forms the south wall of a lateral gulch, and beyond this the limestone appears at a much lower level, dipping gently northward under the overlying shales.

In the soft McCarthy Creek shales overlying the Nizina limestone the accommodation to deformation has been largely by flowage and has given rise to profound folding and plication and well-developed slaty cleavage and fissility. This has obscured the original bedding and made it difficult to determine the inclination of the original strata and the thickness of the series. The perfect cleavage and fissility in these shales causes them to disintegrate very readily, and this gives to the mountains smooth pyramidal forms, which is very characteristic and serves to outline the extent and distribution of the series.

Other rocks.—The valley of McCarthy Creek and those of the different tributaries of the Kennicott Glacier are, as has been noted, flat and

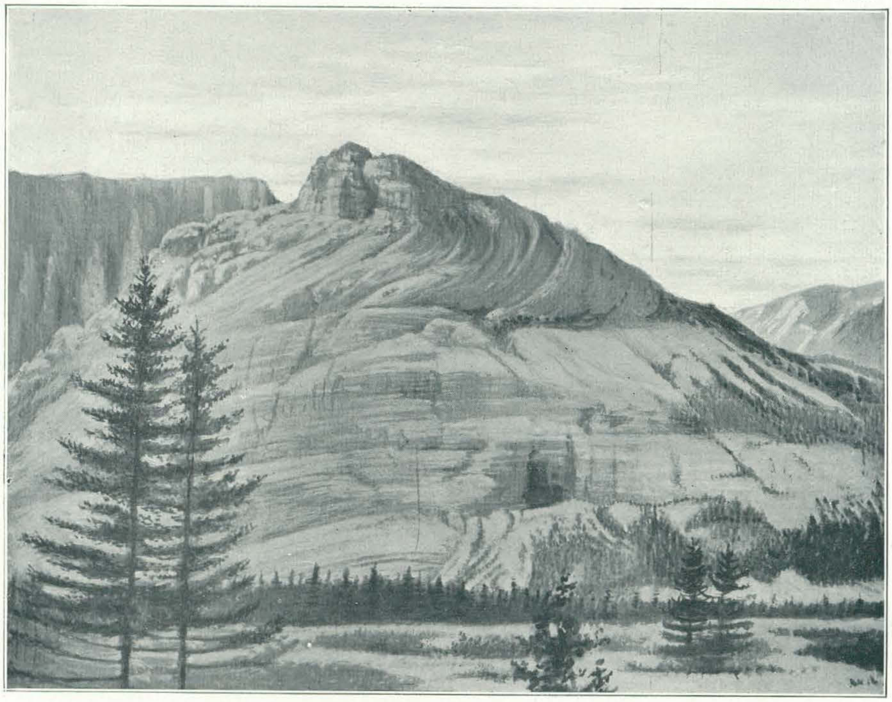
[1] An expedition through the Yukon district, by C. W. Hayes: Nat. Geog. Mag, Vol. IV, 1892.

terminate abruptly northward at the foot of the great terrace or scarp which forms the edge of the main Skolai Range. This scarp and the crests above, where exposed, are seen to be made up of a series of thin bedded, slightly inclined, light-colored sedimentary rocks.

About 3 miles south of this scarp, on the top of a high peak east of McCarthy Creek, near its head, an isolated exposure of conglomerate grading upward into an impure sandstone is found unconformably overlying the shales. In this conglomerate were found several bowlders of limestone which were made up almost exclusively of crinoid stems. Dr. Girty, of the United States Geological Survey, determines these as Carboniferous. Whether these bowlders were originally derived from the great limestone bed overlying the greenstones, or whether they were possibly interbedded with the shales, was not very clear. It seems probable, however, that they represent a part of the great limestone formation.

Among the débris derived from the rock overlying the conglomerate were found fossils referred by Dr. Stanton to the same horizon as those found in the light-colored Cretaceous arkoses, shales, and limestones between the Lachina River and Kennicott Glacier. There can be little doubt that this conglomerate and sandstone are outliers of the sedimentary series northward in the edge of the Skolai Range and that this is the same as the series found at Kennicott Pass, which will be referred to hereafter as the Kennicott series.

At the head of McCarthy Creek the Skolai Range makes a bend to the north around the head of the Nizina, and the section as exposed on the Nizina is somewhat different from that farther west. The Kennicott series does not appear and the shales are replaced northward by a series of amygdaloidal volcanics, which are plainly younger than the Nikolai greenstone. These persist northward in the mountains on both sides of the Nizina Glacier. Toward the summit of the glacier the moraines are composed entirely of an acid volcanic, which has a groundmass inclosing phenocrysts of feldspar and hornblende. Various phases of the same rock, without other rocks, were found in the first moraines seen north of the summit at the head of the Tanana Glacier. Below the great bench in the Tanana Glacier amygdaloidal volcanics similar to those found on the southern side of the range again appear in the moraines. It is probable that many of these amygdaloidal diabases are picked up by the ice higher up on the glacier, but do not appear until uncovered below the snow line. As no sedimentary rocks of any kind were noted in the moraines on either side of the summit, it would appear that the central mass of the Skolai Mountains is composed mainly of later volcanics. To the north of and opposite the foot of Tanana Glacier is an isolated mountain composed of vesicular basaltic lava, evidently much younger than the diabases found along the glacier. Beyond this northward is an open



A. FOLDING AND FAULTING IN CHITISTONE LIMESTONE.

The view was taken at a point in the western wall of the Nizina Canyon, about ten miles below the foot of the Nizina Glacier.

B. AMPHITHEATER FORM OF EROSION.

This form of erosion has been ascribed to local glaciation, and this explanation is borne out by the cut, which shows a remnant of a small local glacier in the bottom of the valley. The débris rolling down the steep sides is deposited upon this and by it carried to its foot, where it is dumped in ridges, while the water formed by the melting of the ice percolates through the loose material without acquiring sufficient force to cut out V-shaped valleys.

valley which has already been described under the heading "Topography." The low, irregular, often flat-topped hills of this valley suggest that they are made up of basaltic lava flows similar to those of the mountain just described, at the foot of Tanana Glacier. Beyond this valley northward is the Nutzotin Range, which appears to be made up of a series of highly inclined, sedimentary rocks. Westward this valley narrows to a pass leading to the Nabesna River. On the southern side of this pass is a granitic mass similar to those described on the Kotsina and along the Chitina. To the west of this amygdaloidal volcanics are found, intimately intermingled with sedimentaries, among which are shales, slates, and limestone. A limestone bed here appears which is nearly as massive as the Nizina limestone bed on the southern side of the range. It is, however, much folded, and was seen only at a distance as a capping on a high mountain. We have here evidently a contact zone between the volcanic series southward and the Nutzotin sedimentary series northward. The general dip and strike of the Nutzotin rocks was not definitely determined, but seemed to be northward.

Northwestward, in the Nabesna Range, which forms the divide between the Nabesna and the Copper rivers, the appearance in the distance indicated flat-lying sedimentaries, very similar to those found on the southern side of the Skolai Range, called the Kennicott series. The sedimentary rocks of the Nutzotin Mountains, judging by topographic features, find their northward continuation in the Mentasta Range. The slightly inclined bedded rocks which compose the foothills northeast of Mount Sanford may readily be a continuation of the bedded rocks, supposedly sedimentary, in the Nabesna Range. On the other hand, both of these may represent bedded volcanics.

BASIC VOLCANIC ROCKS.

Two different types of basic volcanics have been described, one with the Kotsina section and the other with the Nikolai greenstones (see pp. 420 and 426). The basic volcanics of the Skolai Range, as seen in the Nizina-Tanana Glacier, are decidedly different from either of these, as is shown both in hand specimens and in thin sections. In the Nikolai greenstone amygdules are very obscure. In these younger volcanics, which may be called the Skolai volcanics, the amygdules are very fresh and conspicuous, and are filled with quartz, calcite, and epidote. In color they are usually gray to reddish brown. The massive phase is often fine-grained to aphanitic, the latter kind being in color usually almost black. In the thin section these rocks are found to be composed essentially of feldspar, pyroxene, olivine, and unindividualized base. The feldspars are often present in large phenocrysts and always in lath-shaped crystals, which frequently show a tendency toward a parallel arrangement. The pyroxene and olivine are usually younger and fill interspaces between the feldspars. The olivine is sometimes present in large crystals and is always very much altered, usually to a reddish-brown material, which, when the crystals of olivine are large, is conspicuous in the hand specimen. Unindividualized base is always present in these rocks, and is often the most important constituent. Olivine was not found in the dense aphanitic types, and in these magnetite is usually abundant.

Numerous varieties of tuffs and volcanic breccias are common in the moraines of the Tanana Glacier. Some of these contain sufficient copper to give them a decided green tinge.

Recent highly vesicular scoriaceous lavas have been described as found in the Kotsina section (see p. 421), and rocks entirely similar to these were found in the mountain at the foot of the Tanana Glacier. The vesicles in these are empty, and the general appearance leaves little doubt that they are of decidedly later age than the Skolai amygdaloids.

ACID IGNEOUS ROCKS.

The acid rocks of the area exhibit every phase of structure from a holocrystalline granular rock to a fine-grained lava. In some cases they contain much quartz and in others none at all, but almost all contain more or less hornblende.

The coarsest-grained rock found in the area was taken from a bowlder on McCarthy Creek. This was made up in large part of large phenocrysts of hornblende, with considerable biotite in large crystals, and with interspaces filled with an intergrowth of quartz and feldspar. Usually, however, the grain in the coarser phases of the more siliceous rocks is medium, and the hornblende, quartz, and feldspar mutually interlock. This is the nature of the rock found in the boss-like masses at the head of the Kotsina, eastward from the Kuskulana, and again on the pass between the Nabesna and the Tanana, and specimens of it may be found in almost every river bed in the area. At times, as on the Upper Tanana, it constitutes the greater part of the gravel on the river bottom. A frequent variation from this found in the larger dikes consists of large phenocrysts of quartz, feldspar, and hornblende bedded in a cryptocrystalline groundmass. The ultimate phase of textural variation is the rhyolitic rock found in the upper moraines of the Tanana-Nizina Glacier. This is made up of isolated small individuals of quartz and feldspar, and occasionally a little hornblende and magnetite inclosed in a felsitic groundmass, which exhibits marked flow structure. In places, and conspicuously in the great boss immediately east of the Lachina River, needle-shaped phenocrysts of hornblende are embedded in a cryptocrystalline groundmass of quartz and feldspar.

RELATIVE AGE AND PROBABLE CORRELATION.

From the foregoing it appears that in the eastern part of the area the Nizina section presents the following monoclinal series dipping northward. At the base is the Nikolai greenstone, consisting of ancient basic volcanics interfaulted with and older than the Nizina limestone. No fossils were found in the limestone, but in the overlying series Triassic fossils were collected, and in the conglomerate unconformably overlying this Triassic series bowlders of a crinoidal limestone were found, which were referred to the Carboniferous by Dr. Girty, of the United States Geological Survey. These bowlders were probably derived from the Chitistone limestone, or from a continuation of this in a neighboring area. It is very improbable that they were derived from any older formation. It is therefore almost certain that the Chitistone limestone is as old as Carboniferous and perhaps older. Between the Triassic shales, which have been called the McCarthy Creek shales, and the overlying or Kennicott series an unconformity was suspected. This is indicated by a conglomerate at the base of the Kennicott series and by the presence in this series of late Jurassic or early Cretaceous fossils. It is also indicated by the absence of marked folding and plication in the Kennicott series. The latter series is characterized by light-colored arkoses, shales, and impure limestone, and is typically exposed around the head of Kennicott Glacier. Northward from the section described, amygdaloidal volcanics appear, and southward from it, beyond the greenstone, is a topographic break supposed to represent a fault. Beyond this supposed fault southward the rocks are thought to be a sedimentary series with interbedded volcanics, dipping southward.

In the western part of the area, on the Kotsina River, the lowest rock observed was volcanic greenstone very similar to the Nikolai greenstone. Upon this is folded and contorted shale and slate, which is overlain by a massive bed of conglomerate, called the Kotsina conglomerate, dipping 20° to 30° southwestward and striking northwest and southeast. Beyond this conglomerate is an unstudied sedimentary series which extends to and forms the mountains that constitute the southwestern border of the main group and extend continuously eastward to the Kuskulana. At this river the sedimentary series is found to be the Kuskulana shales. The marked uniformity of topographic outline and the direction of the strike of the great underlying conglomerate on the Kotsina are thought to indicate that these youngest rocks southwest of the Kotsina conglomerate are a direct westward continuation of the Kuskulana shales. They are indicated on the map as unclassified sediments.

It has been noted that eastward from the Kuskulana a range forming the northern border of the Chitina Valley is separated from the main mountain area northward by an open valley, along which leads the route which we followed. This range forms a direct eastward continuation of the frontal range west of the Kuskulana which was above described. And for the same reasons that the rocks above the Kotsina conglomerate are thought to be the same as the Kuskulana shales, the rocks of this eastern continuation are also thought to be the same. These reasons are, similarity in topographic forms and situation along a line thought to be the direction of the general strike of the series. However, these rocks were not examined, and in a faulted region, such as this, the impression may be erroneous. They are, therefore, indicated as unclassified sediments. It has been noted that south of the route leading eastward from the Lachina a series of sedimentary rocks appear, quite different from those to the north of this route and that, so far as examined, these consist of shales, slates, and arkoses interbedded with volcanics.

The three areas, two on opposite sides of the foot of the Kennicott Glacier and the third eastward from the Nizina River, present marked uniformity of characteristic topographical outlines. These consist of sharply serrate sawtooth crests which, as viewed from the northwest, suggest strongly bedded rocks with a southerly dip. We have then, here, seemingly, a series of sediments similar to the Kuskulana shales and also similar to the McCarthy Creek shales, but which in position do not accord with either of these. They are indicated on the map as unclassified sediments. West of the Kennicott Glacier and north of the unclassified rocks just described, the Kennicott series appears, and here seems to swing northward, across the strike of the underlying series of older rock. It appears, therefore, that while there is a general similarity between the northward-dipping Nizina section and the southward-dipping Kuskulana section, conditions which would indicate an anticlinal axis between them, the exposures between these sections are so irregular that their position can not be accounted for except by the assumption of marked faulting, possibly in two directions, and by marked local irregularity in folding. To fully elucidate this structure is beyond the possibility of reconnaissance and will require extensive detailed work over a wide area.

Northward, across the Skolai Range, the conditions seem to be less complicated, but for much of this distance the route lay along the strike of the rocks and the opportunities for observation were therefore even more limited than they were on the southern side of the area.

Table of provisional correlations.

	Spurr; Yukon district, 1896.	Brooks; White River and Tanana district, 1898.	Mendenhall; Resurrection Bay to the Tanana River, 1898.	Spurr; southwestern Alaska, 1898.	Eldridge; Sushitna Valley, Alaskan Range, and Cantwell River, 1898.	Schrader; Copper River district, 1898.	Brooks; Pyramid Harbor to Fortymile River, 1899.	Rohn; Chitina River and Skolai Range, 1899.
Pleistocene....	Silts and gravels.	Silts and gravels.	Sands and gravels.	Silts, sands, and gravels.	Sands, gravels, and bowlder clays.	Silts and gravels.	Silts, gravels, and volcanics.	Silts, gravels, and volcanics.
Neocene.......	Twelvemile beds, Porcupine beds, Nulato sandstone, Palisade conglomerate.	Tok sandstone.		Tyonek beds, Hayes River beds, Nushagak beds.			Tok sandstone and effusive rocks.	
Eocene or Oligocene.	Kenai series.			Yentna beds.	Kenai series.	Valdes series. (?) Orca series.		
Cretaceous	Mission Creek series.		Matanuska series.	Tordrillo series, Holiknuk series, Kolmakof series, Oklune series.	Cantwell conglomerate. (?)	Valdes series. (?)		
Jurassic				Naknek series, Skwentna series, Terra-Cotta series.				Kennicott series.
Triassic........								Kuskulana shales, McCarthy Creek shales.
Devonian and Carboniferous.	Tahkandit series.	Wellesley series, Nilkoka beds.	Sunrise series. (?)	Tachatna series.	Cantwell conglomerate. (?)	Valdes series. (?)	Nutzotin series.	Chitistone limestone.
Silurian	Rampart series.	Greenstone-schists.	Greenstones. (?)				Greenstone-schists.	Nikolai greenstone.
Pre-Silurian sediments.	Birch Creek series, Fortymile series.	Tanana schists, Nasina series.	Tanana schists.		Sushitna schists.	Klutena series.	Kotlo series.	
Archean.......	Basal granite.	Gneissic series.			Basal granite and gneissic series.		Gneissic series.	

PROBABLE STRUCTURE OF THE AREA.

Dr. Hayes, who crossed the Skolai Range by way of Skolai Pass from the head of the White River and traveled down the Nizina River, says of the structure of this range:[1]

The geology of the northern [the Skolai] range is simple. In the walls of Skolai Pass, by which the range is crossed, its stratigraphy and structure are magnificently displayed. The rocks are comparatively recent, for the most part Carboniferous, Triassic, and Cretaceous. A bed of limestone about 500 feet thick contains many crinoids and corals, probably of Carboniferous age. Above it are red sandstone and jasper and a great thickness of black shale.

* * * * * * *

Interbedded with these sedimentary rocks, and penetrating them as dikes, are fine-grained, greenish amygdaloidal lavas forming perhaps half of the whole rock mass. The structure of the range consists essentially of a broad, gentle synclinal, with a highly contorted belt on either side.

Excellent examples of typical fan structure were seen in the intensely plicated rocks which form the abrupt northern face of the range. This structure is remarkably well shown in the sides of the gorge from which Kletsan Creek issues. The 500-foot stratum of white limestone above referred to is folded in with dark greenish-black eruptive rocks, so as to form a double V; the overturned southern synclinal limbs dip southward about 30 and 45 degrees, while the normal northern limbs are nearly horizontally.

This plicated belt on the northern side of the mountains is about 6 miles wide, and south of it the synclinal in which the beds are practically horizontal (coinciding with the axis of the range) occupies a belt from 25 to 30 miles in width. On the southern side of the range there is a region of disturbed rocks similar to that on the north, but somewhat wider and less minutely plicated. The structure is well shown in the lower portion of the Nizzenah Canyon, whose walls rise from 2,000 to 3,000 feet vertically above the river.

* * * * * * *

Nizzenah River, for about 7 miles above its confluence with the Chittenah, flows in a narrow canyon with rocky walls from 400 to 500 feet high. For a short distance above the canyon the gravel bluffs are replaced by cliffs of calcareous black shale apparently very recent and slightly affected by the compression which has disturbed the rocks lying on the north. At the upper end of the canyon the black shale contains beds of extremely coarse conglomerate, and is succeded by black slate and mica-schist, the latter containing many small quartz veins. An east and west line through the upper part of this canyon appears to be the approximate limit of the little altered rocks forming the northern range.

Dr. Hayes regards the Chitistone limestone as probably a continuation of the great limestone bed which he found in the vicinity of Skolai Pass and on the northern side of the range. An exposure of this forms a capping on a high, perpendicular-walled cliff which borders the valley of the Nizina on the south. This limestone is here opposite to and at almost the same elevation as the Kennicott series west of the Nizina Valley, and it appears to overlie the McCarthy Creek shales. While this appearance is probably deceptive, the occurrence of the limestone at this point shows marked and irregular displacement, and

[1] A trip through the Yukon district, by C. W. Hayes: Nat. Geog. Mag., May, 1892, Vol. IV, pp. 140-141.

shows that the section east of the Nizina Valley, described by Dr. Hayes, is somewhat different from that on the western side, herein described as the Nizina section. Dr. Hayes also describes the limestone bed as white limestone containing many crinoids and corals. This corresponds to the bowlders which were found in the conglomerate overlying the McCarthy Creek shales west of the Nizina, but the Nizina limestone, at least in the lower portion of the formation where examined, was found to be very dense and very dark in color, and in general appearance different from the bowlders in the conglomerate. It is therefore not certain that the limestone formation of which Dr. Hayes speaks is exactly the same as the Nizina limestone formation. If it is not the same formation, however, it is probably very closely related to it in point of time, and a member of the same general series of formations. There can be little doubt that the limestone which Dr. Hayes found on the northern side of the range interbedded with green amygdaloidal volcanics is the same as that which has been described by me, occurring under exactly the same conditions on the northern side of the range a little farther west, in the pass to the Nabesna River.

The synclinal structure of the Skolai Range, which Dr. Hayes mentions, was not apparent on the Tanana-Nizina section, as the bedded sedimentaries were not observed on the northern side of the range. While volcanics seem to predominate, the examination of the area was so hasty and imperfect that sediments may easily be present and have been overlooked.

The flat-lying bedded rocks of the Nabesna Range and those north of Mount Sanford more nearly resemble in appearance the bedded rocks of the Kennicott series than they do any other rocks seen throughout the entire area.

GENERAL STRUCTURE.

From the foregoing and from what has been said of the inclination of the rocks in the Valdes-Tonsina section, and of those in the section along Copper River below Taral, described by Dr. Hayes[1] and by Schrader,[2] it is evident that the rocks throughout the area strike in a general northwest-southeast direction. This indicates axes of major folding in this direction and makes the structure correspond with that farther northward, where in the Upper Yukon district Spurr[3] shows the existence of a series of broad, gentle geanticlines and geosynclines with axes along the same general direction. A similar structure is shown by Brooks[4] to exist in the Tanana Valley.

It appears, then, that the major folding throughout a large part of eastern Alaska is along a general northwest-southeast axis. In the

[1] Op cit., p. 141.

[2] A reconnaissance of a part of Prince William Sound and the Copper River district, Alaska, in 1898, by F. C. Schrader: Twentieth Ann. Rept. U. S. Geol. Survey, Part VII, pp. 341–423.

[3] Geology of the Yukon gold district, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt III, p. 259.

[4] Twentieth Ann. Rept. U. S. Geol. Survey, Pt. VII, p. 481.

interior this folding is gentle and open but coastward it is close and intense. The pitch of the folds and the manner in which the outcrops of formations alternately narrow and widen indicates that there is present also a series of less prominent cross folds which are obscured by the major folds.[1] In the vicinity of the Wrangell Mountains the detailed structure is further complicated by faulting in one or more directions, by local plication and local irregularity in folding, and by extensive volcanic intrusion.

Spurr, in his Yukon report,[2] calls attention to the fact that the general direction of mountain ranges and main drainage lines in eastern Alaska is southeast and northwest, and he shows that this is due to a series of broad, open folds along axes in this general direction; and in his reconnaissance report[3] on southwestern Alaska he notes that the main mountain ranges and drainage lines of eastern Alaska are continuous westward, but that they make a right-angle turn in a zone from the head of Prince William Sound northward, and in western Alaska assume a general northeast-and-southwest direction. And he finds here a series of broad, open folds similar to those in the eastern part, but in direction at right angles to them.

Professor Van Hise[4] has shown that major folding in one direction is almost invariably accompanied by minor or cross-folding at right angles to it, and that through shifting of the direction of maximum stress producing these folds the major folds of one area, by decreasing in intensity, become the minor folds of an adjacent area, and the minor folds of the first area, by increasing in intensity, become the major folds of the second area; but that the secondary folding is made apparent only by pitching axes of the primary folds and by dome-shaped and canoe-shaped structures. This suggests an explanation of the structure noted by Spurr and Brooks. It is probable that throughout a larger part of Alaska two series of folds are general, one series striking along southeast-northwest axes and another striking along northeast-southwest axes. Eastward and northwestward from Valdes the first series is of major importance and obscures the second, while westward and southwestward the second is of major importance and obscures the first.

MINERAL PROSPECTS.

GOLD.

Considerable work has been done on Quartz Creek, a tributary of the Tonsina, and on Ernestine and Fall creeks, tributaries of the Upper

[1] This has been also ascertained by Mr. Brooks in the Tanana region. (Ibid.)

[2] Op. cit., pp. 252–278.

[3] A reconnaissance in southwestern Alaska, by J. E. Spurr: Twentieth Ann. Rept. U. S. Geol. Survey, Part VII, pp. 328–240.

See also Geology of the Yukon gold district: Eighteenth Ann. Rept. U. S. Geol. Survey, Part III, pp. 136, 155, 256, and map, Pl. XXXVII.

[4] Principles of North American geology, by C. R. Van Hise: Sixteenth Ann. Rept. U. S. Geol. Survey, Pt. I, pp. 626–628.

Kanata. Enough good coarse gold has been taken out of these streams to show the presence of gold-bearing rocks in the vicinity. Working the deposits found on these streams has, however, thus far not proved economically successful on account of the great thickness of glacial drift.

A number of parties were at work during the season of 1899 on the Upper Chislechina, and one party found prospects that have led it to take in an extensive hydraulic plant, which is on the way at this time (March, 1900).

At the head of the Kotsina and in the mountains north of the Chitina Valley diabase dikes frequently carry heavy impregnations of iron pyrite and copper pyrite. A particularly large dike of this kind was noted at the head of the first tributary of the Kotsina River. Zones of similar impregnations are found in many of the larger masses of the acid rock. It is reported that assays of some of these show the presence of gold and silver, but, so far as I have been able to learn, the amounts found are too small to make the deposits of economic importance, unless cheap transportation facilities are provided.

COPPER.

Copper, both native and as a sulphide, has been found on the Kotsina, in the mountains north of the Chitina Valley, and at the headwaters of the Tanana River. The largest deposit which was seen is the so-called "Nikolai vein."[1] This has been known to the Taral natives for a long time, and its location was disclosed by them to prospectors for a consideration of flour and provision. This was found to be a true vein deposit in a fissure due, probably, to faulting. The direction of this fissure is parallel to the strike of the rock. The main body of the ore is massive bornite, and on each side of this is a sheet of chalcopyrite. Offshoots of the main vein parallel to it are common.

This vein is found in the ancient basic volcanic greenstones, which have been called the Nikolai greenstones, and near the contact of these with the overlying Chitistone limestone.

The outcrops of this greenstone and overlying limestone, which are extensive along a persistent strike, have been already described (p. 426). Westward from the Nikolai vein in McCarthy Creek float copper was found in the river gravels below the greenstone exposure, and westward beds in the greenstones were noted in which native copper occasionally filled amygdules.

On the Kotsina River veins of copper ore and impregnations of native copper are reported to have been found during the latter part of the season. Specimens of the ore showed it to be the same as the bornite of the Nikolai vein.

Another vein of entirely similar ore is reported on the Sterlina, a small creek tributary to the Kuskulana from the west.

In the pass between the Tanana and the Nabesna rivers fragments of volcanic rock were found thoroughly impregnated with native copper. Time did not permit following these up to their source.

A native met on the Nabesna River indicated four different places known to him where the natives gather copper. Judging by his descriptions the easternmost of these is probably that seen by Dr. Hayes.[1] The other three are in the Upper Tanana Valley. These may all be copper placers, but even if they are they indicate the presence of copper in place in some of the rocks of the area, and their source can probably be traced out. Pebbles of diabase and volcanic tuff found in the moraine of the Tanana Glacier often showed considerable copper stain.[2]

It appears that the copper on both the southern and northern side of the Skolai Range is associated with basic volcanic rock. And where copper deposits were seen in place the volcanics in which they occur are associated with sedimentary rocks.

The marked similarity of the Nikolai greenstones to the Keweenawan greenstones of Lake Superior has been noted (p. 420). This similarity is apparent not only in manner of occurrence and in the appearance of the hand specimen, but also in the nature and arrangement of mineral constituents as seen under the microscope, and even in the characteristic forms of alteration. The similarity of the Nikolai greenstones to the greenstones at the head of the Kotsina and the probable equivalence of these has been noted (p. 431). The similarity of these greenstones to Spurr's Rampart series has also been noted, and in this connection it is interesting to quote a statement which he makes regarding the Rampart series. This is as follows:

> The rocks of this series are characterized throughout by great basicity. The diabases contain a large proportion of idiogenous sulphides and of iron and other metals as components of augite, olivine, and other bisilicates. In the tuffs, which make up a large proportion of the rocks, these materials are separated and rendered especially liable to decomposition; afterwards the rearrangement of the component elements follows naturally, and the concentration of the metals in favorable localities must be looked for. Such localities are afforded by shear zones, which may form channels for waters bearing metallic solutions derived from the decomposed diabases and tuffs, and along which these metals may be deposited under proper conditions.[3]

The Skolai amygdaloids, though much younger than the greenstones, are in large part very basic and contain mineral constituents very similar to those of the greenstones.

In view of the association of the copper, so far as seen, with these basic volcanic rocks and the fact that such rocks in the Lake Superior

[1] An expedition through the Yukon district, by C. W. Hayes: Nat. Geog. Mag., Vol. IV, 1892, p. 144.

[2] On the Upper White and Tanana rivers, various copper localities are described by Mr. Brooks. See pp. 377 et seq., this report.

[3] Geology of the Yukon gold district, Alaska, by J. E. Spurr: Eighteenth Annual Rept. U. S. Geol. Survey, p. 168.

region are known to be the source of the copper deposits there found, it seems reasonable to assume that these volcanics are the source of the copper in the Wrangell district—a conclusion of economic importance to the prospector, as it indicates the areas on which work should be concentrated. This is of the more importance since the volcanics have so characteristic an appearance that they can readily be recognized and traced by men who have not had the advantage of training in geology.

The fact that, so far as seen, the deposits of copper are found in the contact zones of the volcanics with the neighboring sedimentaries accords with what is known of the Lake Superior deposits and with the latest conception of ore deposits in general; and this, together with the fact that the prevailing strike of the rocks of the area is southeast and northwest, should be taken advantage of in further exploration.

In conclusion, it may be said that, while the existence of workable ore deposits has not been shown by actual exploitation, the information resulting from the year's work shows the area to be mineralized and to be favorable to mineral concentration—an area, therefore, that warrants a detailed economic survey.

APPENDIX.

The fossils collected were referred to Mr. T. W. Stanton, and his report on them is herewith appended.

The eleven small lots from as many localities seem to represent only two general horizons in the Mesozoic. The lots numbered 1, 2, 7, 8, and 13 all consist of fragments of dark, slaty rocks, with impressions of one or more species that seem to belong to *Monotis* and are referred to the Triassic. The lots numbered 3, 4, 5, and 6 all contain a small form of *Aucella*, referred to the Russian species *Aucella pallasi* Keyserling, together with fragmentary ammonites from 5 and 6. The beds from which they came are therefore provisionally referred to the Upper Jurassic, although similar forms also occur in the Lower Cretaceous. Lots numbered 9 and 12 probably came from the same horizon, but they do not contain enough fossils to make this certain. In the following list the locality designations are condensed from the original labels:

1. West side of Kuskulana River. *Monotis* sp. Triassic.
2. A short distance north of No. 1. *Monotis* sp. Triassic.
3. Bowlder in creek between the Lachina and Fohlin Creek, at Camp 9. *Aucella pallasi* Keyserling. Jurassic?
4. East side of Fohlin Creek. *Aucella* sp. Weathered specimens, probably same as last. Jurassic?
5. Three miles east of Fohlin Creek, between Camps 11 and 12.
   Aucella pallasi Keyserling.
   Ammonites—undetermined fragments. Jurassic.

6. Canyon between Camp 13 and Kennicott Glacier.
   Aucella pallasi Keyserling.
   Ammonite fragments—different from those in lot 5. Jurassic?
7. West lateral moraine of Kennicott Glacier. *Monotis?* Triassic?
8. Kennicott Glacier. *Monotis.* Triassic.
9. Top of high mountain east of Camp 20, on McCarthy Creek. Obscure plant impressions pronounced unidentifiable by Professor Knowlton.
   Rhynchonella? sp. Fragment. Jurassic?
   Aucella sp. A single imprint.
12. Near same place as 9. *Astarte?* sp. Probably same horizon as the Aucellæ.
13. Bowlder on flood plain of the Nizena River. *Monotis?* sp. Fragment. Triassic?

PRELIMINARY REPORT ON A RECONNAISSANCE ALONG THE CHANDLAR AND KOYUKUK RIVERS, ALASKA, IN 1899

BY

F. C. SCHRADER

CONTENTS.

	Page.
Introduction	447
Itinerary and methods of work	448
Table of distances by river	450
Routes and trails	453
Chandlar River Basin	453
Fort Yukon to Indian village in flats	453
Fort Yukon to East Fork of Chandlar River	454
Lake Creek, Grave Creek, and Middle Fork trail	454
Granite Creek and Swift River trail	454
Geroe Creek and Sheep Creek trail	454
Baby Creek and Sheep Creek trail	454
Robert Creek portage	454
Chandlar River–Dietrich River trail	454
West Fork of Chandlar to South Fork of Koyukuk	455
Chandlar River and Rampart route	455
Koyukuk River Basin	455
Koyukuk River route	455
Dall River trail	455
Rampart and Hoyn Creek trail	456
Tozi trail	456
To Fort Yukon by way of Chandlar River	456
Middle Fork route to Chandlar River	456
Allen River to Kowak River	456
Nulato trail	456
Koyukuk and Arctic coast trail	456
Population	457
Chandlar River	457
Natives	457
Whites	457
Koyukuk River	457
Natives	458
Whites	458
Climate	458
Animal life	459
Quadrupeds	459
Fish	460
Birds	460
Insects	460
Vegetation	460
Geography	462
Topography and drainage	462
Yukon Basin and Plateau	462
Chandlar River Basin	464

Page.

Topcgraphy and drainage—Continued.
Chandlar River Basin—Continued.
Course of the river 464
Mountainous section 464
Yukon Plateau section 465
Yukon Flats section 465
Chandlar River 466
Koyukuk River Basin 467
Koyukuk River 468
Geology 471
Granite—probably basal 471
Amphibolite-schist 472
Rapids schist 473
Lake quartzite-schist 474
Bettles series 475
West Fork series 475
Lower Cretaceous 476
Upper Cretaceous 477
Kenai series 477
Nulato sandstone 478
Pleistocene 478
Till in Chandlar Valley 478
River gravels of Upper Koyukuk 478
Bench auriferous gravels of Tramway Bar 478
Lacustrine silts and gravels of Yukon and Koyukuk flats 479
Recent stream gravels 479
Igneous rocks other than those described 479
Diabase on Chandlar River 479
Granite on Baby Creek 480
Dioritic rock of Horace Mountain 480
Cretaceous lavas 481
Tertiary lavas 481
Basalt of Koyukuk Mountain 481
Basalt on Chandlar River 481
Mineral resources 482
Copper 482
Lead 482
Gold 482
Coal 485

ILLUSTRATIONS.

		Page.
PLATE LX.	Map of portions of Koyukuk and Chandlar rivers	448
LXI.	*A*, Chandlar Rapids, 128 miles above mouth of river, from west bank; *B*, View up Portage Creek, 194 miles above mouth of Chandlar River	454
LXII.	*A*, Bergman and edge of plateau formed of young rock series, looking north-northwest across Koyukuk River; *B*, Peavey, looking east	456
LXIII.	*A*, Group of Koyukuk natives at native village on left bank of Koyukuk River, 195 miles above its mouth; *B*, Mountains of limestone and mica-schist, looking up north side of Robert Creek from Horace Peak (6,000 feet), on headwaters of Koyukuk River, 652 miles above its mouth	458
LXIV.	*A*, Mountains of limestone and mica-schist, looking down north side of Robert Creek from Horace Peak (6,000 feet), on headwaters of Koyukuk River, 652 miles above its mouth; *B*, View up Chandlar River and Valley from edge of flats, 60 miles above mouth	464
LXV.	*A*, Mountainous topography in limestone, from Fault Mountain (5,400 feet); *B*, Mica-schist mountains, seen from Fault Mountain, west bank of Dietrich River	466
LXVI.	*A*, View of flats on Middle Fork of Koyukuk River; *B*, Gold-bearing schist, showing cleavage and attitude of rocks in bed of Myrtle Creek	468
LXVII.	*A*, Sluicing gold placers by Elsingson party, on Myrtle Creek; *B*, Young rock series of sandstone and conglomerate with some lignite	476
LXVIII.	*A*, Silt bluffs seen from Camp 45; *B*, View up Koyukuk River, showing low, rolling plateau, bluffs, etc., 173 miles above mouth of river	478
FIG. 22.	Profile across Koyukuk Valley above Red Mountain, showing old valley floor 750 feet above river	468
23.	Faulting in sandstone below Bergman	469

PRELIMINARY REPORT ON A RECONNAISSANCE ALONG THE CHANDLAR AND KOYUKUK RIVERS, ALASKA, IN 1899.

By F. C. SCHRADER.

INTRODUCTION.

The field work on which the following report is based was done during the summer of 1899 by a party composed, besides the writer, of Messrs. T. G. Gerdine, topographer, and H. B. Baker, G. H. Hartman, T. F. Lundy, and D. C. Witherspoon. Funds for the work were allotted from the appropriation for explorations in Alaska. As much of the country to be visited north of the Arctic Circle, about the headwaters of the Chandlar and Koyukuk rivers, had never been explored, little or nothing was known about its topographic or geologic character. The purpose of the work, therefore, as set forth in the official letter of instructions, was to make a geologic and topographic reconnaissance of the Koyukuk district, embracing the upper branches of Koyukuk River and contiguous territory, to gather all possible data as to the topography, physiography, geology, and economic resources of the district traversed, and to obtain such other information concerning routes of summer and winter travel and conditions of subsistence as might be of advantage in planning future expeditions.

The time spent in actual field work was eighty days, or about two and two-thirds months, during which the work was extended by instrumental traverse from Fort Yukon, by way of the Chandlar and Koyukuk rivers, to Nulato, a distance of nearly 1,100 miles. Considerable material was collected, and many problems were disclosed which, on account of other office work, could not be worked up during the past winter (1899–1900). The following preliminary statement is therefore submitted, so as to furnish, in a general way, such information as is desired by the practical prospector and miner and other people visiting the region, the preparation of the final report being deferred for later publication.

For courtesies and material assistance in expediting the shipment of supplies and outfits over the Coast Range, the writer would acknowl-

edge his indebtedness to Supt. C. J. Hawkins, of the Skagway, White Pass and Yukon Railway, to members of the Red Line Company, and to the Canadian customs officials at Log Cabin; also to the Canadian Development Company, which, in the journey down the Yukon, extended a helping hand in the through shipment of freight.

For oral information obtained in the field thanks are due to prospectors and miners on the Chandlar and Koyukuk rivers and to Mr. Gordon C. Bettles, a well-informed pioneer in the country and keeper of the post at Bergman, on the Koyukuk. To this post a portion of the party's supplies, shipped from Seattle, was successfully and promptly delivered in good condition, via the all-water route, by the Alaska Commercial Company.

Determinations of the Paleozoic fossils referred to in this report were made by Dr. Geo. H. Girty; those of the Cretaceous, by Dr. T. W. Stanton; while such fossil plant remains as could be collected were examined by Dr. F. H. Knowlton. All of these paleontologists are connected with the United States Geological Survey. The coal analyses and mineral tests were made by the chemical laboratory of the Survey; the assays for gold and silver by E. E. Burlingame & Co., of Denver, Colo.

In conclusion, thanks are due to all the members of the party for a constantly high efficiency of service, indispensable to the success of an expedition in so remote a region, and often rendered under conditions of trial and discomfort.

ITINERARY AND METHODS OF WORK.

The Koyukuk party of 1899, composed of six men, supplies, and outfits embracing three Peterboro canoes, was landed at Skagway June 30. From here, after some delay occasioned by congestion of freight, snow-slides on the mountains, and unfavorable reports concerning the condition of lakes beyond the range, transportation was by rail to White Pass summit, thence to the foot of Summit Lake by horse sleds, thence 3 miles farther by pack animals to Camp C, and from here to Lake Bennett by wagon. After a delay of several days at Bennett on account of low water in the lake, which kept the boats aground, transportation was by steamboat down the Yukon to Fort Yukon. Owing to shallow water and the consequent grounding of the boats at Caribou Crossing and in Marsh Lake several transfers to other vessels were necessary. From the head of Miles Canyon to the foot of White Horse Rapids, a distance of about 3 miles, transportation was by horse tramway. At Dawson another change was necessary to a so-called "down-river" boat. On the upper river the boats were already overcrowded with Nome passengers, but below Dawson the press became very much worse, so that a short night's lodging in


MAP
OF
PORTIONS OF
KOYUKUK AND CHANDLAR RIVERS
WITH GEOLOGIC NOTES
F. C. SCHRADER GEOLOGIST
TOPOGRAPHY BY T. G. GERDINE
1899
Scale 1. 625000
10 0 10 20 30 MILES
Contour interval approximately 500 feet
Intermediate intervals of 100 feet are shown by dotted contours
Datum is mean sea level
Dates refer to camps
Streams which have been traversed
" " " not been traversed
APPROXIMATE TREND OF OLD RIVER VALLEY CONTAINING GOLD-BEARING STREAM GRAVELS
PROBABLY HEAVY-BEDDED LIMESTONE WITH MICA-SCHIST
THE LIMESTONE IS REPORTED TO CARRY GALENA
PROBABLE PALEOZOIC ROCKS, INCLUDING BLACK FLINT AND QUARTZITE, WITH DEVONIAN AND CARBONIFEROUS FAUNA
LACUSTRINE PLEISTOCENE SILTS RESTING ON BLACK GLASSY BASALT AND VOLCANIC TUFFS
IMPURE LIMESTONE AND PORPHYRITIC AMYGDALOIDAL LAVA
PRINCIPALLY IGNEOUS ROCKS
NULATO SANDSTONE AND CONGLOMERATE INTRUDED BY BASALT
PLEISTOCENE SILTS FORMING CLIFFS 200 FEET HIGH
PLEISTOCENE SILTS AND LACUSTRINE
CHANDLAR RIVER
YUKON RIVER
KOYUKUK RIVER
ROMANZOF MTS.
ARCTIC CIRCLE
KOWAK RIVER
NOATAK RIVER
ALLEN RIVER
ALASHUK RIVER
MELOZI RIVER
TOZI RIVER
TANANA R.
FORT COSMOS
Walker Lake
Cone Mt.
Roundabout Mt.
Lookout Mt.
Double Pt. Mt.
Horace Mt.
Table Mt.
Bend Mt.
BEAN RIDGE
RAMPART CITY
FT HAMLIN
FORT YUKON
INDIAN VILLAGE
ST JAMES MISSION
WALKER STATION
WEARE
NULATO
KOYUKUK STATION
NOTALOTEN
CHENTANSITZTAN
ZAKATLATAN
TANAROT
SEAFORTH
SOO CITY
UNION CITY
PEAVEY
BERGMAN
Big Black Riv.
Porcupine River
Birch Creek
Preacher Creek
Crooked Cr.
Beaver Creek
Hess Creek
Ray River
Dall River
Jim Creek
Old Man Creek
Big Bend

one's own blanket on the hurricane deck, on the floor of the cabin, or in the wood pile of the engine room was considered a luxury.

As the astronomic position of Fort Yukon was known, having been determined by Captain Raymond,[1] after verification of the observations by Mr. Gerdine, field work was begun at this point by canoe June 22. From here it was carried 26½ miles down the Yukon to the mouth of Chandlar River; thence 200 miles up the Chandlar to its headwaters, and by portage across the mountains to the headwaters of the Koyukuk, and 700 miles down this river to Nulato, also a point of known astronomic position.[2]

The ascent of Chandlar River was made by towing or "tracking" the canoes up by line, and the use of oars, poles, paddles, or wading, as the varying conditions required. During most of this section of the trip it required hard work to make 4 or 5 miles a day, on account of the swiftness of the current and the frequently impassable condition of the banks for tracking. At Chandlar Rapids (Pl. LXI, *A*) it was found necessary to portage canoes and cargo for about one-eighth of a mile. Between the headwaters of the Chandlar and those of the Koyukuk, a portage (see Pl. LXI, *B*) of 15 miles, a few days' aid was received from a white prospector and a few Chandlar River natives.

From the mouth of Bettles River, on the Koyukuk, the party ascended Dietrich River for a distance of 20 miles. From the mouth of Slate Creek a detachment of the party in charge of Mr. D. C. Witherspoon portaged across to the South Fork of the Koyukuk and carried a compass traverse down that stream to its confluence with Middle Fork, a distance of approximately 140 miles. Later the progress of the party was somewhat expedited by the employment of two prospectors to help carry on the work in descending the Koyukuk below Bergman. The work was finally completed at Nulato September 14, whence the party returned home by way of St. Michael and Unalaska, after visiting the newly discovered Nome gold region on the way.

In the absence of monuments or sight points for triangulation through the Yukon Flats and along the Chandlar and the lowlands of the Koyukuk, the instrumental measurement was carried on by stadia. Through the less flat and the mountainous country it was by triangulation. A stop was made every three or four days to ascend mountains and occupy prominent stations for this work. The journey to these points, sometimes 5 or 6 miles from the river, also afforded opportunity, though rather limited, for topographic and geologic observations and for photography. The astronomic and other principal observations were made by transit, and the topography was done principally by means of the plane table and telescope alidade.

[1] The position of this place is latitude 66° 33′ 47″, longitude 145° 17′ 47″. Report of a reconnoissance of the Yukon River, Alaska Territory, 1869, by Capt. Charles W. Raymond: Ex. Doc. No. 12, Senate, Forty-second Congress, first session.

[2] Loc. cit.

TABLES OF DISTANCES BY RIVER.

Distances by river along the Chandlar from mouth of river on the Yukon to summit of Chandlar River–Robert Creek–Koyukuk portage.

[Surveyed by T. G. Gerdine in 1899 by triangulation and stadia.]

Locality.	Distance from mouth of Chandlar River on the Yukon.	Distance from summit of portage.
	Miles.	*Miles.*
Mouth of Chandlar River	0	197
Native houses, or Fish Camp	7.44	189.66
Camp 11, at edge of flats and mountains	60.04	137.96
Mouth of East Fork of Chandlar River	65.54	131.46
Mouth of Middle Fork	96.74	100.26
West Fork or portage to South Fork of Koyukuk	114.54	82.46
Chandlar River rapids	121.89	75.11
Mouth of Chandlar Lake	129.89	67.11
Camp 23, at head of Chandlar Lake	136.39	60.61
Baby Creek	138.89	58.11
Portage to Middle Fork of Chandlar River	158.49	38.51
Camp 28, at mouth of Portage Creek	193	4
Summit of Robert Creek–Koyukuk portage	197	0

NOTE.—From Camp 28, at mouth of Portage Creek, to forks above it, is 7 miles, or 204 miles from mouth of river.

Distances by river along the Koyukuk from summit of Chandlar River–Robert Creek–Koyukuk portage (latitude 67° 50′, longitude 149°) to the mouth of Koyukuk River on the Yukon.

[Surveyed by T. G. Gerdine by triangulation and stadia in 1899.]

Locality.	Distance from summit of Chandlar River-Robert Creek-Koyukuk portage to mouth of Koyukuk on Yukon.	Distance from mouth of Koyukuk on Yukon to summit of Chandlar River-Robert Creek-Koyukuk portage.
	Miles.	*Miles.*
Summit of Chandlar River–Robert Creek–Koyukuk portage	0	663.87
Sheep Creek	10.50	653.37
Camp 30 and Horace Peak	12	651.87
Head of Robert Creek Canyon	16.50	647.37
Mouth of Phœbe Creek and head of Bettles River	19.75	644.12
Foot of canyon	27	636.87

Distances by river along the Koyukuk from summit of Chandlar River–Robert Creek–Koyukuk portage (latitude 67° 50′, longitude 149°) to the mouth of Koyukuk River on the Yukon—Continued.

Locality.	Distance from summit of Chandlar River-Robert Creek-Koyukuk portage to mouth of Koyukuk on Yukon.	Distance from mouth of Koyukuk on Yukon to summit of Chandlar River-Robert Creek-Koyukuk portage.
	Miles.	*Miles.*
Mary Creek	28.50	635.30
Limestone Creek	30	633.87
Lower Canyon on Bettles River	37.50	626.37
Confluence of Bettles and Dietrich rivers, forming Middle Fork of Koyukuk River	41	622.87
One and One-half Mile Canyon	51	612.87
Nelson Creek	59	604.77
Wiseman Creek	64.10	599.77
Marion Creek	73	590.87
Camp 37, at mouth of Slate Creek	77.25	586.62
Porcupine Creek	80.25	583.62
Camp 38, at mouth of Rose Creek	83.85	580.02
Twelvemile Creek	85.85	578.02
Tramway Bar, at head of canyon	94.25	569.62
Pasco Creek	96.25	567.62
South Creek	104.25	559.62
North Fork of Koyukuk	114.06	549.81
Harriet Creek	117.36	546.51
Creek from south	125.86	538.01
Hokotena River	126.21	537.66
Colored Creek	133.31	530.56
Totsenbetna River	141.13	522.74
Fickett River	154.09	509.78
Twomile Bluff, on left and right	158.48	505.39
Peavey	172.27	491.60
South Fork of Koyukuk	176.27	487.60
Sozhekla River	187.29	476.58
Head of islands	199.56	464.31
Allen River	213.46	450.41
Arctic Circle	219.79	444.08
Bergman [a]	223.29	440.58
Arctic City	227.32	436.55
Oldman Creek	227.44	436.43
Red Mountain	259.82	404.05
Cretaceous fauna in limestone	288.07	375.80

[a] The Arctic Circle is 1½ miles north of Bergman in direct line.

Distances by river along the Koyukuk from summit of Chandlar River–Robert Creek–Koyukuk portage (latitude 67° 50′, longitude 149°) to the mouth of Koyukuk River on the Yukon—Continued.

Locality.	Distance from summit of Chandlar River-Robert Creek-Koyukuk portage to mouth of Koyukuk on Yukon.	Distance from summit of Koyukuk on Yukon to summit of Chandlar River-Robert Creek-Koyukuk portage.
	Miles.	*Miles.*
Head of islands, Waite Island	294.44	369.43
Camp 50, Alashuk River	297.07	366.80
Cretaceous fauna in limestone	305.07	358.80
Cretaceous fauna, bluff on right bank	312.00	351.87
Creek from southeast	325.97	337.90
Batza River	341.76	322.11
Hogatza River	369.14	294.73
Point Winthrop, south rapids, head of island	386.24	277.63
Dakli River	419.67	244.20
End of Cut-off and Treats islands	440.47	223.40
Huslia River	462.22	201.65
Native village on left	469.08	194.79
Stream from west; bluffs begin on right	484.66	179.21
Dulbi River	507.99	155.88
Dagitli River and native village	529.95	133.92
Kateel (?) River	587.49	76.38
Bitzla River [a]	604.27	59.60
Gisasa River	611.03	52.84
Mouth of Koyukuk River on Yukon	663.87	0

Distances along Dietrich River from its mouth and from mouth of Koyukuk.

Locality.	Distance from confluence of Dietrich and Bettles rivers, forming South Fork of Koyukuk, up Dietrich River to David Creek.	Distance by river from mouth of Koyukuk River on Yukon to points on Dietrich River above confluence of Dietrich and Bettles rivers, forming South Fork of Koyukuk.
	Miles.	*Miles.*
Confluence of Dietrich and Bettles rivers, forming South Fork of Koyukuk	0	622.87
Gibson Creek	17	639.87
Fault Mountain	20	642.87
David Creek	23.50	646.37

[a] Bitzlatoilocta on Lieutenant Allen's map (1885).

NOTE.—From mouth of Koyukuk River on Yukon down the Yukon to Koyukuk Station is 5.45 miles, and from mouth of Koyukuk to Nulato is 22.20 miles.

Approximate distances by river along South Fork of Koyukuk.

Locality.	Distance from confluence of Middle and South forks of Koyukuk.	Distance from mouth of Koyukuk, on Yukon.
	Miles.	*Miles.*
Confluence of South and Middle forks of Koyukuk	0	487.60
Union City	1	488.60
Fish Creek	31	518.60
Seaforth	45	532.60
Soo City	50	537.60
Jimtown and Jim Creek	65	552.60
Cripple Creek	94	581.60
Mosquito Fork	107	594.60
Hungarian Creek	115	602.60
Summit of portage between South Fork of Koyukuk and West Fork of Chandlar	145	632.60

Approximate distances from mouth of Slate Creek on Middle Fork of Koyukuk to mouth of Hungarian Creek on South Fork of Koyukuk.

Locality.	Mouth of Slate Creek.	Mouth of Hungarian Creek.
	Miles.	*Miles.*
Mouth of Slate Creek on Middle Fork of Koyukuk	0	20
Mouth of Myrtle Creek (up Slate Creek)	8	12
Summit of portage between Slate Creek and Hungarian Creek	13	7
Mouth of Hungarian Cr. on South Fork of Koyukuk	20	0

ROUTES AND TRAILS.

The Chandlar and Koyukuk River regions form no exception to the rule of Alaskan travel. The almost invariable means is by boat or canoe along the waterways in summer, and overland by trail with the use of dog sleds in winter. The term "trail," as used in Alaska, refers more particularly to the passable condition of the country than to any foot-beaten path or well-worn line of travel. This is especially true of the Chandlar and Koyukuk regions.

CHANDLAR RIVER BASIN.

Fort Yukon to Indian village in flats.—A native trail is known to lead from Fish Camp, on the Yukon, to the Indian village in the flats on the Chandlar River, about 8 miles above its mouth. This same point is reached by overland trail in winter from Fort Yukon across the Porcupine River.

Fort Yukon to East Fork of Chandlar River.—From Fish Camp, above mentioned, the route continues up the Chandlar River to near the edge of the flats, thence more directly northwestward through the low mountains to East Fork village, a distance of about 80 miles from Fort Yukon. In winter the East Fork natives, it is reported, sometimes travel eastward to the Porcupine and then descend that river to Fort Yukon.

Lake Creek, Grave Creek, and Middle Fork trail.—This is a short route of about 20 miles between the main Chandlar River above the lake and the headwaters of Middle Fork, by way of Lake Creek and Grave Creek. So far as known, it is used only by the natives in their hunting and fishing trips.

Granite Creek and Swift River trail.—On the Chandlar River below West Fork the country is reported to be easily passable up Granite Creek and by way of a low portage down "Swift River," and possibly the lower part of the Dall to the Yukon near Fort Hamlin. The Chandlar River natives are reported to use this route occasionally in going to Fort Hamlin for trading purposes.

Geroe Creek and Sheep Creek trail.—This merely denotes that the country is passable with light pack over the mountainous divide between the heads of these two creeks, the latter of which drains westward, finally reaching the Koyukuk. The rise seems to be considerable. The distance is about 15 miles.

Baby Creek and Sheep Creek trail.—This leads from the region about the head of Chandlar Lake by way of Baby Creek to the head of Sheep Creek, above mentioned. The divide, however, seems to be high and rugged. The route is probably but little used, even by the natives, and then only in their hunting trips. The length of the trail, from the mouth of Baby Creek to the mouth of Sheep Creek, is about 20 miles.

Robert Creek portage.—This is the route used by the party during the past summer (1899) in portaging from practically the head of navigation on the Chandlar River to that of Robert Creek, on the Koyukuk River, a distance of 15 to 20 miles. Considering the ruggedness of the surrounding country, the portage is good. On the Chandlar River side it follows along the slope of a prominent sway in the divide, shown in Pl. LXI, *B*. At the bottom of the sway a steep-walled canyon has been intrenched to a depth of 100 feet or more. The summit of the portage has an elevation of about 3,000 feet, the rise being about 1,000 feet above the Chandlar River.

Chandlar River–Dietrich River trail.—It is also possible that by ascending Chandlar River above the sixty-eighth parallel to very near its headwaters, and going light, a portage could be made across to the

A. CHANDLAR RAPIDS, 128 MILES ABOVE MOUTH OF RIVER, FROM WEST BANK, LOOKING N. 45° E.

B. VIEW UP PORTAGE CREEK, 194 MILES ABOVE MOUTH OF CHANDLAR RIVER, LOOKING S. 13° W.

Dietrich River. The natives, however, denounce this region as very rough.

West Fork of Chandlar to South Fork of Koyukuk.—From reports of a few prospectors who have crossed this portage it is known to be easy and the divide low (see map, Pl. LX), so that during the wet season or at high water the distance of actual portage between points of canoe navigation is reduced to 10 miles or less. The creek through which the western side drains into the South Fork of the Koyukuk is said to be called Eldorado. During the past season (1899) many of the miners on the Upper Koyukuk were contemplating sledding their supplies from Fort Yukon up the Chandlar River and into the Koyukuk by this route. It traverses little if any rough country, but the distance is about 150 miles from Fort Yukon.

Chandlar River and Rampart route.—This name is here given to the route followed southward by some of the Chandlar natives, along the divide between the Koyukuk and the Yukon to Fort Hamlin, at the head of the Lower Ramparts, for trading purposes.

KOYUKUK RIVER BASIN.

Koyukuk River route.—The easiest and most practicable way of entering the Koyukuk region in summer, especially with freight, is to ascend the Koyukuk by flat-bottomed steamboat. About 1,500 people entered the country in this way during the season of 1898. Bergman (see Pl. LXII, *A*), 440 miles above the mouth of the river, is reached by steamboat throughout the open season. This may, in a general way, be considered the head of steamboat navigation on the Koyukuk. Above Bergman certain sections of the river contain bars and shallows which render navigation more or less difficult except at high water. During high water, however, steamboats ascended to above Tramway Bar, 100 miles or more above Bergman, and also for considerable distances up the Allen and other large northwest tributaries during the summers of 1898 and 1899.

Dall River trail.—This route leaves the Yukon River at the head of the Lower Ramparts, near Fort Hamlin, leads northward up the Dall River, then northwestward over the divide, and descends Fish Creek to the South Fork of the Koyukuk near the Arctic Circle, a distance by trail of about 100 miles from the Yukon. Up to the present time this has apparently been the principal overland route used by prospectors in entering the Koyukuk. By continuing farther up the Dall some have descended Jim Creek, thus reaching the South Fork of the Koyukuk at Jimtown. It is reported to be also feasible to cross from the Dall to Oldman Creek and down this stream to the Koyukuk below Bergman. This latter, however, seems questionable, as the portage must be very long.

Rampart and Hoyn Creek trail.—This route is known by report only, but it is said to be easier and shorter than the Dall River trail. It is reported to ascend Hoyn Creek, a tributary of the Yukon, near Rampart, cross a low pass in the mountains, and thence a wide, level stretch of country, a total distance of about 90 miles, and to come out on the Koyukuk about 80 miles above Bergman, probably at Fish Creek, the same as the Dall River trail.

Tozi[1] *trail.*—This route leaves the Yukon about 6 miles below the mouth of the Tozi River and leads nearly northward, mostly along the low divide between the Tozi and Melozi rivers, to near the head of Oldman Creek, which it descends to the Koyukuk, near Bergman. This is the route followed by Lieutenant Allen in 1885. Its length from the Yukon to the Koyukuk is about 90 miles. The Tozi may also be ascended by canoe nearly to its headwaters, and the route continued thence by portage to Oldman Creek, as above.

To Fort Yukon by way of Chandlar River.—This route has already been noted under the Chandlar River region trails. Leaving the South Fork of the Koyukuk by way of Eldorado Creek and crossing the low divide, it descends the West Fork of Chandlar River, thence down the river as directly as practicable and across the Yukon Flats to Fort Yukon, about 100 miles distant from the Koyukuk.

Middle Fork route to Chandlar River.—This route, as explained on page 454, is up Bettles River and Robert Creek, and thence by a 15-mile portage to the headwaters of the Chandlar, about 50 miles by river above Chandlar Lake. The portage is fair, but the current in Bettles River and Robert Creek is too swift and the bed too bowldery to permit a safe or easy ascent with a loaded canoe or boat.

Allen[1] *River to Kowak River.*—A route is known to exist by way of Allen to the headwaters of the Kowak, but as it seems to be used only in winter, the length of the portage is not known. Some Kowak River prospectors sledded across it to the Koyukuk in March, 1899. The Allen is a large stream and can be ascended nearly 40 miles by a light-draft, flat-bottomed steamboat.

The country is also said to be portageable between the headwaters of the Alashuk and the Kowak rivers, and also between the Dagitli and the Kowak. This latter portage was made by Captain Stone in 1885.

Nulato trail.—This is a "cut-off" or short overland trail of about 25 miles from the west bend of the Koyukuk about 7 miles above the mouth of the river to Nulato. In winter a sledge trail leading directly north from Nulato up the Koyukuk is sometimes used.

Koyukuk and Arctic coast trail.—According to reports which seem to be authentic, the Malamut natives of the Arctic coast have been known to visit the head of the Koyukuk Basin. They are supposed

[1] Formerly "Tozikakat," "Allenkakat," etc. For Alaskan names see pp. 487–509 of this report.

A. BERGMAN AND EDGE OF PLATEAU FORMED OF YOUNG ROCK SERIES, LOOKING NORTH-NORTHWEST ACROSS KOYUKUK RIVER.

B. PEAVEY, LOOKING EAST.

to have found passage through the mountains at the head of Dietrich River and to have descended this stream, but of this there is no certainty. The country in this region, however, is too rugged to be of promise for a practicable route of any sort, as shown in Pl. LXV, *A*, and on the map (Pl. LX).

POPULATION.

CHANDLAR RIVER.

Natives.—By estimate the Chandlar River natives number about 50 in all. A small settlement, of which the nucleus is a couple of cabins, is found in the flats about 7 miles above the mouth of the river. Most of the natives, however, live beyond the flats, in the mountainous part of the country. Their principal village is on East Fork, remote from the influence of the Yukon travel and traffic. For subsistence they depend principally upon game and fish. A few months during the coldest part of the winter are spent in log cabins or winter tents, and the remainder of the year in roaming about, wherever game or fish may furnish food. In winter the skins collected during the year are exchanged for tea, tobacco, clothing, and other necessities, at Fort Yukon and Fort Hamlin. Though the natives subsist almost exclusively upon game and fish, with some berries during summer, they have a keen relish for white man's food. They are shiftless and improvident, and their destitution and suffering are occasionally great. They are, however, comparatively intelligent. Some who have attended mission schools at Fort Hamlin have learned to read and write.

Whites.—Four white men, all prospectors, were the only whites in the region in 1899. Two of these were connected with the natives by marriage.

KOYUKUK RIVER.

Natives.—The Koyukuk natives, also known as Koyukons, number fewer than 200, so far as can be judged. The Eleventh Census places the number at 174. Their habits of life are much the same as those of the Chandlar natives. They have no cabins on the extreme upper waters much above the sixty-seventh parallel. At present the population, so far as observed, is scattered along the river in small villages containing but a few families and cabins, generally near the mouth of some tributary. There are also some on the Allen and other tributaries. So far as learned, there are no missions nearer than Nulato and Fort Hamlin.

Nulato seems to have been their chief trading post before the location of the post on the upper river. At these upper posts the natives are frequently employed by the whites, and some are also employed by the river steamboats. They are generally peaceful. Types of the Koyukuk natives are shown in Pl. LXIII, *A*.

Whites.—Until two years ago the white population of the Koyukuk was small, though there had been a post on the site of Arctic City for some time, and the country was visited by a few prospectors early in the nineties or before. During the Klondike rush of 1898 there was an influx of nearly 1,500 people, mainly would-be prospectors or gold seekers, embracing men of nearly every profession and calling, organized in parties of from 20 to 80. They ascended the river in flat-bottomed steamboats to various points, where they spent the winter. One of the largest white settlements during 1898–99 was at the present site of Arctic City, almost on the Arctic Circle, where a town of 500 or 600 people was formed, which was lighted by electricity throughout the long, dark winter. Many also wintered at Bergman, Union City, Peavey, and other points. On the opening of navigation the following spring (1899) most of this population, having gained some experience and seeing little gold in sight, descended the river by boat and left the country, some going to Cape Nome and many returning to the States. In August, 1899, there were estimated to be about 100 white men in the country, mainly miners and prospectors, about the new discoveries on Slate Creek and neighboring streams. There were also some on the South Fork and others at Bergman, Arctic City, and Peavey (see LXII, *B*). They were prepared to remain in the country during the winter of 1899.

The principal supply post is at Bergman (Pl. LXII, *A*), near the Arctic Circle, at the head of steamboat navigation on the Koyukuk. The post is kept by Pickarts, Bettles & Pickarts, to whom supplies are delivered each season by the Alaska Commercial Company. During the past season there was also a liberal supply of canned goods stored at Peavey, and preparations were being made by Pickarts, Bettles & Pickarts to open a new post on Slate Creek, in the newly discovered diggings. Much freight was en route for this purpose. According to reports, many people went into the region from the various camps along the Yukon during the months of February and March, 1900.

CLIMATE.

The climate on the Chandlar River is similar to that on the Upper Yukon, but is not so bright nor usually so warm in summer. The amount of precipitation is small. During the summer there is considerable cloudiness, with some foggy, showery, stormy, or windy days, but no great amount of rainfall. The average temperature, as taken on the trip, during the month of July, 1899, was approximately 55° F., with a maximum of 73°; for the month of August the

A. GROUP OF KOYUKUK NATIVES AT NATIVE VILLAGE ON LEFT BANK OF KOYUKUK RIVER, 195 MILES ABOVE ITS MOUTH.

B. MOUNTAINS OF LIMESTONE AND MICA-SCHIST, NORTH SIDE OF ROBERT CREEK, FROM HORACE PEAK (6,000 FEET), ON HEADWATERS OF KOYUKUK RIVER, 625 MILES ABOVE ITS MOUTH, LOOKING N. 15° E.

average was about 58°, with a maximum of 74°. The winter season is also much the same as at Fort Yukon, but it is possibly somewhat colder, as it is farther north. Prospectors report a temperature of from 60° to 70° below zero in the month of February. On cutting holes through the ice in Chandlar Lake, in March, to procure water and fish, the ice was found to be 6½ feet thick.

In the upper part of the Koyukuk Basin the climate seems to be about the same as on the Chandlar River, but farther down it is moister, partaking more of the nature of the climate about Nulato and the Lower Yukon, with an increased amount of precipitation. According to the records of Mr. W. H. Windrick, keeper of the post at Peavey, ice was running on the river at Peavey as early as September 20, 1898, and about a month later the river was frozen over and remained so until spring. February is reported to be the coldest month, during which the average temperature was 55° below zero, and the minimum 72° below. At Jimtown, 30 miles north of Peavey, on the South Fork, a minimum of 80° below zero is reported to have been recorded by spirit thermometer. At Peavey the ice on the river broke on the 19th of May, 1899, and the water reached its highest mark for that season, about 6 feet above normal, early in July.

ANIMAL LIFE.

The following list of animals, based entirely on observations of the party and on authentic reports of prospectors, though reliable as far as it goes, is probably incomplete.

Quadrupeds.—Moose, caribou, mountain sheep, bear, wolf, mink, squirrel, and porcupine are found on the Chandlar River. They are nearly all confined to the mountainous part of the region. To the natives moose, caribou, mountain sheep, and bear are the principal large game. All are very important for food and clothing. Moose are not plentiful, but some are taken each year by the natives. Caribou are seen in the region only occasionally during the migrating season, usually in herds, but are not known to remain long.

During the grazing season the sheep range in the mountains along the upper waters of both the Chandlar and Koyukuk rivers, but in winter they find refuge in the more sheltered lowlands of the Koyukuk.

The only species of bear learned of is the black bear, an animal of medium size. The large brown bear may, however, be present.

The wolves seen by the party were large-sized gray wolves, one of which was killed. These animals may be seen both in the flats and in the mountains.

The principal squirrel is a large brown-striped ground squirrel. This small animal is very abundant. Its home is in the lower reaches of the valleys, where it burrows extensively. It is usually caught in steel traps, like a rat. Its flesh is much used by the natives for food and its pelts are made into clothing.

Fish.—The principal fish is salmon. Both king salmon and dog salmon are reported to ascend the East Fork of the Chandlar, where they are caught and dried in a small way by the natives for food. They do not, however, reach the lake or the main river, probably owing to the swift rapids, which they apparently can not ascend. A rather large-sized fish known as white-fish is also much used. Pike, pickerel, and two other species of fish are reported to occur in the lake. In the small lakes away from the river fine speckled trout and several other kinds of fish are said to be found.

Birds.—The principal indigenous birds are the grouse and ptarmigan. In summer geese and ducks are found along the streams and lakes. The gull is common, and hawks, buzzards, and a crow or black raven were also noted. The region is also visited by many species of the smaller migratory birds of the temperate climate during the summer months.

Insects.—The principal and most annoying insects noted were the mosquito, throughout the region, and *Pediculus vestimenti*, on the natives. The mosquitoes, however, were not so numerous as in most other years. A few bees and some medium-sized butterflies were noted about the wild flowers in the valleys, and a few species of beetles are common.

VEGETATION.

A hasty collection of the flora of the region was made by the writer along the route, of which a list and fuller description will be published later.

The principal timber on both the Koyukuk and Chandlar rivers is spruce. Different species of poplar, with birch, alder, and willow, are also present. In the flats along the Chandlar River the stand of spruce is much the same as elsewhere in the Yukon Flats. It varies from dense to thin, with occasionally more or less barren areas. The trees, which seem in general to be young, probably average less than a foot in diameter at the base. In certain localities, however, some exceed 2 feet and attain a height of nearly 100 feet. In the mountainous part of the valley, below West Fork, the timber line rises to an elevation of about 2,600 feet. One of the best timber areas, covering probably one hundred or more square miles, occurs in the lowland southwest of the Big Bend below West Fork. Here the timber is nearly all spruce.

On the granitic belt of rocks along the south side of the valley, from a point opposite East Fork nearly to Granite Creek, the timber is represented principally by a fair stand of young birch. Above Chandlar Lake the timber line usually rises but a few hundred feet above the edge of the valley flat, where the timber already becomes quite dwarfed. In the more open tributary gulches, however, the timber may ascend considerably higher, but usually ceases at a height of 600 or 700 feet above Chandlar River Valley, nor does any occur much above the head forks, at about 7 or 8 miles above Robert Creek portage. On the Koyukuk side of the portage the timber line is again found at about the same elevation. Timber is first seen on Robert Creek, about 8 miles from the summit of the portage, or about 11 miles from timber line on the Chandlar River side. Toward the head of Dietrich River, on the Koyukuk, the timber seems to vanish much the same as on the Chandlar River.

From the confluence of the Dietrich and Bettles rivers the timber, which occurs more or less all the way down the Koyukuk, is principally spruce and cottonwood. On the lower 5 or 6 miles of Slate Creek many of the trees approach 2 feet in diameter and are 80 or 100 feet in height, while some may exceed this.

Heavy timber is also reported to occur on the Allen and other large northwest tributaries. A sawmill is operated at Bergman and one at Union City.

Considerable birch also occurs on the Koyukuk. Of that observed none was larger than 5 or 6 inches in diameter. The alder and willow, both on the Koyukuk and Chandlar rivers, though often of dense and rank growth, do not attain to real tree or timber size.

Roses and other wild flowers grow in some localities in more or less profusion. Grass, usually in limited amount, occurs in small patches along the margins of the streams and elsewhere in the valley flats. Some also grows on the mountains up to a height of 4,000 or more feet, where it forms the grazing ranges of the mountain sheep.

The most universal type of vegetation throughout both regions is the moss. Here, as elsewhere in Alaska, the surface is nearly everywhere clothed with it. It extends from the flats into the mountains to an elevation of nearly 5,000 feet.

Of the edible vegetable products growing wild the principal are the blueberry, red currant, and salmon berry. The blueberry is nearly everywhere abundant, and is extensively used. The currant is not so common, though in some localities it is quite abundant. Cranberries and moss berries also abound.

At Bergman ordinary garden vegetables were grown by Mr. Bettles with fair success, while in the mission gardens at Nulato, conducted in cooperation with the natives, the more hardy vegetables are grown on a somewhat large scale.

GEOGRAPHY.

The country under consideration lies in the north-central part of Alaska, between the Yukon River on the south and the Arctic Ocean on the north, and our line of reconnaissance extended for a distance of more than 1,000 miles. It can not, therefore, be considered as a compact area, but may be best described in two parts. The first part extends from Fort Yukon, at the great bend or elbow of the Yukon River and on the Arctic Circle, in approximately 66½° north latitude and 145° west longitude, for about 170 miles in a straight line, or more than 200 miles by river, northwest into the highland or mountainous country, in approximately 68° north latitude and 150° west longitude. The southeastern 70 or more miles of the belt lies in the well-known Yukon Flats, while the remaining northwestern portion lies in the highland belt and rugged mountains, where much of the country had never before been explored.

The second part of the route, which forms practically a right angle with the first, traverses a considerable belt of country, extending from the mountains in the region of the sixty-eighth parallel about 330 miles in a straight line, or nearly 700 miles by river, southwestward to Nulato, below the mouth of the Koyukuk River, on the Yukon, in approximately 64⅝° north latitude and 158° west longitude. It is about 170 miles in a straight line from St. Michael. The northeastern 80 miles lies in the rugged region on the south slope of the Rocky Mountains, while the remaining 250 miles are in the low, rolling, and somewhat flat country of the Koyukuk Valley.

At the most northern point attained the two parts of the route form, as stated, a right angle and the two sides of a right-angled triangle. Of this the eastern, or Chandlar, part of the route from Fort Yukon to the sixty-eighth parallel forms the shorter leg, and the western, or Koyukuk, the longer leg, while the Yukon River from Fort Yukon to Nulato, a distance of about 400 miles, forms the hypotenuse. Portions of the country lying within this large triangle between the Yukon and the Koyukuk have been visited by prospectors and explorers, but much yet remains to be explored, especially from a geologic and topographic point of view. The same is more forcibly true of the rugged region north of the route traversed, between the sixty-eighth parallel and the Arctic Ocean, and especially of the large area of northwestern Alaska between the Koyukuk and the Arctic coast on the northwest.

TOPOGRAPHY AND DRAINAGE.

YUKON BASIN AND PLATEAU.

Since the area considered lies within the drainage basin of the Yukon, it will be well to note, though very briefly, the aspect of this great natural feature of the earth's surface in Alaska.

The Yukon River heads in British Columbia and the Northwest Territory. Omitting its great northward bend or elbow at Fort Yukon, its trend is, roughly considered, nearly westward through Alaska to Bering Sea, approximately along the sixty-third parallel. In area this drainage basin ranks among the largest river systems of the world, covering some 440,000 square miles. It consists, for the most part, of an elevated and more or less deeply dissected highland, to which has been applied the name Yukon Plateau. It is virtually an extensive northwestward expansion of the British Columbia Plateau, which gradually widens as the mountains diverge northward and finally embrace the Yukon Plateau. The general elevation of this plateau is about 5,000 feet, but it descends toward the northwest and inward toward the axis of the basin.

The mountains which skirt the plateau on the south and rise high above it are the St. Elias and other coast ranges, and farther north the Alaskan Mountains, while those which form its boundary line on the east and northeast are the Rocky Mountains, these being the northward continuation of the Rocky Mountains of the United States. In their extension northward through the Northwest Territory near to the Arctic coast they continue to form the Continental Divide, and they here form the watershed which separates the drainage flowing eastward into the Mackenzie from that flowing westward into the Yukon Basin. Near the Arctic Ocean the Rocky Mountains spread westward, embracing the Davidson Range and forming the divide between the Arctic Ocean on the north and the Yukon Basin on the south. They are reported to soon diminish in height and to die out at about the one hundred and forty-first meridian. Here, however, the elevation is still from 5,000 to 7,000 feet, and, judging from observations during the past season, the mountains may be continued westward at about this elevation in a rugged highland belt, some 50 or more miles in width, to the one hundred and fifty-first meridian, beyond which they probably diminish more or less rapidly in elevation.

In looking northward from the top of the mountains at Chandlar Lake, the more distant and highest of these mountains seen between the one hundred and fifty-first and one hundred and forty-ninth meridians have the appearance of being fronted by several successively lower subranges or narrow belts of dissected country; but in general a distant view from the top of the mountains across a wide stretch of country gives the aspect of a deeply dissected former plateau, the peaks and dominant crests having a general level (see Pl. LXIV, *A*). To a part of these mountains, between the one hundred and forty-first and one hundred and forty-fourth parallels, apparently overlooking the tundra belt which skirts the Arctic Ocean, the names Franklin and Romanoff mountains have been given.

On the south, in the region visited, these mountains descend somewhat rapidly from 5,000 feet to the edge of the Yukon Plateau, about

3,000 feet in elevation, crossing the Chandlar and the Koyukuk rivers a little north of the sixty-seventh parallel, the former above West Fork and the latter in the region of Slate Creek. From Slate Creek the edge seems to continue, with some decrease in height, northwestward across the upper waters of the several large tributaries of the Koyukuk, all of which seem to head in the mountains beyond the edge of the plateau.

From the intervening region an extension of the Yukon Plateau to the south, between the Yukon and Koyukuk rivers, forms the Yukon Hills, which are reported to attain a height of from 1,000 to 2,500 feet between the Koyukuk and Melozi rivers. As seen at a distance from the Koyukuk side, these hills give the impression of a comparatively even crest line or plateau-like top, having a somewhat great northeastward and southwestward extension, with a more or less gentle slope southward. Throughout most of the Koyukuk Valley, as will be shown later, erosion has carried the surface of the plateau to a much lower level, 1,200 to 1,500 feet being probably an approximate average elevation. Exceptions, however, occur, where detached groups of mountains, as the Batza, near the sixty-sixth parallel, rise to a height of nearly 4,000 feet.

CHANDLAR RIVER BASIN.

Course of the river.—The Chandlar River Basin, as shown on the map, may be said to head in the mountains in approximately 68° to 69° north latitude and 149° to 150° west longitude. From here its general trend is southeastward for 150 miles in a straight line to where the river flows into the Yukon. The distance along the valley, however, is much greater, by reason of heavy bends, and will considerably exceed 200 miles. The most pronounced of these bends, each of which forms about a right angle, are at Bend Mountain and Fish Creek, in the upper part of the valley, and below West Fork.

The topography of the basin is best considered in three sections, all more or less distinct. These are the mountainous section, the Yukon Plateau section, and the Yukon Flats section.

Mountainous section.—The first or mountainous section, extending from the head nearly to West Fork, may be characterized for the most part as a narrow, canyon-like valley whose floor is from 1 to 2 miles in width, with rugged mountains on both sides rising sometimes abruptly to a height of nearly 5,000 feet, or nearly 3,000 feet above the floor of the valley to the general level of the land mass of the region. The rocks composing these mountains are chiefly metamorphosed sedimentaries, quartzite-schists, mica-schists, and limestones. The tributaries of this section, which are nearly all of the short, gulch-like order, do not extend more than 10 or 12 miles back from the river on either side, so that the average width of the valley in this section nowhere greatly exceeds 25 miles.

A. MOUNTAINS OF LIMESTONE AND MICA-SCHIST, NORTH SIDE OF ROBERT CREEK FROM HORACE PEAK (6,000 FEET), ON HEADWATERS OF KOYUKUK RIVER, 652 MILES ABOVE ITS MOUTH, LOOKING S 65° W.

B. VIEW UP CHANDLAR RIVER AND VALLEY FROM EDGE OF FLATS, 60 MILES ABOVE MOUTH, LOOKING N. 48° E.

The regions about the heads of both East and Middle forks also lie in the mountainous section of the basin, but both these tributaries after leaving it flow southward through the Yukon Plateau section for some distance before joining the main river. In the upper reaches of this mountainous section, near the sixty-eighth parallel and from here northward, the valley materially widens, and the river flows in sharp V-shaped, secondary canyons, cut to a depth of 100 feet or more in an older valley floor, which apparently owes its origin to base-leveling at a time when the region stood at a much lower level than now. For 30 or more miles above Chandlar Lake considerable silting has taken place in the valley in comparatively recent times, probably due in part to damming by local glacial deposits about the foot of the lake. In this mountainous section, about 8 miles below the foot of the lake, occur also the Chandlar Rapids (Pl. LXI,*A*), where the river crosses a low east-west anticline which probably marks at least one of the axial lines of uplift which, farther south, near West Fork and elsewhere, gave rise to the difference of level that marks off the mountainous belt from the Yukon Plateau section.

Yukon Plateau section.—In this section the basin extends from the edge of the mountains near West Fork through the Yukon Plateau to the edge of the Yukon Flats, a distance in a straight line of about 60 miles. Its trend is nearly eastward. The canyon-like valley of the mountain section has been left behind, and both the basin and the valley are very much widened and receive tributary valleys of considerable size from the north and from the west. The principal are those of East and Middle forks from the north.

At the big bend below West Fork an apparently old valley of considerable width and length comes in from the southwest. It is reported to head up against the head of a stream known by prospectors as Swift River, which drains in the opposite or southerly direction and must accordingly flow into Dall River or into the Yukon above the Dall.

The general elevation of the land mass, consisting of low mountains dissected out of the Yukon Plateau on either side of the river, is about 3,000 feet. The topography is more or less reduced and rounded. The plateau in general slopes southeastward. The rocks comprising it are granite, quartz-schist, mica-schist, slate, basalt, and probably some diabase. The surface slopes rather rapidly southeastward to where the edge of the plateau meets the Yukon Flats (Pl. LXIV,*B*), to which the descent is by one or more terraces. The rise from the valley to the plateau is usually gradual. This section of the valley contains a more or less continuous mantle of till or glacial drift, often represented by terraces or low bluffs 100 feet or more in height along the river.

Yukon Flats section.—This section includes that part of the basin lying in the Yukon Flats between the edge of the Yukon Plateau and the mouth of the Chandlar River, a distance of about 50 miles in a straight line. Its lateral limits are indefinite, as it is not distinguishable from the Yukon Flats, and but few tributaries are received, all of which are very short and sluggish. These Yukon Flats are a part of the Pleistocene lake floor, outlined by Spurr[1] in his map of the Yukon gold belt. The surface of the deposit has the appearance of a dead level. The rise along the Chandlar River from its mouth at the Yukon to the edge of the Yukon Flats, however, is about 300 feet, with a current in the upper part very swift.

CHANDLAR RIVER.

The Chandlar River is about 250 miles long. It may be ascended about 200 miles by canoe, to some distance above Robert Creek portage, where the gradient becomes torrential. A short portage of about one-eighth of a mile, however, is necessary at the Chandlar Rapids, about 8 miles below the lake (see Pl. LXI), where the river, in crossing a rugged belt of bed-rock mica-schist, produces a rough stretch of water much less navigable than the White Horse Rapids below Miles Canyon on the Lewes River. Between Robert Creek portage and the head of Chandlar Lake, where the floor of the valley has been much silted up, the river in large part has a very winding course, and for the last 20 or 30 miles above the lake it meanders sluggishly through the old flood plain of silts and gravels, and can be ascended by rowing or paddling in canoes.

Through the lake the current is by estimate about one-half mile per hour. The lake is about 10 miles long and 2 miles or more in width. It is probably not deep, but is navigable for steamboats of considerable size. The basin containing the lake seems to owe its existence more to the damming up of the valley at the foot than to any configuration of the bed rock.

From the foot of the lake to the rapids, a distance of about 8 miles, the river is comparatively smooth. The rapids extend for about one-fourth of a mile, in which the fall is 10 feet or more, principally at the lower end, where a portage of one-eighth of a mile, as indicated, is necessary.

From the rapids to the great bend below West Fork the current is swift, with some riffles difficult to ascend with canoe. Almost the same is true throughout the Yukon Plateau section of the river and for about the upper half of its length through the Yukon Flats. In the flats, however, the riffles are composed of fine gravel, and the bed is not beset with large bowlders, as is often the case in the plateau section of the river.

Almost throughout the flats the stream is commonly broken up by islands or bars into several or more channels. Finally, at its mouth, so

[1] Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, p. 253.

A. MOUNTAINOUS TOPOGRAPHY IN LIMESTONE, FROM FAULT MOUNTAIN (5,400 FEET), LOOKING S. 45° E.

B. VIEW OF MICA-SCHIST MOUNTAINS, LOOKING N. 55° W. FROM FAULT MOUNTAIN, WEST BANK OF DIETRICH RIVER.

far as known, the river enters the Yukon by means of several diverging channels through a wide delta of silts and alluvium. During high water Chandlar River could probably be ascended with a flat-bottomed steamboat for 20 or 30 miles, but at ordinary stage for not more than 6 or 7 miles, if at all, on account of the riffles soon encountered.

Some idea of the volume of the river may be gained from the statement that for the lower 10 or 12 miles above the head of the delta, at places where the stream was apparently gathered into a single channel, it was found to average about 300 feet in width and about 6 feet in depth, and to have a velocity of about 4½ or 5 miles an hour. Nearly all cross sections in this region revealed places where the bottom could not be reached with a 13-foot pole.

The two principal tributaries received by the Chandlar River are East Fork and Middle Fork (see Pl. LX). They are of about equal size, swift, and loaded with sediment. Their combined contribution approximates in volume that of the main river above Middle Fork. West Fork is also a stream of considerable size and enters the river at a steep gradient.

KOYUKUK RIVER BASIN.

The Koyukuk drains the northwestern part of the Yukon Basin. It is one of the largest tributaries of the Yukon, which it enters from the north about 450 miles above its mouth. It has a very large drainage basin, which, as already noted, heads to the west of the Chandlar Basin, in the Rocky Mountains, in the northeastern part of Alaska, in approximately 69° north latitude and 150° west longitude. From that point its axis trends southwestward through a distance of more than 300 miles toward the head of Norton Sound to the Yukon River near Nulato. The area drained is probably about 32,000 square miles. Near its upper part it has a width of about 150 miles.

The parallelism of the basin with the adjacent section of the Yukon, extending from Fort Yukon to the mouth of the Koyukuk, is very pronounced, as may be seen on any approximately reliable map.

On the northwest the basin is separated by a rather low and narrow divide from the drainage of the Colville, Noatak, Kowak, and other rivers, which drain northward into the Arctic Ocean and westward into Kotzebue and Norton sounds.

Like the basin of the Chandlar River, already described, the Koyukuk Basin, of which the Middle Fork is a good example, also in part lies in the rugged, mountainous belt (Pl. LXV, *A*) separating the Yukon drainage from that of the Arctic Ocean on the north. This mountainous section of the basin consists mainly in a canyon-like valley but a mile or two in width, into which open similar though smaller lateral canyons and gulches (Pl. LXV, *B*). In the region between Slate Creek and Tramway Bar the mountains begin to give way, and from here to the Yukon the basin lies in the Yukon Plateau, whose general level is but 1,500 or 2,000 feet above the floor of the valley. The valley often attains a width of several miles, and not rarely for sections of considerable extent contains areas of flats (Pl. LXVI, *A*) resembling the Yukon Flats. The flats in the Koyukuk Valley, however, are not known to now have any direct geographic connection with the Yukon Flats or the basin of Lake Yukon, unless it be by way of the valley along the Yukon River. The Koyukuk Flats are, however; Pleistocene, and are contemporaneous with the Yukon Flats, but seem to have been deposited in water cut off from the lake of the Yukon Flats and in bodies of water or lakelets more or less disconnected. This can be determined only by further investigation.

In the upper, northwestern, part of the Koyukuk Basin the plateau is deeply marked by four or five tributary valleys of large size, most of which seem to head in the mountainous belt which apparently continues to skirt the basin in that region. Along the valley of the Koyukuk near its middle part, in the region of Red Mountain and

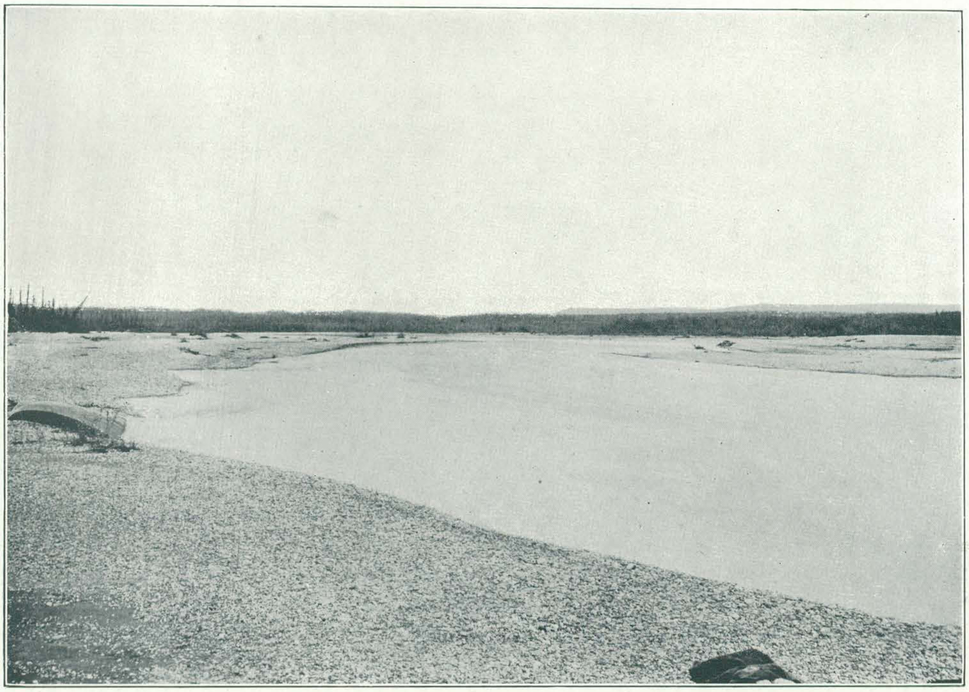
FIG. 22.—Profile across Koyukuk Valley above Red Mountain, showing old valley floor 750 feet above river.

below Bergman, are found remnants of an old valley floor at an elevation of about 750 feet above the present flood plain of the river. The benches of this old floor on either side of the river often vary in width from less than 1 mile to 2 or more miles (see profile, fig. 22), and give to the old valley floor a total width of 3 or 4 miles.

KOYUKUK RIVER.

Considering Dietrich River as the source of the Koyukuk, it apparently heads at about parallel 69° north latitude and east of 150° west longitude, giving to the river from this point to its mouth at the Yukon a length of approximately 700 miles. Throughout almost the whole of this distance, from near the sixty-eighth parallel to the Yukon, there are no rapids.

Dietrich River was ascended by the survey party to Fault Mountain, near the sixty-eighth parallel. This seems to be approximately the head of canoe navigation at the ordinary stage of the river, not owing, however, to insufficiency in the volume of water so much as to the distribution of the river into innumerable channels which thread the silted-up gravel floor of the valley. This condition prevails for 15 miles or more below Fault Mountain. A little above Fault Mountain the stream seems to improve and to be confined more nearly to a



A. VIEW OF FLATS ON MIDDLE FORK OF KOYUKUK RIVER, LOOKING S. 60° W.

B. GOLD-BEARING SCHIST, SHOWING CLEAVAGE AND ATTITUDE OF ROCKS IN BED OF MYRTLE CREEK, LOOKING N. 60° E.

single channel for some distance. In this region the mountains rise from 2,000 to 3,500 feet above the valley.

The course of Dietrich River from its source for a distance of about 75 miles is nearly due south to the point where it unites with Bettles River, a stream similar to the Dietrich, coming in from the east and forming at its confluence with the Dietrich the Middle Fork of the Koyukuk (see Pl. LX). From the confluence of Bettles and Dietrich rivers the Middle Fork of the Koyukuk, receiving short tributary creeks from either side, continues southward with comparatively swift current in a generally narrow, canyon-like valley for about 30 miles, to the southern edge of the mountains, in the region of Slate Creek.

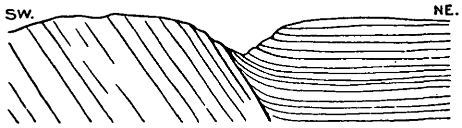


Fig. 23.—Faulting in sandstone below Bergman.

Here, upon entering the Yukon Plateau, the course of the river becomes southwesterly through a country whose topography is varied by low mountains, plateaus, and occasionally areas of flats, the latter sometimes of considerable extent. From Slate Creek to the sixty-seventh parallel, a distance of about 40 miles, the general elevation of the plateau surface or land mass will probably average about 2,800 feet. Just below the sixty-seventh parallel the mountains extending southward between the Middle and South forks attain some prominence, rising to a height of about 3,000 feet. From this point, however, to below the confluence of the Middle and South forks, near the Arctic Circle, the country between the two forks is principally flats. These flats continue for some distance south of the Arctic Circle.

Upon leaving the mountains below Slate Creek the river soon enters a zone of younger and softer rocks (Pl. LXVII, *B*), and the valley becomes wider and more open. At Tramway Bar; however, where a belt of harder conglomerate is encountered, the river flows through a narrow canyon whose steep walls rise about 100 feet above the river.

It is in the upper Yukon Plateau section of the river, between Tramway Bar and the Arctic Circle, that the Koyukuk receives nearly all its large tributaries. They come principally from the northwest and are nearly of equal size. Within a distance of about 75 miles along the river the North Fork, Hokotena, Totsenbetna, Fickett, and Allen rivers, all entering at points about equally distant, contribute, respectively, large volumes of water. They nearly all seem to head well back in the mountainous belt, and in length will probably average 100 miles. They have a comparatively steep gradient and a velocity of 6 miles or more an hour. At high water some of these streams have been ascended for a considerable distance by prospectors in flat-bottomed steamboats.

On the southeast side the only tributary of much note received in this section of the river is South Fork, a little above the Arctic Circle. At their confluence South Fork is by estimate about two-thirds the size of Middle Fork, or the main river. It heads in the high, rugged mountains between Middle Fork and the Chandlar River, in approximately 67½° north latitude, near the one hundred and forty-ninth meridian. Its course for nearly 100 miles is southwestward, parallel with Middle Fork, to near the Arctic Circle, where, below Fish Creek, it trends westward about 25 miles and unites with Middle Fork. The two streams, in general, are only about 20 miles apart. South Fork is also reported to head in or be associated with lakelets in its upper waters. Along its course it receives numerous tributary creeks, some of which are of considerable size, especially on the southeast, of which the principal are Mosquito Creek, Jim Creek, and Fish Creek. For 100 miles or more southward from the Arctic Circle the velocity of the Koyukuk River is about 6 miles an hour.

Another tributary of considerable size is the Alashuk, heading in the northwest, near the head of the Noatak and Kowak rivers, which flow westward into Kotzebue Sound. The Alashuk enters the Koyukuk near the head of Waite Island, at about the sixty-sixth parallel.

For the first several hundred miles above its mouth the course of the Koyukuk River is very tortuous or winding, where it meanders over the flats with a velocity of scarcely 4 miles an hour. The only large tributary received in this lower region is the Huslia, which heads near the Selawik on the northwest. The latter flows westward into Kotzebue Sound.

The Koyukuk is a large river and carries a large volume of water. From the edge of the mountains near Slate Creek to the Arctic Circle near Bergman, a distance of 150 miles, the velocity will probably average about 6½ miles an hour. From Bergman to the mouth of the river at the Yukon, a distance of 440 miles, the current is estimated at about 4 miles an hour, but in many places it is considerably less. The average width of the river in this section, excluding islands, is about one-third of a mile, or about 600 yards. Near its mouth, as noted by Allen,[1] the width is about 500 yards and the current about 3 miles an hour.

Its depth, its slow current, and the absence of rapids and riffles render the Koyukuk admirably navigable for flat-bottomed steamboats of moderate size from its mouth to Bergman. At the normal stage of the river Bergman may be considered as the head of steamboat navigation, on account of the bars, riffles, and swifter currents which begin a short distance above this point and the perceptible diminution in the volume of water above the mouth of the Allen. At

[1] Report on an Expedition to the Upper Tanana and Koyukuk Rivers, in the Territory of Alaska, by Lieut. Henry T. Allen, U. S. A.

high water, however, during early summer, steamboats ascend to above Tramway Bar, and during the seasons of 1898 and 1899 some of the larger northwest tributaries were ascended for a considerable distance by the steamboats of prospecting parties. The Allen is reported to have been thus ascended by steamboat for a distance of more than 40 miles above its mouth.

GEOLOGY.

GRANITE—PROBABLY BASAL.

Apparently the oldest rock seen during the exploration is granite. The first good exposure was seen on the south side of Chandlar River, about 4 miles west of the edge of the Yukon Flats and about 1½ miles above the mouth of East Fork. Here it largely takes the form of a gneissoid granite, with a northwest-and-southeast structure trend and a northerly dip of 75°. The rock is considerably crushed and sheared and shows the effects of dynamic action. What seems to be the major jointing trends about north and south with a steep easterly dip. Macroscopically the more gneissic portion of the rock is evenly fine grained. Microscopically it is seen to be greatly sheared and crushed and to consist of quartz, orthoclase and plagioclase feldspar, biotite, and some hornblende. On fresh surfaces the rock is greenish gray in color, but it weathers brown. It is intruded by an apparently younger and fresher-looking granitoid rock, which in hand specimen is medium grained and more or less disposed to be porphyritic, with feldspar phenocrysts occasionally one-fourth inch in diameter. On fresh surfaces this intrusive rock has the appearance of a typical gray granite, conspicuously dotted and speckled by crystals and flakes of black biotite about one-sixteenth inch in diameter. Under the microscope it is found to have the constituents of a granodiorite, being composed of quartz, fresh orthoclase, plagioclase, biotite, and hornblende. This rock occurs as a dike in the gneissoid rocks. This is shown by the contact metamorphism and by its fineness of grain along the contact, where also a graphic granite structure to some extent has originated. This structure is radially disposed and dies out with recession from the contact line.

The gneissoid rock is also cut by narrow or thin acidic aplite dikes. The aplite is of a light-gray color, very fine and even grained, and microscopically is seen to consist of quartz and feldspar, with a very small amount of green, apparently chloritic, mica. These dikes much resemble those of the Fortymile district, described by Mr. Spurr.[1]

Eastward this gneissoid rock seems to extend to the edge of the Yukon Plateau at the flats, where olivine-basalt appears to rest upon

[1] Geology of the Yukon gold district, Alaska, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Pt. III, p. 229.

it. The actual contact of the basalt and granite was not observed, on account of the covering of talus and moss, but the presence of large angular bowlders of the granite on the slopes only a short distance below the exposures of the basalt in place seems to leave little doubt concerning the relations of the two rocks.

Westward along the south edge of the river the granite has a known extent of 25 miles, and it may extend 8 or 10 miles farther to Granite Creek Valley, where it gives way to a series of metamorphic sedimentary rocks. Judging from the observations, that part of the Yukon Plateau lying between the Chandlar River and the Yukon Flats on the south and extending from the edge of the flats at the river westward to Granite Creek, a distance of about 40 miles, is largely composed of this rock. The granite may occur also on the north side of the river, especially in and below the region of East Fork; this was not visited, however, on account of the difficulty of access and want of time. As the rock weathers brown and is nearly always densely coated with lichens, where not covered with moss, its character could not be satisfactorily determined from a distance, even with the field glass. Topographic criteria were found to be of some aid, but were not satisfactory.

Westward along the river the rock occurs in more or less broad ridges. In the western part of the known granitic area it continues as the dominant rock of the Yukon Plateau, which here rises to an elevation of about 3,500 feet, or about 2,000 feet above the floor of the valley. Here the rock is sometimes so highly sheared and altered as to partake much of the nature of a granitic mica-schist. In some zones it can not be distinguished macroscopically from a true biotite-schist, and it is often somewhat folded, jointed, and cleaved. Here in general it is medium to rather fine grained, and except in the more micaceous zones is highly acidic. It is cut by some pegmatitic and aplitic dikes and seams. The pegmatite dikes sometimes carry conspicuous crystals of black hornblende. The general structure of the schistosity trends northwest and southeast, with steep northeasterly dip. Trending with the schistosity occur a few nearly white quartz veins, the largest of which is about 2 feet in thickness, but so far as observed the quartz is not mineralized to any great extent.

From the highly sheared and schistose condition of the granite it is inferred that it may probably be basal, or the oldest rock found in the field. It resembles the basal granite of the Fortymile district, as described by Spurr.[1]

AMPHIBOLITE-SCHIST.

This rock was seen only in the bottoms of the valleys near the headwaters of both the Chandlar and Koyukuk drainages and in one other

[1] Op. cit., p. 135.

locality. Judging from its apparent position in the geologic horizon it ranks among the older rocks in the field. It is apparently younger than the Rapids schist, just described, and it seems to occupy a lower horizon than the Lake quartzite-schist, which may provisionally be referred to the Birch Creek series. It is a fine-grained fissile or fibrous schist of apple-green color. It occurs on Chandlar River about 3 miles above Bend Mountain. Here it is not, as usual, restricted to the floor of the valley, but seems to be the conspicuous rock in a mountain of moderate size known by the prospectors as Green Mountain. Along with gray mica-schist and limestone it forms the mountainous slope fronting the valley on the north. Back of this front it seems to have a somewhat wider extent to the northward. At the base of Green Mountain, near the edges of the valley, the schistosity trends northeast and southwest, with dip gently northwestward. Here it is found to be very siliceous and to partake largely of the nature of a micaceous quartz-schist. The quartz, however, is disposed in small bands and veinlets, all of which have suffered flexing and folding, the small folds often occurring in the most recumbent manner. The presence of sulphides, and occasionally carbonates, denotes mineralization. Assays of the contained quartz show it to carry both silver and gold, a fuller account of which is given under the heading "Mineral resources," on page 485.

In the floor of the valley a few miles below Portage Creek the schist forms a low bench of some prominence, whose surface is about 25 feet above the present level of the river. It was next met with on Robért Creek, at about the same elevation as on Chandlar River, to the northeast of Horace Mountain, where it exclusively forms the low bluffs and benching along the northeast side of the creek. It occurs also in Robert Creek Canyon. On Dietrich River, at about 5 miles below Fault Mountain, on the north edge of the valley, it again forms a low bench rising to about 20 feet above the river. The trend of the schistosity here is northeast and southwest, with a dip of about 35° southeastward. Here the rock also has a pitch or plunge structure, with a dip of about 20° southeastward. A couple of exposures of limited extent were also met with at the base of the mountains along the Middle Fork of the Koyukuk River, between Bettles River and Slate Creek. Here gray micaceous quartzite-schist, probably referable to the Birch Creek formation, seems to rest upon it.

RAPIDS SCHIST.

This term refers to a narrow belt of highly metamorphosed or altered mica-schist traversed by the Chandlar River in the region of the rapids, where the schist forms a low anticline, with much quartz, in the bight of the fold. Here the rock embracing the rapids extends for several miles downstream nearly to West Fork. This rock in geological horizon is supposed to lie next to the basal granite. It seems to underlie the Lake quartzite-schist, but may prove to be a lower member of this series, so altered by metamorphism as to bear little resemblance to the general type to be next described. In the region of the rapids, and to some extent below, the rock is a biotite-schist, closely appressed or crowded into numerous short folds, and contains much quartz, some garnet, and other metamorphic minerals.

The trend is east and west. At a short distance below the rapids the dip is southward, while above the rapids it soon becomes northerly.

The rock was noted only along the river and does not seem to ascend high into the mountains. From its mineralized character it would ordinarily be regarded as one of the most auspicious to be examined for mineral resources.

On the Middle Fork of the Koyukuk, at the mouth of Bettles River, occurs a small area of what appears to be much the same rock. It here passes with southerly dip beneath the heavy-bedded limestone of this region.

LAKE QUARTZITE-SCHIST.

This rock is here called the Lake quartzite-schist because of its great prominence at Chandlar Lake. In the bend of the lake it forms a steep-faced cliff, rising nearly 2,000 feet above the lake, offering a fine exposure of structure and jointing. It seems probable that with future examination this rock may be correlated with the Birch Creek schists, studied and described by Mr. J. E. Spurr in his report on the Yukon gold district.[1]

Geologically this rock overlies the Rapids schist, and it apparently underlies the limestone series on the northwest. In distribution it seems to extend from near the West Fork of Chandlar River northward to beyond the lake, and from east of Chandlar River westward to the Middle Fork of the Koyukuk. It is apparently one of the chief rocks constituting the rugged mountainous mass in the above area, rising to a height of nearly 6,000 feet.

From near the West Fork of Chandlar River to near the rapids the dip is southerly; but above the rapids, near the head of the lake, it becomes gently northwestward, the divergent dips apparently denoting the two sides of an anticline, the rock being thus more or less conformable with the Rapids schists previously noted.

So far as observed the rock is principally a micaceous quartzite-schist, though in some localities the mica becomes the dominant essential mineral. The quartz grains are usually rolled and rounded, denoting a sedimentary origin. Besides biotite, which is usually greenish, some muscovite and chlorite also occur. Magnetite as an accessory is often present in considerable amount. Garnet has been

[1] Eighteenth Ann. Rep. U. S. Geol. Survey, Pt. III, p. 141.

sparingly noted. In some instances the minerals are considerably crushed, and the foils of biotite bent and flexed about the quartz. In other cases there is present considerable graphitic material, giving to the rock occasionally the aspect of a graphitic schist. The rock carries some quartz veins of moderate size, trending usually parallel with the schistosity, while some deviate or run nearly at right angles to it. A few exhibit mineralization, though this is not pronounced. At about 3 miles south of the head of Chandlar Lake the rock is cut by a greenish dioritic dike several hundred feet in thickness, which has a northeast and southwest trend.

BETTLES SERIES.

This name is here provisionally used on account of the excellent exposures of the rocks afforded on the lower part of Bettles River, where the mountains which they compose rise steeply 2,000 feet or more above the river. The rocks consist of a series of heavy-bedded limestone, with more or less interbedded mica-schist. The limestone or marble is usually banded and schistose, but sometimes occurs comparatively massive. It is usually of light or impure white color, and is frequently mottled with stains of a reddish mineral, probably hematite.

This series forms the principal capping rock over an extent of country embracing apparently an area of about 2,000 square miles on the upper waters of the Chandlar and Koyukuk rivers. Its geologic relation to the lake quartzite-schists would place it in a higher horizon, and it may with future examination be correlated with the Fortymile series of the Yukon, described by Mr. Spurr.

The rocks are considerably folded and greatly faulted on the Chandlar, Bettles, and Dietrich rivers. They are also cut by pronounced jointing and numerous well-marked cleavages. This faulting is perhaps best shown on the south side of Bettles River, where the dislocation by fault contact with the schist on the east is very pronounced. It is well marked also in the region of Fault Mountain, on Dietrich River.

The dip of the rocks on the Chandlar River side is northwestward, while on Dietrich River, on the Koyukuk side, it is southerly.

The topography formed by this limestone is the most rugged met with throughout the season's work. It is shown in Pls. LXIII, *B;* LXIV, *A;* and LXV, *A*, of which latter it forms but a part of the topography. In the two former plates the rock is seen forming the dissected surface of the high, mountainous plateau.

WEST FORK SERIES.

This series of rocks, of which but little was seen, so far as known, crosses the Chandlar River Valley in a belt about 15 miles in width, from below Granite Creek to above West Fork. The series, however, in all probability, if understood, has a very much wider distribution. It seems to rest unconformably against the basal granite on the southeast and to overlie the lake quartzite-schists on the northwest. The dip, so far as observed, is southeasterly at an angle of about 40°.

These rocks, which are only partially schistose, consist of fine-grained, dark-gray quartzite, dark flint, calcareous black shale, and impure limestone. The series is cut or intruded by dioritic and greenish diabasic dikes, which have a northeast-and-southwest trend, with the structure of the rocks. The dark quartzite, and especially the black flint above referred to, bears a marked resemblance to the fossiliferous black flint found in the gravels below East Fork. The fossils in these gravels have been determined by Dr. Girty, of the United States Geological Survey, as certainly Paleozoic and probably Devonian. A list of the fossils, as determined, will appear in a later report. It is therefore suggested that the West Fork series may be Paleozoic.

The trend of the series across the country to the northwestward would include in the belt the rocks about the head of East Fork, whence the Paleozoic gravels seem to have been derived.

Southwestward the series apparently occurs on the South Fork of the Koyukuk, in the region of Jim Creek, where it was noted and where specimens were collected by Mr. D. C. Witherspoon, in charge of the South Fork detachment of the party. Here also the rock is fossiliferous, containing the same Paleozoic forms as the black flint gravels below the East Fork on the Chandlar River. It may also be noted that the trend of this series, continued still farther northeastward beyond the Chandlar River East Fork region, would strike the lower ramparts of the Porcupine, where Mr. McConnell, of the Canadian Geological Survey, reports the limestone to yield fossils referable, in part at least, to the Devonian.[1]

The topography throughout the belt, especially to the southeast of Chandlar River, has been much reduced, giving a marked contrast between that of the Yukon Plateau, formed by these rocks, and that of the higher and more rugged mountainous type, formed by the Lake quartzite-schist, to the north.

LOWER CRETACEOUS.

Apparently the next succeeding geologic horizon met with is the Lower Cretaceous. It is found near the middle part of the Koyukuk River Basin, along the Koyukuk River, where it is known to extend from about 10 miles north of the sixty-sixth parallel, or about 15 miles north of Waite Island, southwestward for a distance of 30 or more miles, to where the river makes a pronounced northwesterly bend, which course it follows for some 40 miles.

[1] Ann. Rept. Geol. Survey Canada, new series, Vol. IV, 188-189, p. 133 D.

A. SLUICING GOLD PLACERS BY ELSINGSON PARTY ON MYRTLE CREEK, LOOKING UPSTREAM, N. 20° E.

B. YOUNG ROCK SERIES OF SANDSTONE AND CONGLOMERATE, WITH SOME LIGNITE, LOOKING N. 65° W.

The rocks consist of impure limestones bearing a fauna which has been determined by Dr. Stanton as Lower Cretaceous. The limestone is often of a pink or reddish color, and usually dips northeastward at an angle of about 40°. It is frequently associated with igneous amygdaloidal rocks and sometimes with tuffs of andesitic nature. These igneous rocks apparently denote volcanic activity during Cretaceous times. The extent of this formation may be very much greater, but exposures of it were not observed away from the river.

UPPER CRETACEOUS.

South of the Lower Cretaceous localities, fossils found in an impure limestone, sometimes arenaceous, were determined by Dr. Stanton as characteristic of the Upper Cretaceous.

KENAI SERIES.

On the Middle Fork of the Koyukuk, about 5 miles above Tramway Bar, the metamorphic rocks give way to a younger rock series composed of impure sandstones, arkose, grit, and conglomerate, indiscriminately carrying more or less lignite and remains of fossil plants. On account of its fossil contents and its resemblance to the Kenai found elsewhere in the Yukon district, this formation is provisionally referred to the Kenai, which is regarded by Dr. Dall as Upper Eocene. In some localities the beds are quite firmly consolidated, especially the sandstones, while in others they are sufficiently soft to be readily plucked away with a pick or hammer. In nearly all localities the beds show more or less disturbance and some faulting and folding. Above Tramway Bar they have a southerly dip, as shown in Pl. LXVII, *B*. At Tramway Bar they consist of a belt of firmly consolidated conglomerates, 3 or 4 miles wide, through which the river has cut a canyon about 80 feet deep.

From Tramway Bar to below the Arctic Circle frequent exposures of sandstone, soft shale, and mud rock, carrying more or less imperfect plant remains, are met with. These rocks are probably principally Tertiary and are apparently younger than the Kenai series. Their attitude often varies, and they nearly always show more or less disturbance.

Judging from the occurrence of lignite and materials resembling the Kenai contained in the Pleistocene deposits of till in the Chandlar River Valley, it seems probable that the Kenai may also occur in this valley, though no exposures of it were observed in place. This inference is based principally on the belief that the till is of local origin and that its materials have been derived from within the Chandlar Basin.

NULATO SANDSTONE.

The Nulato sandstone is exposed principally along the Yukon River, between the mouth of the Koyukuk and Nulato, where it has been described by both Dr. Dall and Mr. Spurr. It probably also covers a considerable area in the lower part of the Koyukuk Basin, near the mouth of the river.

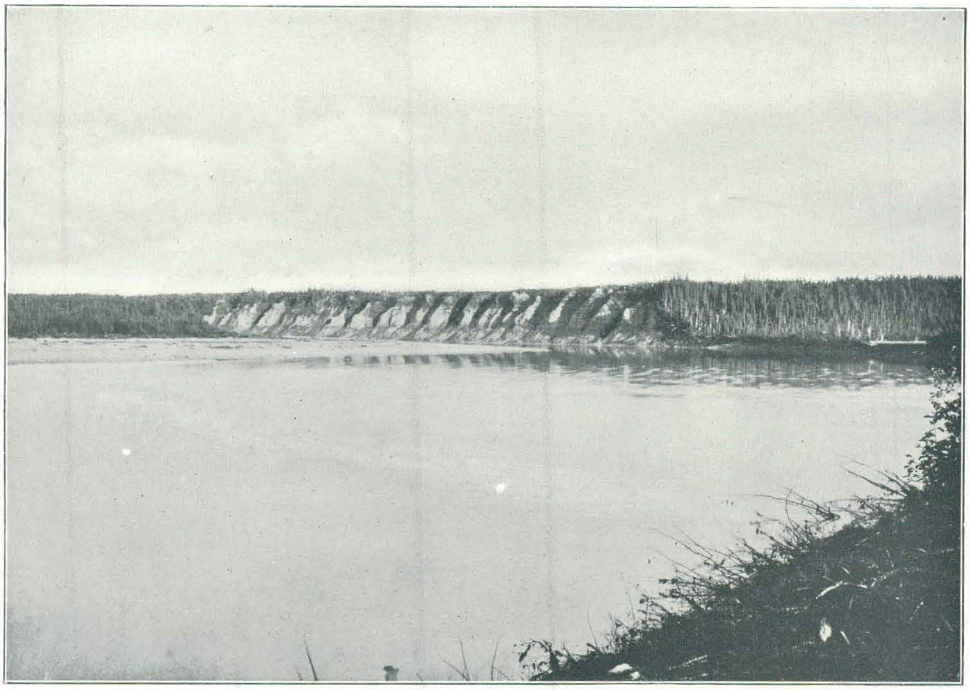
Along the Yukon the dip of the Nulato sandstone is principally gently northwestward, but toward Nulato the dip increases.

PLEISTOCENE.

Till in Chandlar Valley.—From the edge of the flats westward, principally in that portion of the Chandlar River Valley occupying the plateau section of the country, occurs an apparently more or less continuous sheet of unconsolidated Pleistocene deposits, which was found on examination to be till. Along the river it often forms bluffs about 100 feet high, and on the south side of the valley, opposite Flat Creek, it was found at a height of about 2,200 feet. It is composed of heterogeneous materials, but substantially all, so far as observed, may have been derived from within the Chandlar River Basin. The bowlder clay has a sandy matrix, usually yellowish or buff-colored. The gravels range from fine pebbles to bowlderets, and sometimes bowlders of considerable size. As already noted, the till also contains a considerable quantity of lignite, supposed to have been derived from the Kenai formation. In the mountainous section of the river below the rapids the drift in some localities is disposed in ridges of coarse bowlders, trending north and south with the direction of the valley.

River gravels of Upper Koyukuk.—On the upper part of the Middle Fork of the Koyukuk, where it crosses the parallel of $67\frac{1}{2}°$, just above the mouth of Nelson Creek, a deposit of Pleistocene river gravels is first encountered in descending the river. These gravels form more or less argillaceous bluffs rising 30 to 60 feet above the river, and apparently denote the bed of an old river channel, cut when the land stood at a lower level than at the present time. From this point southward they occur more or less continuously throughout the mountainous section of the valley.

Bench auriferous gravels of Tramway Bar.—On the plateau-like surface of the conglomerates through which the river has cut its canyon at Tramway Bar lies a deposit of coarse gravels which for some time have been known to be auriferous. They apparently represent the deposits in the bed of an old river channel which was occupied by the stream before it began its down-cutting in the present canyon of Tramway Bar. These gravel deposits may have been contemporaneous in deposition with those above alluded to, in the mountainous section of Middle Fork. They range from fine gravel to bowlderets and



A. SILT BLUFFS, ON KOYUKUK RIVER NEAR ARCTIC CIRCLE, LOOKING EAST.

B. VIEW UP KOYUKUK RIVER, SHOWING LOW ROLLING PLATEAU, BLUFFS, ETC., 173 MILES ABOVE MOUTH OF RIVER, LOOKING N. 20° E.

bowlders 9 inches or a foot in diameter. So far as observed, they seem to have a considerable extent westward, at least for a mile or more.

Lacustrine silts and gravels of Yukon and Koyukuk Flats.—The Pleistocene deposits forming the Yukon Flats have been somewhat extensively considered by Mr. Spurr, and require but little notice here. On the Chandlar River they extend from the Yukon River to the plateau section of the river, a distance of 40 miles in a straight line. Along the lower part of the Chandlar River the deposits consist almost exclusively of fine silts, the banks rising perpendicularly to a height of 10 or 15 feet above the river. Toward the edge of the flats, however, in ascending the stream the deposits become more gravelly, the gravel growing continually coarser as the edge of the Yukon Plateau is approached.

In the Koyukuk Basin deposits of a nature somewhat similar to those of the Yukon Flats are seen, which seem also to be of lacustrine origin. They are inferred to be so from the extreme fineness of the silts, the occasional perfect horizontality and evenness of the stratification, and the shell remains of *Succinea chrysis* which they contain. The deposits were nowhere traced continuously along the Koyukuk River, but were found presenting good exposures at disconnected points. They sometimes form bluffs with fresh, almost vertical faces, rising from 100 to 200 feet above the river. An example of the bluffs is shown in Pl. LXVIII, *A*. These silts on the Koyukuk occur considerably above the Arctic Circle.

RECENT STREAM GRAVELS.

This term is applied merely to the gravels and detritus being deposited by the streams at the present time. On both the Chandlar and the Koyukuk at high water the streams spread over a valley floor sometimes a mile or more in width, upon which a considerable sheet of gravel and detritus is deposited during the flood period. Upon the recession of the stream to its more normal stage and limited channel, this sheet appears as a waste of detritus. On the lower waters of the Chandlar and Koyukuk rivers at low water the inner side of the large bends of the rivers is occupied by such extensive wastes of gravel.

IGNEOUS ROCKS OTHER THAN THOSE DESCRIBED.

DIABASE ON CHANDLAR RIVER.

This rock was observed at but a single point. It may, however, occur in considerable amount along the northern side of the Chandlar River Valley. It is well exposed a few miles above the mouth of Middle Fork, on the north side of the river. Here it rises in prominent hills or low mountains to a height of about 1,000 feet. It is a very heavy, greenish, dark or nearly black rock, much of it ferruginous, carrying considerable magnetite. It is cut by prominent east-and-west jointing which has a northerly dip of about 40°. Two other minor sets of joints are present, and one or more cleavages. The rock on the whole is considerably crushed, and has the appearance of age. It is seen under the microscope to consist essentially of plagioclase, with considerable augite and some olivine, while accessory magnetite is present in considerable amount. There is also a little quartz. In some cases serpentinization has taken place to a marked extent.

GRANITE ON BABY CREEK.

The rock referred to under the above name is prominent in the mountains just north of Baby Creek, on the Chandlar River, where it trends southwestward and northeastward toward Bend Mountain. Judging from observations made in the region of Chandlar Lake and from the granite bowlders found in the Chandlar Valley in the region of the rapids and below, the rock probably forms a prominent part of the divide trending from West Fork northward to Bend Mountain. It is also supposed to continue northward beyond the Chandlar River in the Bend Mountain region.

It is a light-colored rock, with greenish tinge, of medium grain, and is considerably sheared or schisted. It has received but a cursory examination, from which it seems to be a granodiorite. It is composed of orthoclase and plagioclase feldspars, with some quartz, hornblende, and green biotite.

DIORITIC ROCK OF HORACE MOUNTAIN.

On the Koyukuk side of Robert Creek portage, opposite the mouth of Sheep Creek, the upper 1,000 feet or more of Horace Mountain is composed principally of a greenish-gray, speckled, igneous rock, which is apparently a large dike intruded into the schist series of this region. This is inferred from the completely altered condition of the country rock along the zone of contact, sometimes 100 yards or more in width. This was best observed on the northern slope of the mountain. The trend of this intrusive rock is northeast and southwest. From Horace Mountain southwestward for a distance of 10 miles it seems to form a somewhat prominent line of rugged peaks rising to a height of nearly 6,000 feet. From the same point northeastward it extends across Robert Creek in the direction of Geroe Creek and Bend Mountain, on the Chandlar River.

The rock in its different phases seems quite different from anything elsewhere met with on this trip. In its various stages it seems to show passage by dynamic action from an augite-diorite to an amphibolite-schist. In structure it varies from a medium-grained, somewhat gneissoid rock to a schist. The southeastern slope of the mountain is traversed by a more or less mineralized belt one-fourth of a mile wide. Here the rock seems to consist principally of quartz. It is greatly crushed, sheared, and folded, and stained a bright red. The staining material has not been examined in detail, but is probably hematite.

CRETACEOUS LAVAS.

These rocks can not here be taken up in detail. It may be well, however, merely to state that in the middle part of the Koyukuk Valley the intrusion and association of diabasic, andesitic, basaltic, and amygdaloidal rocks, and the association of tuff with the fossil-bearing Cretaceous strata, seem to denote considerable volcanic action during and subsequent to Cretaceous time.

TERTIARY LAVAS.

Basalt of Koyukuk Mountain.—At the mouth of the Koyukuk River on the Yukon, the sandstone and conglomerate considered Miocene are intruded by Tertiary lavas which are thought by Mr. Spurr to be post-Miocene, but still Tertiary. The intruded lavas at this point largely form the prominence known as Koyukuk Mountain, referred to by Dr. Dall in his Resources of Alaska, and later described and figured by Mr. Spurr in his report on the Yukon gold fields.[1] The mountain rises about 800 feet above the river. This lava has been determined by Mr. Spurr to be an olivine-basalt. The same lava seems to be intruded into the sandstones for some distance east of Koyukuk Mountain, where it rises somewhat abruptly, forming what is known as Elephant Mountain, about 2 miles above the mouth of the Koyukuk.

Southwestward the intrusive Tertiary lavas are known to occur more or less continuously between Nulato and St. Michael along the Yukon River. Also, at various points along the Koyukuk River exposures of black basaltic lava are frequently met with, which is probably largely of Tertiary age. This lava seen in outcrop is sometimes glassy, while the river gravels in the middle part of the Koyukuk Valley were found to carry cobbles of obsidian or true volcanic glass.

Basalt on Chandlar River.—Where the Yukon Flats meet the edge of the Yukon Plateau on the south side of the Chandlar River, as shown in the left of Pl. LXIV, *B*, the capping rock of the plateau, as already noted, is a black olivine-basalt, apparently resting on an eastward extension of the basal granite. This basalt, which seems to be a surface flow, is probably Tertiary or later. Its contact with the granite was not observed, on account of the covering of talus and moss. Its extent was observed 5 miles westward along the Chandlar River, where it

[1] Geology of the Yukon gold district, Alaska: Eighteenth Ann. Rept. U.S. Geol. Survey. Pt. III, p. 245.

gives way to the granite. Southwestward, however, it may have a considerable extent, probably forming in this direction the edge of the plateau, as at the river. It is supposed to occur also on the north side of the river at the edge of the plateau, but was not visited there.

MINERAL RESOURCES.

As the region is remote and comparatively new, much of it having never before been explored, only the most general statement of mineral resources can here be made.

COPPER.

The only indications of copper on the Chandlar River seen by the writer were detached fragments, apparently of quartz veins, carrying, with iron pyrites, copper pyrites and malachite, and a trace of bornite. Such specimens were found sparingly in the gravels above Chandlar Lake. Some also seen in the hands of prospectors were reported to have been collected on Mineral Creek, at the head of the lake on the southwest. On the East Fork Prospector Funcheon is reported to have found a ledge, samples of which assayed enough in copper to render it of commercial value if the occurrence is in sufficiently large quantity and the ore accessible.

On the Koyukuk River the indications seem to be much the same as on the Chandlar, the occurrences being on the headwaters of the upper tributaries heading in the mountainous limestone belt.

LEAD.

Galena is known to occur in the Bettles limestone on the upper waters of both the Chandlar and the Koyukuk. It is also reported on the East Fork of Chandlar River. Specimens were seen from Bettles River. Some reported to be from the upper part of the Hokotena were presented to the writer by Mr. Windrick at Peavey. In this instance the galena is associated with or partly incloses quartz crystals five-eighths of an inch in diameter and an inch or more long. On the eastern side of the divide, between Middle Fork and South Fork, opposite the head of Wiseman Creek, a limestone mountain of considerable size is reported by prospectors, in which galena is said to occur in large quantity.

GOLD.

Gold is not known to have been prospected for on the Chandlar River before the season of 1899. In ascending the river the gravel was occasionally panned by the writer and colors were found at a few points. The only prospectors by whom the river is known to have been visited are the four met at Chandlar Lake in 1899. These men had entered the region by the overland trail from Fort Yukon, arriving at the lake early in March with a two-years' grub stake. They reported that they found light prospects and colors of coarse gold on several tributary creeks between Chandlar Rapids and the lake, though nothing rich had been encountered. These men were hopeful of the country and were prepared to extend their investigations. The prospects found seem to have been derived in large measure from the Lake quartzite-schist, whose hypothetical correlation with the Birch Creek schist has already been suggested.

On the Koyukuk River placer gold has been known for some time—since the early nineties, if not before. One of the earliest known occurrences is at Tramway Bar, above the sixty-seventh parallel, about 570 miles above the mouth of the river by boat. This has been referred to by Allen and Spurr. The gold was first discovered on the Koyukuk in the bars of the river, of which the most noted seem to have been Hughes and Florence bars. The Tramway Bar diggings, however, are bench placers, consisting of deposits of auriferous river gravels resting on a bench of apparently Kenai bed-rock conglomerate and sandstone at about 80 or 100 feet above the level of the river. The gravels are generally coarse, consisting largely of rolled cobbles and pebbles of quartz-schist and the older classes of rocks composing the mountains to the north. Several attempts seem to have been made to work these deposits, but thus far with no great success, owing probably to the remoteness of the region, the difficulty of transportation, and the lack of capital to provide water supply, which could readily be drawn from the river above, or possibly from lakelets said to occur to the westward.

The gold region of the Koyukuk River, as known at present, is roughly contained between the Arctic Circle and the sixty-eighth parallel and meridians 149½° and 154°, west longitude. Diagonally across this area the gold belt, approximately 100 miles in width, embracing most of the tributary streams, follows the trend of the Koyukuk River southwestward. It is only in certain localities in this area, however, that gold placers have been found, and in only a few of these is the gold known to occur in paying quantities. The formations on which these placers lie are the Lake quartzite-schist, the West Fork schist, and the Kenai series, but whether any or all of these formations is the original source of the gold can not yet be stated.

The principal diggings when the region was visited by the writer last August (1899) were those of Slate Creek and Myrtle Creek, along the zone where the Lake quartzite-schist gives way to the West Fork series on the south. This, as will be noted, is also along the line where the mountains meet the Yukon Plateau. Here in the month of March, 1899, coarse placer gold in paying quantities was discovered on Slate Creek, an east-side tributary of the Middle Fork of the Koyukuk, which it enters 16 miles (approximately) above Tramway Bar.

The discovery was made by members of the Dorothy party, commonly known as the "Dorothy boys," from Boston, Massachusetts.

The country rock is principally mica-schist and slate. It is uplifted and stands on edge, while the gold occurs as shallow creek and gulch diggings. It is found principally on or near bed rock, in the jointings, fissures, and cleavage crevices. The gravels rarely exceed 3½ feet in thickness. The diggings begin about 9 miles above the mouth of the creek, at the confluence of the two main forks, of which the north one is known as Myrtle Creek and the south one as Slate Creek proper. From this point they extend up to the head of Myrtle Creek, a distance of 5 or 6 miles, and up Slate Creek considerably farther. At the time the region was visited by me, in August, 1899, but little mining, beyond development work, had yet been attempted. Two mining districts had been organized, known as Slate Creek and Myrtle Creek districts. Most of the season was devoted to bringing in supplies and building cabins preparatory for winter. Sluicing had been begun on but two claims, one of which, on Myrtle Creek, reported the gravel as yielding from $60 to $80 a day per shovel. The gold is clean looking and coarse. It is considerably rolled, or flattened, and shows travel. The largest nugget taken out had a value of nearly $20. The benches along these creeks are also found to be auriferous and are reported to prospect from 3 to 5 cents per pan.

In August there were reported to be 75 men at the diggings. A score or so others were on their way, many from along the South Fork, where they had been working with only moderate success during most of the summer. By estimate, there are probably 100 men now wintering (1899–1900) in the region. The principal supply post for the region is Bergman, near what was formerly known as Arctic City, 440 miles by river above the mouth of the Koyukuk and 146 miles from the diggings. This post is supplied principally by the Alaska Commercial Company, but is owned by and in charge of Pickarts, Bettles & Pickarts. It is practically at the head of steamboat navigation on the Koyukuk. A nearer post is Peavey, 104 miles below Slate Creek. Here are located a United States post-office, a United States land-office, and a store, but at present the place is not stocked with the staple articles of provisions needed by the miners. The establishment of a post at the mouth of Slate Creek during the coming winter is proposed by Pickarts, Bettles & Pickarts, who had much freight en route for the purpose. The principal summer route into the region is up Koyukuk River by flat-bottomed steamboat. In winter the region may be best reached by the trails leading overland from the Yukon near Fort Hamlin by way of Dall River, or from Fort Yukon by way of Chandlar River. Placer gold is known to occur over a somewhat wide range of country in the Koyukuk region, but, like that at Tramway Bar, the most of it may require capital to work the gravels. The placers on

Slate and Myrtle creeks are the only known rich diggings seen by members of the Survey. Late in August, 1899, word was received at Bergman that rich prospects had recently been found in a region known to the miners as Rocky Bottom, on the upper waters of Allatna or Allen River, a large tributary to the Koyukuk, which it enters from the northwest about 10 miles above Bergman.

Gold was also reported to occur on Wiseman, Marion, Porcupine, Twelvemile, and Pasco creeks, and on several of the larger northwest tributaries of Middle Fork. During the season of 1899 considerable mining was done on various tributaries of South Fork with fair success. On Rail Creek and some other of the smaller tributaries below Bergman, gold has also been found and the deposits have been worked to a small extent.

The Slate Creek gold is probably derived from the Lake quartzite-schists. These schists are traversed by quartz veins of considerable size, but the larger veins are not known to carry gold. A secondary series of smaller veins or veinlets and small lenticular quartz bodies or leaflets contained in the schist are apparently to some extent auriferous.

Of the quartz specimens collected, however, those yielding the best assays were from near the base of Green Mountain on Chandlar River, the yield being about 0.42 ounce gold and 0.14 ounce silver per ton, or a money value of about $8.50 per ton. All specimens assayed showed at least a trace of gold.

Recently (April, 1900) word has been received from the interior of the Koyukuk region that strikes have just been made on McKinley and Bryan creeks, small streams which are said to head in a range of low hills on the south side of the mountains. They are reported to have a pay streak of considerable width and are being worked by fifty or more men. Early in the sledding season of 1900, prospectors from numerous camps on the Yukon are reported to have started for these diggings, most of them taking their supplies with them by dog sled overland from Fort Yukon.

COAL.

The only indications of coal seen on the Chandlar River were isolated fragments of tree stems, etc., found in the Pleistocene drift.

On the Koyukuk, in the supposed Kenai formation, lignite in small amount is common in the sandstones, grits, and especially in the conglomerates. The best occurrence is just above Tramway Bar, where a bed of it is nearly 12 feet in thickness, the middle 9 feet being comparatively pure lignite. The test, however, does not indicate the probability of its proving to be of much commercial value.

In the Nulato sandstone, on the Yukon, coal mines have recently been opened at several points a few miles above Nulato. Of these the principal is Pickart's coal mine, about 10 miles above Nulato. Coal is found here in considerable quantity. It is a lignitic coal, but it is comparatively well metamorphosed and is shown, both by test and practical experiments, to be a good steaming coal, comparing very favorably with good steaming coals of Indian Territory and other regions in the Western States. It is being used to a considerable extent by companies operating steamboat lines on the Yukon River. One ton of the coal is reported to more than equal two cords of wood. Similar coals are also receiving considerable attention at other points farther up the Yukon, both above Circle City and at Cliff Creek, where the coal is mined in comparatively large quantity by the North American Transportation and Trading Company.

APPENDIX.

LATER CONDITIONS ON THE UPPER KOYUKUK.

As this report goes to press (December, 1900), authentic information is received of further discoveries of paying gold placers on the upper waters of the Koyukuk, mostly on tributaries of the Middle Fork. Of these the principal are Clara Creek, about 3 miles above Slate Creek, on the same (east) side of the river; Emma Creek, on the other (west) side of the river, just opposite Marion Creek; and Gold Creek, on the east side of the river, about 10 miles above Marion Creek. The Emma Creek gravels are reported to be very rich. Both here and on Gold Creek the ground is said to be all staked.

The principal supply post for the region is Bettles, located about 30 miles above Peavey, on the west bank of the river, near the sixty-seventh parallel.

ALASKAN GEOGRAPHIC NAMES

BY

MARCUS BAKER

ALASKAN GEOGRAPHIC NAMES.

By Marcus Baker.

Much confusion has existed, and to some extent still exists, respecting the geographic names in Alaska. These names, of various origins, come chiefly from Russian, English, and native sources. A few come from Spanish and French sources.

When the United States Board on Geographic Names was created, in 1890, one of its earliest efforts was to agree upon the spelling to be adopted for the names of some of the more important features in Alaska as to which prevailing usage was divided. It soon appeared that nothing short of a general examination and revision of all the names would yield satisfactory results. Accordingly the preparation of a card catalogue of the names was begun. Names of features in southeastern Alaska were carded at the office of the Coast and Geodetic Survey, under the direction of Mr. H. G. Ogden, and names in the remaining part of the Territory were carded by the writer. Some 5,000 names were thus carded, and the systematic writing up of these names in form for publication as a dictionary of Alaskan geographic names was carried forward as far as the letter F. This work, done at irregular and broken intervals, made slow progress and finally came to a standstill in 1896. Since that date there has been great activity in Alaskan exploration and survey and several hundred new names have appeared on the maps. Accordingly the Director of the United States Geological Survey has authorized the writer to resume work upon and to complete this dictionary.

In the present (Twenty-first) Annual Report of the Geological Survey are three papers on Alaskan topics. Several maps accompany these papers. The names appearing on these maps are here printed in dictionary order, accompanied by brief notes as to their origin, application, and spelling. This list has been prepared in the absence of the authors of the papers, who can not therefore be held solely responsible for the names as they appear in their papers and on their maps. In some cases the spelling used by the authors has not been followed, departures having been made in the interest of simplicity and uniformity as well as for the purpose of correcting supposed errors and inconsistencies.

The list is not exhaustive, i. e., does not contain every name on every map in the Twenty-first Annual Report relating to Alaska. It does aim, however, to include all geographic names used in the text of those Alaskan papers.

ALASKAN GEOGRAPHIC NAMES APPEARING IN PART II OF THE TWENTY-FIRST ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY.

ABERCROMBIE; mountain near latitude 61½° and longitude 142°. Named by the United States Geological Survey in 1899 after Capt. William R. Abercrombie, U. S. A.

ABERCROMBIE; see Klutena.

ADAMS; creek tributary to Middle Fork of the Koyukuk River from the north near longitude 150°. Prospector's name, now first published.

ADMIRALTY; see Yakutat.

AGULOGAK; see Naknek.

AGUSTA; see Augusta.

AIRS; hill near international boundary, in latitude 62½°. Named in 1898 by Peters and Brooks, of the United States Geological Survey, after A. R. Airs, a member of their party.

AISHIHIK; lake and a village on its shore, in the southwest part of Yukon district, Canada. Apparently Ta-ku-ten-ny-ee of Davidson. Glave in 1892 reported the name as I-she-ik. It has also been written Ishiih and I-shi-ih and, erroneously, Ashink. The above form, Aishihik, has been adopted by the Canadian Board on Geographic Names.

AKHA; see Chilkoot.

ALASHUK; river tributary to the Koyukuk from the north opposite Waite Island, near longitude 154½°. Has been written Allashook and Alloshook. Apparently it is identical with Batzakakat River of Allen in 1885.

ALEUTIAN; mountains on Alaska Peninsula northeast of Becharof Lake. Named by the United States Geological Survey in 1898.

ALLEN; mountain near head of Tanana River. Named by the United States Geological Survey in 1898 after Maj. Henry T. Allen, U. S. A.

ALLEN; river tributary to the Koyukuk from the north near the Arctic Circle. Named Allenkakat by Allen in 1885, the termination kakat meaning river. Has been written Allenkakat, Allankakat, and Allatna. See Kakat.

ALSEK; river in St. Elias region, debouching between Lituya and Yakutat bays. Called Riviere de Behring by La Perouse in 1786, Alsekh by Tebienkof in 1849, and Harrison by the Coast and Geodetic Survey in 1890. Variously written Alseck, Alsekh, Altsekh, Alzech, etc. The above form, Alsek, has been adopted by the United States and Canadian Boards on Geographic Names. The form Alseck, in the first report of the Canadian Board on Geographic Names, is a typographical error.

AMANKA; lake near north shore of Bristol Bay, drained by the Igushik River. Native name, according to Spurr and Post of the United States Geological Survey. Petrof reported its name in 1880 as Pogakhluk.

AMBLER; river tributary to the Kowak from the north near longitude 158°. Named in 1890 after Dr. James M. Ambler, surgeon of the De Long arctic expedition.

AMERICAN; creek in the Eagle mining district. Named by prospectors in 1898.

ARCHER; see Tonsina.

ARCTIC; city on Koyukuk River near Arctic Circle. Named by prospectors in 1899.

ARKELL; see Kusawa.

ASCHEESHNA; see Fickett.

ATNA; see Copper.

AUGUSTA; mountain in St. Elias region, named by Prof. Israel C. Russell, after his wife. Has been published erroneously as Agusta.

BABY; creek tributary to Chandlar River from the west near longitude 148½°. Named by prospectors in 1899.

BAIE DE MONTI; see Yakutat.

BAKER; creek tributary to the Tanana from the north near longitude 151°. Named by Allen in 1885.

BAKER; creek tributary to Middle Fork of the Koyukuk from the north near longitude 150°. Named by prospectors in 1899. Also called Nelson Creek.

BAKER; mountain on west bank of White River near latitude 63°. Named in 1898 by Peters and Brooks, of the United States Geological Survey, after H. B. Baker, a member of their party.

BATES; rapids in the middle part of the Tanana River. Named by Allen in 1885.

BATZA; village, mountains, and river tributary to the Koyukuk River from the north near longitude 154°. Native name, reported by Allen in 1885 as Batzakakat. See Kakat and also Alashuk.

BATZULNETAS; post on north bank of the Copper River, in latitude 62° 37′. Apparently a native name; published by the United States Coast and Geodetic Survey in 1898. Has also been written Batzulnatos.

BEAN; ridge on the north bank of Tanana River, opposite mouth of Toklat River. Named by the United States Geological Survey in 1899 after Mrs. Bean, wife of a fur trader at Harper Bend, who was murdered by the Indians.

BEAR; creek tributary to South Fork of the Koyukuk from the south near latitude 67°. Named by prospectors in 1899.

BEAVER; creek tributary to the Yukon from the south near latitude 66°. Name published by United States Coast and Geodetic Survey in 1897. This may be the stream called Nocotocargut by the Western Union Telegraph Expedition in 1867.

BECHAROF; lake and mountains, Alaska peninsula. The lake was named at an early day by the Russians after Becharof, a master in the Russian navy, who was at Kadiak in 1788. It has been variously written Becharoff, Betchareff, Bocharof, Bochonoff, Botcharoff, Rochanoff, etc. The Eskimo name appears to be Igiagiuk, or Ugiagwik, or Ugashik, etc. It has also been known as Tugat or Ninuan-Tugat, etc. The above form, Becharof, has been adopted by the United States Board on Geographic Names.

BEND; mountain (5,000 feet) on east bank of Chandlar River near latitude 68°. Descriptive name given by the United States Geological Survey in 1899. There is a large bend in the river near this mountain.

BENNETT; lake and town at its head, terminus of the railroad from Skagway. Lake Bennett was named by Schwatka in 1883 after Mr. James Gordon Bennett.

BERGMAN; post or mining camp on the Koyukuk near Arctic City. Named by miners in 1899.

BERING BAY; see Yakutat.

BERING RIVER; see Alsek.

BETTLES; river tributary to the Middle Fork of the Koyukuk from the east near longitude 150°. Named in 1899 after Mr. Bettles, of the firm Pickarts, Bettles & Pickarts, owners of the post Bergman.

BIG; creek tributary to the Chandlar River from the east near longitude 149°. Named by prospectors in 1899.

BIG BLACK; river tributary to the Porcupine from the east near longitude 145°. Named by the United States Coast and Geodetic Survey in 1890.

BIRCH; creek tributary to the Yukon from the south a little below Fort Yukon. Named by traders of the Hudson Bay Company. Its Indian name is reported to be Tohwun-nukakat. Either this creek or the one next below it is Nocotocargut of the Western Union Telegraph expedition of 1867.

BITZLA; river tributary to the Koyukuk from the east near longitude 157½°. Part of a native name reported in 1885 by Allen, who has Bitzlatoilocta on his map and Bitzlatoilóeta in his text.

BLACKBURN; mountain east of and near the Copper River. Named in 1885 by Allen after Hon. J. C. S. Blackburn, of Kentucky.

BLACKBURN; river tributary to Copper River from the east a little south of latitude 62°. Named by Abercrombie in 1898.

BOCHAROFF; see Becharof.

BOULDER; creek tributary to the Klehini River, in the Porcupine gold district. Prospector's name, now first published.

BOUNDARY; creek tributary to the White River from the south near the international boundary. Descriptive name.

BOVE; see Tagish.

BRANCH; creek tributary to South Fork of the Koyukuk from the east near latitude 68°. Name published by United States Coast and Geodetic Survey in 1899.

BRISTOL; see Nushagak.

BRONSON; creek tributary to Middle Fork of the Koyukuk from the north near longitude 150½°. Prospector's name, now first published.

BULSHAIA; see McKinley.

CANTWELL; river tributary to the Tanana from the south near longitude 149°. Named in 1885 by Allen, presumably after Lieut. John C. Cantwell, U. S. R. M., who explored the Kowak River in 1884 and 1885. According to Peters and Brooks the native name is Tutlut.

CARIBOU; mountain on west bank of White River near latitude 63°. Named by Abercrombie in 1898.

CARIBOU; see Cutler.

CARMEL; Moravian mission and school, established in 1886, near the mouth of the Nushagak River.

CATHEDRAL; bluff and rapids on the Tanana near longitude 144°. Descriptive name given by Allen in 1885.

CHANDLAR; lake and river tributary to the Yukon from the north near the Arctic Circle. Locally known as the Chandlár and said to be named after John Chandlar, a factor of the Hudson Bay Company. Has also been called Gens de Large. The above name, Chandlar, has been adopted by the United States Board on Geographic Names.

CHAPMAN; creek tributary to Middle Fork of the Koyukuk from the east near longitude 148°. Prospector's name, published by the United States Coast and Geodetic Survey in 1899.

CHENA; river tributary to the Tanana from the east near longitude 147½°. Native name reported by the United States Geological Survey in 1898.

CHENTANSITZTAN; village on north bank of the Yukon near longitude 156°. Native name published by the United States Coast Survey in 1898.

CHILKAT; inlet, islands, lake, mountains, pass, peak, point, and river at the head of Lynn Canal. A native word, variously written Chilcat, Chilkaht, Tchillkat, Tschilkat, T'silkat. The form Chilkat is in general use and has been adopted by the United States and Canadian Boards on Geographic Names.

CHILKOOT; inlet, lake, mountains, pass, and village near head of Lynn Canal. A native name, variously written Chilcout, Tschilkut, etc. The inlet has been called False Chilkaht or Tschillkat; the lake, Akha; the pass, Dejah and Perrier; and the village Tananei or Chilcoot. The form Chilkoot has been adopted by both the United States and Canadian Boards on Geographic Names.

CHISLECHINA; river tributary to the Copper River from the north near latitude 63°. Native name, reported by Allen (text pp. 65, 66) in 1885 as Chitslétchiná. On his maps it is Chistotchiná. Has also been written Chestochena, Chistochina, and Tieschenni.

CHITINA; river tributary to the Copper River from the east near latitude 62°. A native name, reported in 1885 by Allen, who spells it Chittyna (from chitty=copper and na=river). Hayes writes it Chittenah; Brooks, Chittena; Abercrombie, Chettyna.

CHITISTONE; river tributary to the Chitina. Named Chittystone by Allen in 1885 (from chitty=copper and stone=stone), i. e., Copperstone River, on account of copper discolorations on the bowlders and rocks of the river's bed.

CHUGACH; mountains near head of Cook Inlet. A native word obtained by the early Russian traders and by them written Chugatz and Tchougatskoi. Now usually written Chugach or Chugatch.

CIRCLE CITY; trail and also mining camp on west bank of the Yukon near the Arctic Circle; hence the name which was given by the prospectors.

CLARK; lake near Iliamna Lake. Discovered and named in 1891 after John W. Clark, chief of the Nushagak trading post.

COFFEE; point near mouth of the Nushagak River. Trader's name, published by the U. S. Fish Commission in 1891.

COLVILLE; river draining to the Arctic Ocean near longitude 151°. Named by Dease and Simpson in 1837 after Andrew Colvile, esq., of the Hudson Bay Company. On Dease and Simpson's map it was spelled Colville. This form thus gained currency and has been adopted by the United States Board on Geographic Names. The Eskimo name is reported to be Or-kim-ya-nook. Ray (Report, 1885, p. 55) says: "The Colville River was always spoken of as 'Neg-a-len-mi-ku,' 'the river at Negalek,' and we did not obtain the name."

CONE; mountain on north bank of Koyukuk River near longitude 156°. Descriptive name given by the United States Geological Survey in 1899.

COOK; inlet on south coast of the Alaskan mainland. First explored and mapped by Capt. James Cook in 1778. Not having in his journal applied any name to it "Lord Sandwich directed that it should be called Cook's River." Vancouver calls it Cook's Inlet, and also refers to it as Groosgincloose or Cook's Inlet. The Russians call it Kenai Bay. It has been called an arm, bay, gulf, inlet, and river, and the name Kenai has been rendered Kenaiskoi, Kenaiskaia, Kenaiskischer. According to Grewingk, quoting Zagoskin, the correct name is "Ttunaiskysch" Bay.

COOPER; pass between the Nabesna and Tanana rivers near latitude 62°. So named by Peters in 1899.

COPPER; river discovered by Nagaief in 1781 and called by the Russians Miednaia (copper) and by the natives Atna. Has been usually referred to as the Atna or Copper River.

COPPER CENTER; mining camp or village on the Copper River. Prospector's name, first published in 1898.

COPPER RIVER; plateau between the Copper and Sushitna rivers, about latitude 62°. Named by Abercrombie in 1898.

CRANBERRY MARSH; prospector's name for the flat, marshy mouth of the valley northwest of Klutena Lake.

CREADON; river tributary to Kluane Lake from the east near latitude 61°. Named by the United States Geological Survey in 1899.

CRIPPLE; creek tributary to South Fork of the Koyukuk from the south near latitude 67°. Prospector's name, now first published.

CROOKED; creek tributary to Birch Creek from the west near Circle City. Descriptive name, published by the United States Coast Survey in 1895.

CUDAHY; post on west bank of the Yukon near Fortymile Creek. Also called Fort Cudahy. The above form, Cudahy, has been adopted by the Canadian Board on Geographic Names.

CUTLER; river tributary to the Noatak from the south near longitude 158°. Name published by U. S. Coast Survey in 1890. Has recently been called Caribou.

DAGITLI; river tributary to the Koyukuk from the north near longitude 157°. Native name, reported by Allen, in 1885, as Doggetlooscat and Doggetlooskat. Schrader writes it Doggetlikakat. See Kakat.

DAKLI; river tributary to the Koyukuk from the north near longitude 157°. Native name, reported by Allen in 1885. Has been written Daklikakak, Daklikakat, and Dakliakakat. See Kakat.

DALL; river tributary to the Yukon from the north at the Lower Ramparts. It is Notokakat or Dall of the United States Coast Survey, 1869, and Notochangut or Dall of Raymond, 1871.

DALTON; post, range of mountains, and trail from head of Lynn Canal to the interior. The name, as applied to the mountain range, has been adopted by the Canadian Board on Geographic Names.

DASSAR-DEE-ASH. See Dezadeash.

DAVIS; creek tributary to South fork of the Koyukuk from the south near latitude 67°. Prospector's name, published by United States Coast Survey in 1899.

DAWSON; peak near Teslin Lake, Yukon.

DAWSON; range of mountains at the confluence of the Lewes, Pelly, and Yukon rivers, Yukon.

DAWSON; town, Government headquarters, and post-office on Yukon River, at mouth of Klondike River, Yukon. (Not Dawson City.) The above entry for Dawson is copied from the First Annual Report of the Canadian Board on Geographic Names. Named after Dr. George M. Dawson, of the Canadian Geological Survey.

DEASE; creek, lake, and river of British Columbia. Named as early as 1867, and perhaps earlier, after Peter Warren Dease, of the Hudson Bay Company.

DEITRICK; see Dietrich.

DEJAH; see Chilkoot.

DELTA; river tributary to the Tanana from the south near longitude 146°. So named by Allen in 1885 and erroneously on a late map as Delt.

DELTA; see Silok.

DENNISON; fork of Fortymile Creek. Named by Abercrombie in 1898. Has also been written Denison.

DEZADEASH; lake back of the St. Elias range of mountains. Native name reported by Davidson as Tots-an-tee-ash and by E. J. Glave in 1892 as Dassar-dee-ash. Variously written Deza-de-ash, Dazadeash, etc. The above form, Dezadeash, has been adopted by the Canadian Board on Geographic Names.

DIETRICH; river tributary to Middle Fork of the Koyukuk, near its source. Published in 1899 by United States Coast Survey with the spelling Deitrick, here changed to Dietrich.

DISCOVERY; creek tributary to Birch Creek from the south near latitude 66°. Prospector's name, published by the Coast Survey in 1898.

DOGGETLOOSCAT; see Dagitli.

DONJEK; river tributary to the White from the south in latitude 62°. The form Donjek has been adopted by the Canadian Board on Geographic Names.

DOUBLE POINT; mountain on north bank of the Koyukuk near Arctic City. Descriptive name given by Allen in 1885.

DRUM; mountain east of Copper River near longitude 144°. Named in 1885 by Allen after Adjt. Gen. Richard C. Drum, U. S. A.

DUGAN; river tributary to the Tanana from the south near longitude 150°. Named in 1885 by Allen after Lieut. Thomas B. Dugan, U. S. A.

DULBI; river tributary to the Koyukuk from the east in longitude 156½°. Native name, reported by Allen in 1885. Usually written Dulbikakat. See Kakat.

DYEA; port of entry and post-office at head of Lynn Canal. The inlet was called Tyÿa by Meade in 1869, Dejah by Krause in 1882, Dayay by Schwatka in 1883, and Chilkoot or Taiya by the miners according to Dawson (Rept. Canadian Geological Survey, 1887–88, p. 174 B). The United States Board on Geographic Names has adopted the name Dyea as the name of the port of entry and post-office, and Taiya as the name of the inlet and river.

EAGLE; mining camp on west bank of the Yukon near latitude 65°. Prospector's name is Eagle City.

EAST; fork of the Chandlar River near longitude 147°. Prospector's name, now first published.

EGOUSHIK; see Igushik.

EKUK; cape and Eskimo village near mouth of the Nushagak River. Native name, given by Lütke in 1828 as Ekouk.

ELDORADO; creek tributary to South Fork of the Koyukuk from the east near longitude 147°. Prospector's name, now first published.

FAREWELL; see Pyramid.

FAULT; mountain on headwaters of the Koyukuk River near latitude 68°. Named by the United States Geological Survey in 1899.

FICKETT; river tributary to the Koyukuk from the north near longitude 150°. Named in 1885 by Allen after Private Fred W. Fickett, U. S. A., a member of his party. Allen calls it the Ascheeshna or Fickett. Has also on late maps been called Oschesna and Ochesna.

FISH; creek tributary to Chandlar River from the east near latitude 68°. Named by the United States Geological Survey in 1899.

FISH; creek tributary to South Fork of the Koyukuk from the south near longitude 151°. Name published by Coast Survey in 1899.

FLAG; hill on east bank of Tanana River near longitude 147°. Descriptive name given by the United States Geological Survey in 1898.

FLAT; creek tributary to Chandlar River from the north near longitude 148°. Named by prospectors in 1899.

FLORENCE; bar on Koyukuk River near longitude 154°. Named by prospectors in 1899.

FOHLIN; creek. Name in manuscript. Not identified.

FORT ADAMS; see St. James.

FORT ALEXANDER; see Nushagak.

FORT COSMOS; post on Kowak River near longitude 157°. Presumably named by the traders.

FORT CUDAHY; see Cudahy.

FORT HAMLIN; post on the south bank of the Yukon near longitude 149°. Presumably a trader's name. First published by the Coast Survey in 1897.

FORT SELKIRK; Canadian military headquarters at the mouth of Lewes River. The site of the old fort of the Hudson Bay Company is on the opposite bank of the river. This name has been adopted by the Canadian Board on Geographic Names.

FORTYMILE; town and trail; also creek tributary to the Yukon from the west near latitude $64\frac{1}{2}$°. Prospector's name, given, presumably, in 1886, when gold was first discovered here. The creek is about 40 miles below old Fort Reliance. The above form, Fortymile, has been adopted by the Canadian Board on Geographic Names.

FRANKLIN; creek tributary to South Fork of Fortymile Creek. Prospector's name, reported by United States Geological Survey in 1898.

FREDERICK; lake east of and near Dezadeash Lake in longitude 137°. Name published by the Canadian Board on Geographic Names in 1899.

GENS DE LARGE; see Chandlar.

GENS DES BUTTES; see Tanana.

GEROE; creek tributary to the Chandlar River from the south near latitude 68°. Presumably a miner's name; reported by the United States Geological Survey in 1899.

GIBSON; creek tributary to Dietrich River from the west near latitude 68°. Presumably a miner's name; reported by the United States Geological Survey in 1899.

GISASA; river tributary to the Koyukuk River from the west near latitude 65°. Native name, reported by Allen in 1885. In his text, page 106, it is Gissassakakat; on his map 4 it is Gissakakat. See Kakat.

GLACIER; bay penetrating the Alaskan mainland in the Fairweather region. Explored and named by United States naval officers in 1880. Descriptive name.

GLAVE; river tributary to Chilkat River from the west. Named in 1899 by the United States Geological Survey after Mr. E. J. Glave, who explored in this region in 1891.

GOLD; creek tributary to Middle Fork of the Koyukuk from the east near longitude 150°. Prospector's name, reported by United States Geological Survey in 1899.

GRANITE; creek tributary to Chandlar River from the west near latitude 67°. Prospector's name, reported by United States Geological Survey in 1899.

GRANITE; creek tributary to South Fork of the Koyukuk from the east near longitude 150°. Prospector's name, reported by United States Geological Survey in 1899.

GRAVE; creek tributary to Middle Fork of Chandlar River near longitude 148°. Prospector's name, reported by United States Geological Survey in 1899.

HAINES; mission, post-office, and village at head of Lynn Canal. The mission was established by the Presbyterians in 1880.

HARPER; "About 20 miles below Toclat River is the log house once used by Mr. Harper as a trading station; also the scene of Mrs. Bean's murder while her husband was a fur trader there." (Allen, page 86.) This post is in a bend in the river and is sometimes referred to as Harpers Bend.

HARRIET; creek tributary to the Koyukuk from the south near longitude 151°. Prospector's name, reported by the United States Geological Survey in 1899.

HARRISBURG; see Juneau.

HARRISON; see Alsek.

HAYES; glacier and river flowing from it to the Skwentna northwest of Cook Inlet. Named by the United States Geological Survey in 1898 after Dr. C. Willard Hayes.

HAYES; mountain near longitude 147°, latitude 63½°. Named by the United States Geological Survey in 1898 after Dr. C. Willard Hayes. Erroneously "Hays" on a recent chart.

HESS; creek tributary to the Yukon from the east near Rampart City. Apparently identical with Whymper River of the Coast Survey in 1869.

HOGATZA; river tributary to the Koyukuk from the north near longitude 156°. Native name reported by Allen in 1885. Usually written Hogatzakakat. See Kakat. This may be the same river as the one called Hokachatna.

HOKOTENA; river tributary to the Koyukuk from the north near longitude 149°. Native name, published by the Coast Survey in 1899.

HOLOÖATNA; see Kowak.

HOOTALINQUA; see Teslin.

HOOTCHY-EYE; see Hutshi.

HORACE; mountain on headwaters of Koyukuk River near longitude 149°. Prospector's name, reported by the United States Geological Survey in 1899.

HOT SPRINGS; 20 miles northwest of Katmai.

HUBBARD; mountain near Yakutat Bay; named in 1891 by the National Geographic Society after its president, Gardiner G. Hubbard.

HUDSON BAY; creek tributary to South Fork of the Koyukuk from the south near latitude 67°. Prospector's name, reported by the United States Geological Survey in 1899.

HUNGARIAN; creek tributary to South Fork of the Koyukuk near longitude 150°. Prospector's name, reported by the United States Geological Survey in 1899.

HUSLIA; river tributary to the Koyukuk from the west near longitude 156½°. Native name, reported by Allen in 1885 as Hussliakatna on his maps 1 and 4, and Husliakakat in his text, page 105. See Kakat.

HUTSHI; chain of lakes draining northward into the Lewes River in longitude 137°. Native name, apparently first published by Glave in the Century, September and October 1892, where it is spelled Hootchy-Eye. It has been variously written Hootch Eye, Hootch-i, Hutchi, Hotchi, Huchai, etc. The Canadian Board on Geographic Names has adopted the above form, Hutshi.

IGAGIK; see Ugaguk.

IGIAGIUK; see Becharof.

IGUSHIK; river draining from Amanka Lake to Nushagak River. Eskimo name, reported by Petrof in 1880 as Igushek, by the United States Fish Commission in 1890 as Egashak, by the United States Coast Survey in 1897 as Egashik, and by Spurr of the United States Geological Survey in 1898 as Egoushik.

INLAND; see Noatak.

ISHIIK; see Aishihik.

JACK WADE; see Wade.

JIM; river draining into the South Fork of the Koyukuk from the south near longitude 151°. Prospector's name, published by U. S. Coast Survey in 1899.

JIMTOWN; mining camp at the mouth of Jim River near longitude 151°. Prospector's name, reported by the United States Geological Survey in 1899.

JOHNSTON; hill near mouth of Naknek River, Bristol Bay. Named by the United States Fish Commission in 1890.

JUKCHANA; see Yukon.

JUNEAU; city, harbor, and island, southeastern Alaska. "Two prospectors, Harris and Juneau, found mineral here in 1880, and soon afterwards a camp was located." This camp, it is said, was named Harrisburg and the district Juneau. United States naval officers reconnoitered the harbor about this time, and called the camp Rockwell, after Commander Charles H. Rockwell, U. S. N. Owing to the resulting confusion in names, the residents held a town meeting and adopted the name Juneau.

KAIYUH; mountains south of the Yukon River, in longitude 158°; also river, near same, tributary to the Yukon from the south. Native name, reported presumably by Dall and published in 1869.

KAKAT; This is an Indian word used in northwestern Alaska, meaning river, and is appended to the name. Thus we have:

Allenkakat River=Allen (river) River.
Batzakakat River=Batza (river) River.
Daklikakat River=Dakli (river) River.
Dulbikakat River=Dulbi (river) River.
Gisasakakat River=Gisasa (river) River.
Hogatzakakat River=Hogatza (river) River.
Husliakakat River=Huslia (river) River.
Tozikakat River=Tozi (river) River, etc.

In such cases it has been thought best to drop the generic termination *kakat* and write Allen, Batza, Dakli, etc. This word kakat was written in 1871 by Captain Raymond, U. S. A., on his maps of the Yukon, "kargut" and "chargut;" as, Atutsakulakuschchargut, Tosekargut, etc.

KANUTENA; village; also river tributary to the Koyukuk from the south near Arctic City. Native name, reported by Allen in 1885 and by him written Konoóténá. This is apparently Old Man River of the prospectors.

KASKAWULSH; river tributary to the Alsek River. Native name, published in 1898 and probably earlier. Has been variously written Kaskarwurlch, Kaskarwulch, etc. The above form, Kaskawulsh, has been adopted by the Canadian Board on Geographic Names.

KATEEL; river tributary to the Koyukuk from the west in latitude 65½°. Native name, reported by Allen in 1885. Usually written Kateelkakat; see Kakat.

KATMAI; bay, creek, and village on north shore of Shelikof Strait. Native name, reported by the Russians. Lütke in 1828 calls it Katmaiskoi.

KATRINA; river tributary to the White from the west in latitude 63°. This name has been adopted by the Canadian Board on Geographic Names. It is apparently an error for the native word Katsiná, published by the United States Coast Survey in 1890.

KECHUMSTUK; range of hills south of the Tanana, in longitude 145°. Often called Razorback Divide by prospectors. On Coast Survey Chart T, editions of 1895 and 1896, it is called Razor Back Divide, and on later editions and maps Ketchumstock Hills.

KENAI BAY; see Cook Inlet.

KENNICOTT; glacier and creek flowing from it near latitude 61½°. Named in 1899 by the United States Geological Survey, presumably after Robert Kennicott, a pioneer on the Yukon River, who died at Nulato, May 13, 1866.

KHILTAT; river tributary to the Tanana from the north near longitude 144½°. Named by Allen in 1885 after an Indian chief, Kheeltat.

KIMBALL; mountain south of the Tanana River near longitude 145°. Named by Allen in 1885.

KINIAAK; see Naknek.

KLANAKAKAT; see Minook.

KLATSUTA; river tributary to the Yukon from the south below the Tanana. Native name, reported by Allen in 1885 as Klatsutakákat; see Kakat.

KLEHINI; river tributary to the Chilkat from the west in latitude 59° 24′. Native name, reported by United States naval officers in 1880 as Kluheeny. Krause in 1882 spelled it Tlehíni. The above form, Klehini, has been adopted by the Canadian Board on Geographic Names.

KLETSAN; creek flowing northward to the White River near longitude 141°. Native name, reported by Hayes in 1891 as Klet-san-dek, or Copper Creek, the termination *dek* meaning creek.

KLONDIKE; gold district; also river tributary to the Yukon from the east near latitude 64°. This river was named Deer River by the Western Union Telegraph Expedition of 1867, and so appeared on various maps. Later it was called Raindeer and afterwards Reindeer. Ogilvie, writing September 6, 1896, from Cudahy, says: "The river known here as the Klondike," and in a footnote says: "The correct name is Thron Duick." It has also been called Clondyke and Chandik or Deer.

KLOTASSIN; river tributary to the White from the east near latitude 62½°. Native name, reported by Hayes in 1891. The above form, Klotassin, has been adopted by the Canadian Board on Geographic Names.

KLUANE; lake and river flowing therefrom to the Donjek River near latitude 61½°. Native name, reported by Hayes in 1891 as Kluantu River, the termination *tu* meaning river. The name has also been written Kluahne. The above form, Kluane, as applied to both lake and river, has been adopted by the Canadian Board on Geographic Names.

KLUANTU; see Kluane.

KLUK-TÁS-SI; see Lebarge.

KLUKWAN; village near the mouth of Chilkat River. Native name, first reported by naval officers in 1880 as Chilkat or Klukquan. Krause in 1882 calls it Kloquán. The above form, Klukwan, has been adopted by the Canadian Board on Geographic Names.

KLUTENA; glacier, lake, and river emptying into Copper River. Native name, adopted by several hundred prospectors who camped at the lake in the season of 1898; has also been called Abercrombie.

KLUTLAN; glacier and river draining from it northward to the White River in longitude 141°. Native name, reported by Brooks in 1899.

KOGIUNG; Eskimo village at mouth of Kvichak River, Bristol Bay. Native name, reported by Petrof in 1880, who spelled it Koggiung.

KOIDERN; river tributary to the White River from the south near longitude 140½°. Native name, reported by Hayes in 1891.

KOTSINA; river near Mount Wrangell, tributary to Copper River from the east in latitude 62½°. Native name, reported by the U. S. Geological Survey in 1899.

KOWAK; river tributary to Hotham Inlet, Kotzebue Sound. An Eskimo word, long in use and variously spelled Kooak, Kowuk. According to Spurr it is Kubuk or Kuvuk, meaning great river. According to Allen it is Holoöatna or Kowak River. It has also been called Putnam or Kowak River.

KOYUKUK; river tributary to the Yukon from the north a little above Nulato. Also a mountain near the mouth of the river. A native name, reported by the Western Union Telegraph Expedition in 1867 as Coyukuk. On Coast Survey maps it has been called Kouiak, Koyoukuk, and Koyukuk. The above form, Koyukuk, has been adopted by the United States Board on Geographic Names.

KUSAWA; lake northwest of Chilkat Pass draining to Lake Lebarge. Native name, written Kussooä by Krause in 1882, Küssüa by the Coast Survey in 1883, Kusawah by the Canadian Geological Survey in 1898. Has also been called Arkell. The above form, Kusawa, has been adopted by the Canadian Board on Geographic Names.

KUSKOKWIM; bay and river, western Alaska. A native name, reported by Lütke in 1828 as Kouskokvim. Variously written Kuskokvim, Kouskoquim, etc. The above form, Kuskokwim, has been adopted by the United States Board on Geographic Names.

KUSKULANA; creek tributary to the Chitina from the east near latitude 61½°. A native name, reported by the United States Geological Survey in 1899.

KVICHAK; village, and river draining from Iliamna Lake to Bristol Bay. Native name, reported by the early Russians. Lütke, writing in 1828, says "Kvitchak called by Cook Bristol."

KWIKPAK; see Yukon.

LABERGE; see Lebarge.

LABOUCHERE; see Pyramid.

LACHINA; creek tributary to Chitina River from the north in longitude 143½°. Native name, reported by the United States Geological Survey in 1899.

LADUE; creek tributary to the White River from the west near longitude 140°. Presumably named after a prospector, La Due, who wintered on the Yukon in 1884–85.

LAKE; creek tributary to Chandlar River from the east near longitude 148½°. Presumably a descriptive name, now first published.

LEBARGE; lake and river in the Yukon district, Canada. Named in 1868 by the Western Union Telegraph Expedition, after Michael Lebarge. According to Schwatka the native name is Kluk-tás-si. The above form, Lebarge, has been adopted by the United States Board on Geographic Names, that form being the one used by Lebarge himself. The Canadian Board on Geographic Names has adopted the form Laberge.

LEWES; river tributary to the Upper Yukon. The present usage appears to regard the Yukon as beginning at the junction of the Lewes and Pelly rivers at Fort Selkirk. Often written Lewis. The above form, Lewes, has been adopted by the Canadian Board on Geographic Names.

LIARD; river tributary to the Mackenzie from the west. Has also been called Mountain River. The above name, Liard, has been adopted by the Canadian Board on Geographic Names.

LIMESTONE; creek tributary to Bettles River from the north near longitude 149½°. Descriptive name, now first published.

LOGAN; mountain (19,539 feet) in the St. Elias region. Named by Prof. Israel C. Russell, in 1890, in honor of Sir William E. Logan, "founder and long director of the Geological Survey of Canada." The name has been adopted by the Canadian Board on Geographic Names.

LOOKOUT; mountain about 800 to 1,000 feet above the river on west bank of Koyukuk River near latitude 67°. Named by Allen, who ascended it in August, 1885.

LORENTZ; river tributary to the Tanana from the south near longitude 150½°. Named by Allen in 1885 after Mr. Lorentz, of the Alaska Commercial Company, chief trader for the Yukon country. On some maps it is Lorenz.

LOWE; point and river on north shore of Port Valdes, Prince William Sound. Named by Abercrombie in 1898.

LYNN; canal, first explored and named by Vancouver in 1794.

MACKENZIE; river, named after its first explorer, Alexander Mackenzie.

McKINLEY; creek in Porcupine gold district. Prospector's name, now first published.

McKINLEY; mountain (20,460 feet) near headwaters of Kuskokwim River. Name published by the United States Coast Survey in 1897. Also called Bulshaia, a corruption of the Russian word for *big*.

MACMILLAN; mountains (3,500 feet), and river tributary to Pelly River from the east near latitude 63°. This form has been adopted by the Canadian Board on Geographic Names.

MAHUTZU; creek or river tributary to the Tanana from the south near longitude 146½°. Native name, reported by United States Geological Survey in 1898.

MARION; creek tributary to Middle Fork of the Koyukuk from the east near longitude 150°. Prospector's name, reported by the United States Geological Survey in 1899.

MARSH; lake northeast of Chilkoot Pass, on headwaters of Lewes River. Named in 1883 by Schwatka, after Prof. O. C. Marsh, of Yale College. This name has been adopted by the Canadian Board on Geographic Names.

MASON; narrows in Tanana River near longitude 146°. Named in 1885 by Allen in honor of Prof. O. T. Mason of the Smithsonian Institution.

MAUD; lake draining to Kusawa Lake near latitude 60°. Name published by Coast Survey in 1895.

MELOZI; river tributary to the Yukon from the north near longitude 155½°. Native name, reported by the Western Union Telegraph Expedition of 1867 as Melozecargut and usually written Melozikakat. See Kakat.

MENA-KAK-A-SHAH; see Walker.

MENTANONTLI; lake and river near longitude 152°. Native name, reported by Allen in 1885. On his map 4 it is Mentantlekakat, and in his text, page 97, etc., it is Mentanóntlekákat. See Kakat.

MENTASTA; lake, mountain range, pass, and trail between Copper and Tanana rivers. Native name reported by Allen in 1885.

MIDDLE; fork of Chandlar River. Descriptive name.

MIDDLE; fork of Koyukuk River. Descriptive name.

MILLARD; trail about 90 miles long from Copper Center to Mentasta Pass, along the western slopes of Mounts Drum and Sanford. Prospector's name.

MINOOK; creek tributary to the Yukon from the east near longitude 150°. Apparently identical with Klanarchargut (? Klana-kakat) River of Coast Survey chart 900, published in 1890. Is sometimes spelled Mynook. Named, presumably, after Mr. Minook, interpreter at Fort Reliance.

MIRROR; creek tributary to the Tanana from the east near latitude 62½°. Descriptive name, given by the United States Geological Survey in 1898.

MOOSEHORN; mountain near international boundary and latitude 63°. Named by United States Geological Survey in 1898.

MOSQUITO; fork of South Fork of the Koyukuk near longitude 150°. Descriptive name, given by prospectors.

MUIR; large glacier at head of Glacier Bay. Named, in about 1880, after John Muir.

MYNOOK; see Minook.

MYRTLE; creek tributary to Middle Fork of the Koyukuk, from the east, near longitude 150°. Prospector's name, reported by the United States Geological Survey in 1899.

NABESNA; river, one of the principal tributaries of the Upper Tanana. According to Allen, page 136, "The natives of the Upper Tanana call that river Nabesna."

NAKNEK; lake and river draining from it and village at mouth of river. Apparently a corruption of an Eskimo name, first reported by early Russian surveyors. The earliest Russians reported the name of the river to be Naknek, and of the lake, Agulogak. Lütke, in 1828, calls both lake and river Naknek. Tebienkof, in 1849, also gives Naknek, with Naugvik as an alternative form, this being taken from old Russian charts. A Russian post at or near the village was named Fort Suworof, and variously written Souworoff, Suvaroff, etc. This seems for a time to have superseded the native name of the village. Petrof, in 1880, named the lake Walker, after Gen. F. A. Walker, Superintendent of the Census, and reported the name of the village to be Kinghiak, on late maps Kiniaak. Out of all this confusion the above form *Naknek* has been selected and adopted by the United States Board on Geographic Names.

NATAZHAT; mountain range north of Mount St. Elias. Native name, reported by Hayes in 1891 as Nat-azh-at.

NATSINA; see White.

NAUGVIK; see Naknek.

NEEDLES; mountain near latitude 62° and between the one hundred and forty-first and one hundred and forty-second meridians. Descriptive name given by the United States Geological Survey in 1898.

NELSON; see Baker.

NEMETH; creek tributary to South Fork of the Koyukuk from the east near longitude 148°. Presumably a prospector's name, published by the U. S. Coast Survey in 1899.

NEWBERRY; see Teslin.

NIGA TO; see Yukon.

NIKOLAI; house on Nizena River, south bank, near mouth of the Chitistone. Name of an Indian chief, reported by Hayes in 1891, who says "Nicolai, or Scolai, as the Yukon Indians call him."

NILKOKA; river tributary to the Tanana from the north near latitude 65°. Native name, reported by the United States Geological Survey in 1898.

NISLING; river tributary to the White River from the east near longitude 140°. Native name, reported by Hayes in 1891.

NIZINA; glacier and river tributary to the Chitina. Native name, reported in 1891 by Hayes, who spells it Nizzenah.

NOATAK; river in northwest Alaska, tributary to Hotham Inlet. On early maps this is called Inland River and sometimes Inland, or Nunatok. The prevailing modern usage is Noatak, as above given.

NOCOTOCARGUT; see Bean.

NOHTALOHTON; see Notaloten.

NORDENSKIOLD; river tributary to Lewes River from the south near longitude 136°. Named by Schwatka in 1883 after Baron A. N. E. von Nordenskiöld, the celebrated Swedish Arctic explorer.

NORTH; creek tributary to South Fork of the Koyukuk from the east near longitude 147°. Name published by U. S. Coast Survey in 1899.

NORTH; fork of Birch Creek. Name published by the Coast Survey in 1899.

NORTH; fork of Koyukuk. Prospector's name, now first published.

NORUTAK; lake near Arctic circle, drained by the Kowak. Native name, reported by Cantwell in 1885 as Nor-u-tak. Schrader, in 1899, calls it Nowgettoark.

NOTALOTEN; village (of 15 people) on north bank of the Yukon near longitude 157°. A native name, reported in the Tenth Census (1880) as Natulaten, in the Eleventh Census (1890) as Notaloten, and on U. S. Coast Survey chart 3093, edition of 1898, as Nohtalohton.

NOTOKAKAT; see Dall.

NOWGETTOARK; see Norutak.

NOWI; village, and river tributary to the Yukon from the south near longitude 154½°. Native name, first reported by the Western Union Telegraph expedition in 1867 as Newicargut, the termination *cargut*, now written *kakat*, meaning river. (See Kakat.) Petrof, in 1880, wrote the name Noyakakat, now usually written Nowikakat.

NUDRE-WOK; see Selby.

NULATO; post or village on the Yukon River, north bank, about 400 miles above the mouth. Founded by the Russian Malakof, who, in 1838, built a blockhouse here. Shortly after, in his absence, this was burned by the Indians. It was rebuilt by Vasili Derzhabin (? Derabin) in 1842.

NUNATOK; see Noatak.

NUSHAGAK; lake between Kuskokwim River and Bristol Bay. On late maps this is called Tikchik, and the river draining from it to the Nushagak River is called Tikchik River.

NUSHAGAK; river tributary to the head of Bristol Bay. Native name, reported by the early Russian explorers as Nushegak and Nushagak. Lütke (1828) writes it Nouchagak. Apparently the same river which Cook, in 1778, named Bristol. The form Nushagak has been adopted by the United States Board on Geographic Names.

NUSHAGAK; trading post at mouth of Nushagak River. The Russians established a trading post at the mouth of the Nushagak in 1818 or 1819 and called it Alexandrovsk, perhaps after Alexander Baranof, under whose orders the post was established. Variously called since then Redoubt or Fort and spelled Alexander, Alexandrovsk, Alexandrovski, etc., and erroneously Alexandra. Now generally known as Nushagak.

NUTUVUKTI; lake near Arctic circle, drained by the Kowak. Apparently a native name, reported by Schrader in 1898 as Nootowucktoy.

NUTZOTIN; range of mountains near headwaters of Tanana River. Named by the United States Geological Survey in 1898 after a tribe of Indians in the region.

O'BRIEN; creek tributary to Fortymile creek. Miner's name, published by the Coast Survey in 1898.

OBSERVATORY; see Pyramid.

OCONNOR; glacier and river northeast of Mount Hubbard. Named by the United States Geological Survey in 1899.

OLD MAN; see Kanutena.

OR-KIM-YA-NOOK; see Colville.

OSCHESNA; see Fickett.

PAH; rapids in the Kowak River near longitude 156°. Near these rapids debouches a river whose name, according to Cantwell, 1885, is Shok-ah-pok-shegiak river. The name of the rapids, Pah, transformed to Par, has been applied to this river.

PASCO; creek tributary to Middle Fork of the Koyukuk from the south near latitude 67°. Prospector's name, now first published.

PAWIK; an Eskimo village on the east side of Bristol Bay. Also written Pawkìk and Pawig.

PEAVEY; post-office and mining camp on the north bank of the Koyukuk near longitude 152°. It is also called Peavy and Peavy Trading Post.

PELLY; mountains, lake, and river, Yukon, Canada. Named after a former governor of the Hudson Bay Company.

PERRIER; see Chilkoot.

PESTCHANI; see Pyramid.

PHOEBE; creek tributary to Bettles River from the east near longitude 149°. Prospector's name, now first published.

PICKARTS; creek tributary to the Koyukuk from the north near Arctic City. Named in 1899 after Pickarts, of the firm of Pickarts, Bettles & Pickarts, owners of the trading post Bergman.

PLEASANT CAMP; place on the Dalton trail, in Pocupine gold district.

PLEVEZNIE; see Tazlina.

POGAKHLUK; see Amanka.

PORCUPINE; city, creek, and gold district near Chilkat River. Prospector's name, reported by the United States Geological Survey in 1899.

PORCUPINE; creek tributary to Middle Fork of the Koyukuk from the north near longitude 150½°. Prospector's name, now first published.

PORCUPINE; creek tributary to the South Fork of the Koyukuk River from the north near latitude 68°. Published by the United States Coast and Geodetic Survey in 1899. Perhaps this creek is identical with the previous one.

PORCUPINE; river in northeastern Alaska tributary to the Yukon. Old name, probably given by factors of the Hudson Bay Company.

PREACHER; creek tributary to Birch Creek from the south near latitude 66°. Name published by the United States Coast and Geodetic Survey in 1895.

PUTNAM; see Kowak.

PYRAMID; harbor, island, point, etc., at head of Lynn Canal; so named by Meade in 1869. The name is descriptive of the island. The harbor was called Labouchere Bay from the fact that the Hudson Bay Company steamer of that name often anchored there. The island was called Pestchani (sandy) by the Russians. It has also been called Farewell, Stony, and Observatory, while its Indian name is Shla-hatch, or, according to Krause, Chlachátsch.

QUARTZ; creek tributary to Chandlar River from the west near latitude 68°. Presumably a descriptive name, now first published.

RAY; river tributary to the Yukon from the west near longitude 150°. So named by Allen in 1885 after Capt. P. H. Ray, U. S. A.

RAZORBACK; see Kechumstuk.

REDSTONE; river tributary to Ambler River near longitude 158°. Descriptive name, reported by Schrader in 1899.

REGAL; mountain in longitude 143°, ESE. from Mount Wrangell. Named by the United States Geological Survey in 1899.

ROBERT; creek tributary to Bettles River from the east near longitude 149°. Prospector's name, now first published.

ROBERTSON; river tributary to the Tanana from the west near longitude 145°. Named in 1885 by Allen in honor of Sergt. Cady Robertson, U. S. A., a member of his party.

ROCKWELL; see Juneau.

ROMANZOF; mountain near latitude 67°. Named by Franklin in 1826 after the late Baron Romanzof, chancellor of the Russian Empire. The mountains so named are on the north coast of Alaska. Schrader applies the name to mountains considerably farther south.

ROOT; glacier near Kennicott Glacier, in longitude 143°. Named by the United States Geological Survey in 1899.

ROSE; creek tributary to the Middle Fork of the Koyukuk from the east near longitude 150°. Prospector's name, now first published.

ROUNDABOUT; mountain on north bank of Koyukuk River near longitude 156°. Apparently a descriptive name, now first published.

RUSSELL; glacier near Skolai Pass near longitude 142°. Named by the United States Geological Survey in 1899 after Prof. I. C. Russell, of Ann Arbor, Mich.

ST. ELIAS; mountain peak (18,024 feet) and range, discovered and named by Bering July 16, 1741 (o. s.). According to Topham its Indian name is Yahtse-tah-shah.

ST. JAMES; mission on north bank of the Yukon near the mouth of Tozi River. An Episcopalian mission was established here in 1891 by Rev. J. L. Prevost. The place is called Fort Adams.

ST. MICHAEL; canal, bay, island, mountain (472 feet), and town, Norton Sound. A stockaded post was established here by the Russians in 1833 and, according to Zagoskin, named after Capt. Michael Dmitrievich Tebienkof, afterwards governor of the Russian-American colony. It was called Redoubt St. Michael or Michaelovski. The above form, St. Michael, has been adopted by the United States Board on Geographic Names.

SAGHADELLAUTAN; see Zakatlatan.

SAJAHLAKAT; see Sozhekla.

SAKATALODEN; see Zakatlatan.

SALCHAKET; river tributary to the Tanana River from the east near longitude 147°. Native name, reported by the United States Geological Survey in 1898 and spelled Salchacket and Salchaket.

SALMON; river tributary to the Chilkat from the west. Name reported by Brooks, of the United States Geological Survey, in 1899.

SALMON; see Sheenjek.

SANFORD; mountain east of and near Copper River, in longitude 144°. Also river tributary to Copper River. Named by Allen in 1885 in honor of the Sanford family, his "great-grandfather being Reuben Sanford."

SAVONÓSKI; an Eskimo village at the east end of Naknek Lake. Name obtained by the United States Geological Survey from Rev. A. Petelin in 1898.

SCOLOI; see Skolai.

SCOTTIE; creek near international boundary, between latitudes 62° and 63°. Named by Peters and Brooks in 1898 after a member of their party.

SEAFORTH; mining camp on South Fork of Koyukuk River near longitude 151°. Prospector's name, reported by United States Geological Survey in 1899.

SEAL; an isolated rock near Katmai. Name obtained by the United States Geological Survey in 1898 from Rev. A. Petelin.

SEATTLE; mountain in St. Elias region. Named by the United States Geological Survey in 1899.

SEKULMUN; lake in latitude 61½°, longitude 137½°. Apparently a native name, which has also been spelled Sekulman. The above form, Sekulmun, has been adopted by the Canadian Board on Geographic Names.

SELAWIK; lake and river tributary to Kotzebue Sound. An Eskimo name, written Salawik and Selawik. The Point Barrow natives, according to John Murdoch, pronounce it Sílawik. The above form, Selawik, has been adopted by the United States Board on Geographic Names.

SELBY; lake near Arctic Circle, drained by the Kowak River. Name reported by Schrader, of the United States Geological Survey, in 1899. This appears to be Nudre-wok Lake of Cantwell in 1885.

SEVENTYMILE; creek tributary to the Yukon from the west, near latitude 65°. Prospector's name. The creek is about 70 miles below old Fort Reliance.

SHAK-AH-POK-SHEGIAK; see Pah.

SHEENJEK; river tributary to the Porcupine from the north near longitude 144½°. Late Coast Survey charts call it Salmon River, and earlier ones give Sheenjek or Salmon. Name apparently first published in 1895.

SHEEP; creek tributary to Dietrich River from the west near latitude 68°. Prospector's name, reported by Schrader, of the United States Geological Survey, in 1899.

SHEEP; creek tributary to Robert Creek near headwaters of the Koyukuk. Prospector's name, reported by the United States Geological Survey in 1899.

SHEVLIN; creek tributary to the Yukon from the south near longitude 151°. Name now first published.

SHORTY; creek tributary to the headwaters of the Alsek. Name now first published.

SILOK; creek tributary to the Tanana from the south near longitude 148°. This stream was called Delta Creek by Allen in 1885. To avoid confusion with Allen's Delta River and because the exact locality of his Delta Creek is not clear, this change has been introduced by the Geological Survey. Apparently a native name, which has also been spelled Silokh.

SKAGWAY; river and town at the head of Taiya Inlet. So spelled by both the Canadian and United States Boards on Geographic Names.

SKOLAI; pass, creek, and mountains between the White and Copper rivers. Spelled variously Scolai, Scoloi. Scolai is the name by which the Copper River Chief Nicolai or Scolai is known amongst all the Yukon natives. (Hayes in Nat. Geog. Mag., IV, 135.)

SLANA; river draining from Lake Suslota to Copper River. A native name, reported by Allen in 1885. Has also been written Slahna.

SLATE; creek tributary to the Middle Fork of the Koyukuk from the east near longitude 150°. Prospector's name, first published in 1899.

SLIMS; river tributary to Kluane Lake near latitude 61°, longitude 138½°. Name now first published.

SNAG; river tributary to the White from the west near longitude 140½°. Descriptive name, given by Peters and Brooks in 1898.

SNAKE; river tributary to the Nushagak River from the west. Local name, apparently suggested by the tortuous course of the stream.

SOLUKA; creek tributary to Katmai Creek near longitude 155°. Native name, obtained by the United States Geological Survey from Rev. A. Petelin in 1898.

SOO CITY; mining camp on South Fork of the Koyukuknear longitude 151°. Prospector's name, reported by the United States Geological Survey in 1899.

SOONKAKAT; village, and river tributary to the Yukon from the south in longitude 156°. Petrof in 1880 uses Soonkakat as the name of the village. Allen, in 1885, calls a stream which appears to be identical with this the Yukokakat. See Kakat.

SOONKAKAT; see Yuko.

SOUTH; fork of Birch Creek. Name published by the Coast Survey in 1895.

SOUTH; fork of the Koyukuk, tributary to the Koyukuk, near the Arctic Circle. Name published by the Coast Survey in 1899.

SOZHEKLA; river tributary to the Koyukuk from the north near longitude 151°. Native name, reported in 1885 by Allen, who writes it Sohjeklakakat in his text, page 99, and Sajeklakat on his map 4. It has also been written Sajahlakat.

SPURR; glacier in longitude 143°, near Skolai Pass. Named after J. E. Spurr, of the United States Geological Survey.

SQUAW; creek tributary to South Fork of the Koyukuk from the east near latitude 67°. Prospector's name, now first published.

STIKINE; strait and river debouching from the mainland near Wrangell. Supposed to be the native name of the river, and, since 1860 at least, written Stachine, Stahkeen, Stickeen, etc.; also, erroneously, Francis River and Pelly River. The above form, Stikine, has been adopted by both the Canadian and United States Boards on Geographic Names.

STONY; see Pyramid.

SUKOSLEANTI; river tributary to the Koyukuk from the west near its mouth. Native name, reported in 1885 by Allen, who writes it Succoslëanty in his text, page 106, and Succoslcanty on his map.

SUNSHINE; village or camp on the Klehini River near Chilkat River. Prospector's name.

SUSHITNA; mountain; river tributary to head of Cook Inlet; also Indian village and trading station of the Alaska Commercial Company, 50 miles north of the village of Tyonek. A native name long in use; has been written Suchitna and Sushetno. The above form, Sushitna, has been adopted by the United States Board on Geographic Names.

SUSLOTA; creek tributary to the Slana River. Native name, reported by Allen in 1885. In his text it is printed Suslota, and also, apparently erroneously, Sustota.

SUWOROF; see Naknek.

TABLE; mountain (6,000 feet) on headwaters of Koyukuk River in latitude 68°. Descriptive name, now first published.

TAGISH; lake and post-office east of Bennett Lake, Yukon district, Canada. Named Bove, in 1883, by Schwatka, after Lieutenant Bove of the Italian navy, but by Dr. Dawson called Tagish. The native name, according to Ogilvie, is Takone. The above name, Tagish, has been adopted by the Canadian Board on Geographic Names.

TAHKO; see Teslin.

TAIYA; see Dyea.

TAKHIN; river tributary to the Chilkat from the west, near head of Lynn Canal. Native name, reported by United States naval officers in 1880 as Takheen. Krause's map of 1882 has Takhin. Has also been called Tahini, Taklini. The above form, Takhin, has been adopted by the Canadian Board on Geographic Names.

TAKHINI; river draining from Kusawa Lake to the Lewes River. Native name, reported in 1883 by Schwatka, who writes it Tahk-heen-a. The above form, Takhini, has been adopted by the Canadian Board on Geographic Names.

TAKONE; see Tagish.

TAKU; arm, inlet, harbor, mountain pass, and river, near Juneau. Local name, first applied by Vasilief in 1848. Variously written Taco, Tahko, Takou, etc. The above form, Taku, has been adopted by the Canadian Board on Geographic Names.

TANADA; creek and lake tributary to Copper River from the east near longitude 144°. Apparently a native name; reported by the United States Geological Survey in 1899.

TANAKOT; village on north bank of the Yukon, near mouth of the Melozi River. The Tenth Census (1880) gives as the name of a town near this locality Tanakhotkhaiak. On later maps this name appears as Tahnohkalony.

TANANA; large river of central Alaska, tributary to the Yukon; literally Tenan-ná or Tenan River, said to mean river of the mountain men. According to Allen its upper part is called Nabesná by the natives. It was known to the traders of the Hudson Bay Company as Gens des Buttes. Has been variously written Tananah, Tannanah, Tennanah, etc., but is now universally known as the Tanana.

TANANA; glacier in latitude 62°, longitude 142½°. Named by the United States Geological Survey in 1898.

TARÁL; village consisting in 1885 of two houses on the Copper River, at the mouth of the Chitina. Native name, reported by Allen.

TATSHENSHINI; river tributary to the Alsek River. Native name, reported in 1882 by Krause as Tatschanzhíni, and variously spelled. The above form, Tatshenshini, has been adopted by the Canadian Board on Geographic Names.

TAZLINA; glacier and river north of Prince William Sound, near latitude 62°; also a lake called Tazlina or Pleveznie. Native name, reported by Geological Survey in 1898.

TESLIN; lake and river tributary to the Upper Yukon; often called Hootalinqua or Teslin. On early charts mistakenly called the Tahko. It is the Newberry River of Schwatka. The above form, Teslin, has been adopted by both the Canadian and United States Boards on Geographic Names.

TETLING; village (two houses), and river tributary to the Upper Tanana. Named in 1885 by Allen after an Indian.

THRON DUICK; see Klondike.

TIKCHIK; see Nushagak.

TLEHINI; see Klehini.

TOK; river tributary to the Tanana River from the south near longitude 143°. Native name, reported by Allen in 1885 as Tokái. According to Peters and Brooks, of the United States Geological Survey, this name, Tok, is in general use by both whites and Indians.

TOKLAT; river tributary to the Tanana from the south near longitude 151°. Native name, reported in 1885 by Allen, who spells it Toclat, and says its meaning is "dish water."

TONSINA; creek or river tributary to the Copper River from the west near latitude 62°. Native name, published on several maps. On recent maps it has been called Archer River.

TOTSENBETNA; river tributary to the Koyukuk from the north near longitude 149°. Native name, published by the Coast Survey.

TOWER; bluff on the Tanana River near longitude 144°. Named by Allen in 1885.

TOWER BLUFF; rapids in the Tanana near the above. Named by Allen in 1885.

TOZI; river tributary to the Yukon from the north near longitude 152½°. Native name reported by the Western Union Telegraph Expedition of 1867 as Towshecargut, and by Allen in 1885 as Tozikakat. See Kakat.

TRAMWAY; bar on Middle Fork of the Koyukuk River near longitude 150½°. Gold-producing bar located and named in the spring of 1899.

TREAT; island in Koyukuk River near longitude 156°. Named by Allen in 1885 after his classmate Lieut. Charles G. Treat, U. S. A.

TUTLUT; see Cantwell.

TWELVEMILE; creek tributary to the Middle Fork of the Koyukuk from the north near longitude 150½°. Apparently a descriptive name.

UGAGUK; river draining westward from Becharof Lake to Bristol Bay; also village at mouth of stream. An Eskimo name, reported by Lütke in 1828 as Ugaguk (Ougagouk) and by later Russians as Ugaguk or Igagik and since variously written Agouyak, Igiagik, Ugiagik, etc.

UGASHIK; see Becharof.

UNION CITY; mining camp at the mouth of South Fork of the Koyukuk River near longitude 152°. Prospector's name.

VALDES; glacier, narrows, port, and village at the head of Prince William Sound. According to Vancouver the port was named in the last century, by Fidalgo, Puerto de Valdes, and the spelling Valdes has been usually followed until quite recently, when the spelling Valdez has appeared. Valdes Narrows has also been called Stanton Narrows.

VANCOUVER; mountain in St. Elias region, named by the Coast Survey in 1875 after Capt. George Vancouver, who explored in this region in the last decade of the last century.

VOLKMAR; river tributary to the Tanana from the east near longitude 146°. Named in 1885 by Lieutenant Allen in honor of Col. William J. Volkmar, U. S. A.

WADE; creek in Fortymile mining district. Prospector's name, published by United States Geological Survey in 1899. Presumably named after a prospector, Jack Wade.

WAITE; island in the Koyukuk River. Named by Allen in 1885 "in honor of Miss Waite, of Washington City."

WALKER; fork of South Fork of Fortymile Creek. Miner's name, published by the U. S. Coast Survey in 1898.

WALKER; lake near latitude 67°, drained by the Kowak River. Name reported by Schrader of the United States Geological Survey in 1898. The lake is seemingly identical with Mena-kak-a-shah of Cantwell in 1885.

WALKER; station on north bank of the Yukon near the mouth of Tozi River, apparently identical with Nuklukayet.

WALKER; see Naknek.

WALKERVILLE; village near or in the Porcupine gold district. Name now first published.

WEARE; town on the north bank of the Yukon at the mouth of Tanana River.

WELLESLEY; lake near international boundary, named by Hayes in 1891 after Wellesley College. Also mountain near the same, named by United States Geological Survey in 1898.

WEST; fork of Chandlar River near latitude 67°. Name now first published.

WEST KUSSUA; see Kusawa.

WHITE; pass at head of Lynn Canal, named in 1887 by Ogilvie after the Hon. Thomas White, minister of the interior (of Canada).

WHITE; river in Alaska and British Columbia tributary to the Upper Yukon. Discovered in 1850 by Robert Campbell of the Hudson Bay Company and by him named White on account of its color. According to Allen its Indian name is Natsiná.

WHYMPER; see Hess.

WILSON; creek tributary to South Fork of the Koyukuk River from the north near longitude 150°. Prospectors name, reported by the United States Geological Survey in 1899.

WINTHROP; spur of mountain on north bank of the Koyukuk near longitude 156°. Also called Point Winthrop. Named in 1899.

WISEMAN; creek tributary to Middle Fork of the Koyukuk from the east near longitude 150°. Prospector's name, reported by United States Geological Survey in 1899.

WOOD; river draining from Aleknagik Lake to Nushagak River. Apparently so named by the United States Fish Commission in 1890.

WRANGELL; mountain east of Copper River near latitude 62°. Named by the Russians after Baron von Wrangell, whose branch of the family always used the double "l." Erroneously written Wrangle.

YACHERGAMUT; village on the Igushak River. Native name, reported by Geological Survey in 1898.

YAHTSE-TAH-SHAH; see St. Elias.

YAKUTAT; large bay in St. Elias region. Visited in 1786 by La Perouse, who named it Baie de Monti. In the same year Portlock named it Admiralty Bay. The Spaniards, a little later, following Portlock, called it Almiralty and Almirantazzo. Lisiansky in 1805 called it Jacootat and Yacootat. On the supposition that the bay was visited by Bering in 1741 it has been called by his name. Usage has, however, settled upon the native name Yakutat, and this form has been adopted by the United States Board on Geographic Names.

YUKO; river tributary to the Yukon from the south near longitude 156°. Native name, reported by Petrof in 1880 as Yukokakat; see Kakat. This stream appears to be identical with that called Soonkakat.

YUKON; principal river of Alaska. The headwaters of this river were known to traders of the Hudson Bay Company early in the century. Its lower part was explored by the Russians in 1837–38. Derzhabin founded the Russian post, Nulato, in 1841, and McMurray the English post, Fort Yukon, in 1847. The Eskimo name of the river, by which it was long known, is Kwik-pak (River-big), variously spelled Kvichpak, Kvikhpakh, etc. The Indian name is Yukon, variously written Youcon, Yucon, etc., while one tribe of Indians, according to Allen, call it Niga To. Grewingk also gives the names Jukchana and Juna. The form Yukon has been adopted by the United States and Canadian Boards on Geographic Names.

ZAKATLATAN; village (population 39) on north bank of the Yukon near longitude 156½°. In the Tenth Census a village called Zakatlatan is located here on the south bank. In the Eleventh Census we have Sakataloden, supposed to be the same place. On late maps it is Saghadellautan.

INDEX.

A.

Page.

Abercrombie, Capt. W. R., exploration in Alaska by 343, 399, 400, 402
Adams, G. I., and Taff, J. A., paper on geology of Eastern Choctaw coal field, Indian Territory, by 257-311
Adkins, C. G., coal-mining operations in Indian Territory by 302, 304
Alaska, acid igneous rocks in 430
  animals in 387-388, 415, 459-460
  Archean rocks in 356-357, 367, 433, 471-472
  basic volcanic rocks of 429-430
  birds in 388, 415, 460
  Carboniferous rocks in 359, 367, 369, 370, 431, 433
  climate and seasons in .. 388, 412-414, 458-459
  coal in 382-383, 485-486
  Coast Range of 345
  copper in 377-382, 437-439, 482
  correlation of geologic formations of . 367, 431-433
  Cretaceous rocks in 367, 370, 433, 476-477
  Devonian rocks in 367, 369, 370, 433, 476
  distances in (tables) 450
  early explorations in . 340-343, 400-401, 431, 433
  effusive rocks of 362-363, 364
  fish in 415, 460
  fossils from 439-440
  game in 387-388, 415, 459 460
  geographic names in 487-509
  geologic maps of 356, 404
  geologic reconnaissances in 331-486
  glacial phenomena in 364-365
  gold in 373-377, 436-437, 482-485
  ground ice in 366
  igneous rocks of 360-362, 364, 430, 479-482
  intrusive rocks of 360-362, 370
  insects in 460
  Jurassic rocks and fossils of .... 367, 370 (note), 431, 433, 439, 440
  lead ore in 482
  maps of .... 338, 356, 374, 380, 400, 404, 448, in pocket
  mineral resources of . 373-383, 436-439, 482-486
  Miocene rocks of 372
  names of geographic features of 487-509
  native inhabitants of 388-390, 457-458
  pack trains, use of, in 418
  Pleistocene deposits of 363-364, 367, 371-372, 433, 478-479
  railway routes possible in 386-387
  routes, trails, and methods of travel in 383-387, 415-418, 453-457
  Silurian rocks in 358, 367, 368, 433, 474-475
  Tertiary rocks of 362-363, 367, 370, 372, 433, 477, 478

Alaska—Continued. Page.
  timber and vegetation in 387, 414, 460-461
  topographic maps of portions of 338, 346, 355, 374, 380
  trails and routes in .. 383-387, 415-418, 453-457
  Triassic rocks and fossils of 426-427, 431, 433, 439, 440
  vegetation in 387, 414, 460-461
  volcanic rocks in 371, 429-430, 481-482
  volcanic tuff in 365-366
  white inhabitants of 390-391, 457, 458
Alaskan Range, features of 372
Algonkian rocks, Rico Mountains .. 25, 26, 37-41
Allen, Lieut. H. T., explorations in Alaska by 341, 400, 410
Allen River, Alaska, route along 456
Alluvial fans, Rico Mountains, Colorado . 162-163
Allyn Gulch, Rico Mountains, Colorado, glacial cirque near 156
Alsek River basin, Alaska, features of .. 348-349
Alunite, analyses of 94
Amphibolite-schist, Alaska, character and occurrence of 472-473
Analyses, alunite rocks 94
  banatite 82
  coal 207, 306-311, 325-329
  diorite-porphyry 86
  monzonite 82
  monzonite-porphyry 86
  quartz-monzonite 86
Animals, Alaska 387-388, 415, 459-460
Aplite, metasomatic alteration of 246-247
Archean rocks, Alaska .. 356-357, 367, 433, 471-472
Arkansas, maps showing area of Camden coal field in 320, 322
  report on Camden coal field of 313-329
Arkansas Valley region, Indian Territory, topography of 267
Aspen Creek, Colorado, landslide areas on . 145
Atlantic Cable claim, Rico, Colo., section at 27, 42
Atoka formation, Indian Territory, features of 273-274
Augite-vogesites, Rico Mountains 32, 88
Aztec Gulch, Rico Mountains, Colorado, view of alluvial fan at mouth of .. 162

B.

Baby Creek, Alaska, granite on 480
  route along 454
Backbone anticline, Indian Territory, features of 283-284
Backbone fault, Indian Territory, course and general features of 285
Baker Creek, Alaska, features of 352
Baker, Marcus, list of Alaskan geographic names prepared by 487-509

Page.

Banatite, analyses of ... 82
occurrence of, Rico Mountains ... 30-31, 79-82
Barnard, E. C., Alaskan exploration by ... 343
Basalt, Alaska ... 471-472, 481-482
Basic dike rocks, Rico Mountains ... 31-32, 87-90
Bazanof, exploration in Alaska by ... 400
Beardslee, Capt. L. A., Alaskan exploration by ... 340
Becker, G. F., cited on solution of gold in thermal waters ... 249
Bedding faults, Rico Mountains, features of ... 107-110
origin of ... 110-112
Bergman, Alaska, faulting in sandstone near ... 469
location and importance of ... 484
view of ... 456
Bergschrund, cirque sculpturing by means of ... 173, 178, 185-187, 190
Bettles, G. C., acknowledgments to ... 448
Bettles series of rocks, Alaska, character and occurrence of ... 475
Bighorn Mountains, Wyoming, glacial sculpture in ... 167-190
Birch Creek schists, Alaska, age and correlation of ... 367, 433
Birds, Alaska ... 388, 415, 460
Blackhawk mine, Rico Mountains, Colorado, fault at ... 116-118
Blackhawk Peak, Colorado, landslide areas near ... 144-145
view from ... 18
views of ... 21, 22, 24
Boggy shale, Indian Territory, features of ... 278-279
Bokoshe syncline, Indian Territory, coal beds in ... 295
features of ... 284
Boulder Hot Springs, Montana, alteration of rocks by action of water of ... 244-247
faulting of vein at ... 249
fissures and fissure filling at ... 238-240
gold and silver content of veins at ... 248-249
jasper and quartz veins at ... 234-235
location and general features of ... 235-237
map of ... 238
metasomatic alteration of rocks at ... 246-247
microscopic petrography of altered rocks and vein filling at ... 252-255
mineral vein formation at ... 227-255
ore deposition at ... 249-252
origin of vein-forming material at ... 248
quartz and jasper veins at ... 234-235
recent movement or faulting of vein at ... 249
rock decomposition affected by ... 244-245
theory of ore deposition at ... 249-252
vein filling at ... 240-244, 248
view of ... 234
water of ... 237-238
Brazil anticline, Indian Territory, coal beds in ... 291
features of ... 282-283
Broca, George, Alaskan exploration by ... 341

Page.

Brogger, W. C., rock name "monzonite" proposed by ... 79
Brooks, A. H., cited on Alaskan topography and geology ... 351-352, 362, 367, 369, 435, 436
exploration in Alaska by ... 343, 400
report of reconnaissance in Alaska by ... 331-486
Brown, Ed., acknowledgments to ... 337
Bryan Creek, Alaska, gold on ... 485
Bryan, L. W., acknowledgments to ... 265
Burlingame & Co., assays made by ... 448
Burnett Creek, Colorado, landslide areas near ... 141-143

C.

Cahill, Joseph, acknowledgments to ... 337
Calcareous spring deposits, Rico Mountains ... 163-164
Calcite netted with silica, Boulder Hot Springs, Montana ... 242-243
Calico Peak, Colorado, porphyry of ... 87
solfataric action at ... 33, 91-93
view of ... 32
Camden coal field, Arkansas, age of coal-bearing rocks of ... 320-321
coal of ... 322-329
location of ... 319
maps of ... 320, 322
rocks of ... 321-322, 325-329
sections in ... 321, 322
topography of ... 319-320
Canadian Development Company, acknowledgments to ... 448
Cantwell conglomerate, Alaska, age and correlation of ... 367, 433
Cantwell River, Alaska, features of ... 352
Carbonic acid exhalations, Rico Mountains, Colorado ... 33, 164, 165
Carboniferous fossils, Rico Mountains, Colorado ... 48, 59, 66
Carboniferous rocks, Alaska ... 359, 367, 369, 370, 431, 433
Rico Mountains, Colorado ... 27-28, 47-66
Cavanal coal, Indian Territory, occurrence and character of ... 292-294
Cavanal coal-mining district, Indian Territory, operations in ... 300
Cavanal Coke and Railway Company, Indian Territory, operations of ... 301
Cavanal mine, Indian Territory, vertical section showing coal bed and associated rocks in ... 292
Cavanal Mountain, Indian Territory, syncline at ... 282
Cavanal syncline, Indian Territory, coal beds in ... 289, 291-292, 292-293, 294-295
features of ... 282
Cave Spring, Nevada, view of lake beds at ... 204
Cercis nevadensis, a fossil plant from Nevada, description of ... 217-218
figure of ... 222
Chance, H. M., survey of Choctaw coal field, Indian Territory, made by ... 263-264

Page.
Chandlar Lake, Alaska, quartzite-schist at 474
Chandlar River, Alaska, amphibolite-schist on 472-473
basalt on 481-482
course and character of 464, 466-467
diabase on 479-480
distances along (tables) 450
explorations on 449
features of 466-467
gold on 482-483
granite on 471
lacustrine silts along 479
map of portion of 448
mica-schist on 473-474
natives of region near 457
routes and trails along 454, 455, 456
view of rapids on 450
view up 464
Chandlar River Basin, Alaska, animals in 459-460
Bettles series of rocks in 475
climate in 458-459
routes and trails in 453-455
till deposits in 478
timber and vegetation in 460-461
topography and drainage of 464-466
West Fork series of rocks in 475-476
Chandlar and Koyukuk rivers, Alaska, report of reconnaissance by F. C. Schrader on 441-486
map of portions of 448
Chandlar Rapids, Alaska, location and features of 465
view of 450
C. H. C. Hill, Colorado, Carboniferous limestones at 54
faults at 128, 148
landslide areas at 137-138, 140-141, 145, 146, 148
present landslide action at 139-140
views of 140, 142, 144, 146
Chilkat Indians, Alaska, notes on 388-389
Chilkat River, Alaska, features of 347-348
Chislechina River, Alaska, drainage area of 411
gold mining on 437
trails along 417
Chitina River, Alaska, features of mountains south of 410
features of valley of 409
geology of region near 422-425
trails along 416-417
Chitina River and Skolai Mountains, Alaska, report of reconnaissance of 393-440
Chitistone limestone, Alaska, age and correlation of 433, 434
occurrence and character of 426, 427
faulting and folding in 427-429
view showing folding in 428
Choctaw Coal and Mining Company, Indian Territory, operations of 301, 304
Choctaw coal fields, Indian Territory, maps of 280, in pocket
Choctaw fault, Indian Territory, course and general features of 284-285

Page.
Choctaw Nation, Indian Territory, geology of coal field in 257-311
map of 264
Choctaw, Oklahoma and Gulf Railroad Company, Indian Territory, coal-mining operations of 300, 304
Chrysobalanus pollardiana, a fossil plant from Nevada, description of 216
figure of 222
Cinchonidium turneri, a fossil plant from Nevada, description of 218
figure of 222
Cirques, glacial, mode of recession of walls of 178-179
origin of 173-175, 178-179, 185-190
Clayton Valley, Nevada, view of lake beds east of 200
Climate and seasons, Alaska 388, 412-414, 458-459
Cloud Peak, Wyoming, map of glaciated region near 176
Coal, Alaska 382-383, 485-486
analyses 207, 306-311, 325-329
Arkansas 322-329
Indian Territory 285-296, 306-311
Nevada 206-207
Coal-bearing rocks, Camden coal field, Arkansas 320-322
Coal field in Indian Territory, geology of 257-311
Coal field of southwestern Arkansas, preliminary report by J. A. Taff on 313-329
Coal mining, Indian Territory, history, extent, and detailed operations of 297-305
Coast Range of Alaska, features of 345
Colorado, geologic investigations in 7-165
Conglomerates, Rico Mountains, Colorado 38-39
Contact metamorphism, Rico Mountains, Colorado, features of 32, 91-92
Cooper, E. J., aid by 339
Copper, Alaska 377-382, 437-439, 482
Copper River, Alaska, features of valley of 408-409
trails along 415-416, 417
Copper River district, Alaska, climate and seasons in 412-414
Correlation of geologic formations of Alaska 367, 431-433
Creadon River, Alaska, position of 351
Crescent Coal and Mining Company, Indian Territory, operations of 300, 304
Cretaceous lavas, Alaska 481
Cretaceous rocks, Alaska 367, 370, 433, 476-477
Rico Mountains 77-78
Cross, Whitman, cited on geology of areas in Colorado 85, 93, 95, 113, 152
Cross, Whitman, and A. C. Spencer, paper on geology of Rico Mountains by 7-165
Cushing, H. P., explorations in Alaska by 341
cited on Alaskan geology 362

D.

Dall, W. H., cited on Alaska and Alaskan geology 340, 372, 377, 400, 481
fossils from Nevada examined by 204

Page.
Dall River, Alaska, trail along ... 455
Dalton, Jack, Alaskan exploration by ... 341, 342
Dalton House, Alaska, buildings at ... 338, 391
Dalton Range, Alaska, features of ... 345
Dalton trail, Alaska, course and general features of ... 338, 384
Dana, E. S., cited on origin of thinolite ... 202
Darling Ridge, Rico Mountains, Colorado, landslide areas at and near ... 132-136, 150
rocks of ... 25, 30, 31, 83, 91
view of ... 130
Davidson, George, work on Alaska by ... 340
Dawson, G. M., Alaskan exploration by ... 341
cited on Alaska ... 361, 370, 378, 387, 389
Deadwood fault, Rico Mountains, features of ... 114-115
Deadwood Gulch, Colorado, evidences of glacial action at ... 157, 158
fault at ... 114-115
Delta River, Alaska, features of ... 352
Deformation, definition of ... 103
Deposition of ores by hot springs, theory of ... 249-252
Devonian rocks, Alaska ... 367, 369, 370, 433, 476
Rico Mountains, Colorado ... 26-27, 41-47
Diabase, Alaska ... 479-480
Dikes, basic, Rico Mountains, Colorado, occurrence and character of ... 31-32, 87-90
Diorite-porphyry, analysis of ... 86
Dioritic rock, Horace Mountain, Alaska ... 480-481
Dietrich River, Alaska, amphibolite-schist on ... 473
course and general features of ... 468-469
distances along (table) ... 452
explorations of ... 449
Dolores formation, Colorado, definition and description of ... 67-68
distribution and occurrence of ... 72-73
igneous intrusions in ... 105
lower division of ... 68-71
sections of ... 68-70
thickness of ... 66
upper division of ... 71-72
Dolores Mountain, Colorado, faults at and near ... 115-116
landslide areas at ... 143-144, 145
section at ... 58
views of ... 21, 22, 24, 26
Dolores Plateau, features of ... 19, 20, 23
Dolores River, Colorado, course and character of ... 20, 21
landslide dam on ... 138-139
Dolores Valley, Colorado, features of ... 20, 23
view of ... 22
Donjek River, Alaska, features of ... 350, 351
views on ... 354
Drake, N. F., survey of coal fields of Indian Territory made by ... 264
Dryopteris gleichenoides, a fossil plant from Nevada, description of ... 211
figure of ... 222
Dunn, R. L., Alaskan exploration by ... 343
cited on gold prospects in Shorty Creek district, Alaska ... 373-374
Dutton, C. E., cited on Permo-Carboniferous rocks of Western States ... 64

E.

Page.
Eagle City, Alaska, map showing reconnaissance from Pyramid Harbor to ... 338
report on reconnaissance from Pyramid Harbor to ... 331-391
Eakins, L. G., analyses by ... 82, 93-94
Eastern Choctaw coal field, Indian Territory, Arkansas Valley region of ... 267
boundaries of ... 263
composition and adaptability of coals in ... 306-311
descriptions of maps of ... 264-265
distribution of coal in ... 285-296
geology of ... 257-311
highland plain of ... 268-270
literature of ... 263-264
lowland plain of ... 267-268
maps of ... 280, in pocket
mining development in ... 296-305
mountains of ... 270-271
Ouachita Mountains region of ... 266
stratigraphy of ... 271-279
structure of ... 266, 279-285
summary of coal-mining operations in ... 304-305
topography of ... 265-271
Eastern Coal and Mining Company, Indian Territory, operations of 297, 298, 304
Effusive rocks, Alaska ... 362-363, 364
Emmons, S. F., cited on geologic history of Rocky Mountain region ... 37, 78
Endlich, F. M., cited on origin of certain metamorphic rocks in Colorado ... 37
geologic work in Colorado by ... 17, 18
Enterprise mine, Colorado, section at ... 52
Ernestine Creek, Alaska, gold on ... 436-437
Esmeralda formation, Nevada, age of ... 203-205
character and distribution of ... 198-199
coal beds of ... 206-207
fossil fish from ... 223-226
fossil plants of ... 209-222
location of ... 197
map showing areal distribution of ... 198
relation of adjacent lava flows to ... 205-206
sections of ... 199, 200-203
sulphur deposits of ... 207-208
thickness of ... 199-203
vein deposits of ... 206
views showing ... 200, 202, 204, 206, 208
Expectation Mountain, Colorado, view of 148

F.

Fall Creek, Alaska, gold on ... 436-437
Fanshawe coal mining district, Indian Territory, operations in ... 299
Farish, J. B., cited on Colorado veins and ore deposits ... 107, 108
geologic work in Rico Mountains, Colorado, by ... 18
Fault Mountain, Alaska, views near ... 466
Faults, Eastern Choctaw coal field, Indian Territory ... 284-285
Faults and fissures, Rico Mountains, Colorado ... 23-24, 105-112, 114-128, 148-149
Ferruginous deposits, Rico Mountains ... 164-165

Page.
Ficus lacustris, a fossil plant from Nevada, description of ... 215-216
figure of ... 222
Fish, Alaska ... 415, 460
Fish, fossil, from Nevada, description of 223-224
figure of ... 226
Fissures and fissure filling, Boulder Hot Springs, Montana ... 238-240
Fort Smith and Western Railway Company, coal-mining operations in Indian Territory by ... 303, 304
Fort Yukon, Alaska, determination of astronomic position of ... 449
trails from ... 453-454, 456
Fortymile gold region, Alaska, operations in ... 376-377
Fortymile Post, Alaska, location and importance of ... 391
Fortymile River, Alaska, features of ... 353
gold on ... 376-377
Fortymile series, Alaska, age and correlation of ... 367, 433
Fossil fish from Esmeralda formation, Nevada ... 223-226
Fossil plants of the Esmeralda formation, Nevada ... 209-222
Fossils, Mesozoic, Alaska ... 439-440
Carboniferous, Colorado ... 48, 59, 66
Fourche Maline Valley, Indian Territory, geologic structure in ... 288
Frazer, S. M., acknowledgments to ... 338

G.

Galena, Alaska ... 482
Game, Alaska ... 387-388, 415, 459-460
Garvey, D. D., acknowledgments to ... 338
Gas springs, Rico Mountains ... 165
Gastaldi, B., cited on origin of glacial cirques ... 173
Geographic names, Alaska, list of ... 487-509
George, R. D., aid by ... 16
Gerdine, T. G., Alaskan surveys by ... 447, 449, 450
Geroe Creek, Alaska, route along ... 454
Gilbert, G. K., cited on geology of Western United States ... 64, 94
definition of deformation by ... 103
Girty, G. H., Paleozoic fossils from Alaska determined by ... 428, 431, 448, 476
Permo-Carboniferous (Rico) fossils from Colorado determined by ... 60, 65
Glacial cirques, mode of recession of walls of ... 178-179
origin of ... 173-175, 178-179, 185-190
Glacial motion, cause of ... 185-190
Glacial phenomena, Alaska ... 364-365
Glacial sculpture in the Bighorn Mountains, Wyoming, paper by F. E. Matthes on ... 167-190
Glaciation, Rico Mountains, Colorado 35, 156-159
Glave, E. J., Alaskan exploration by ... 341, 342
Gleichenia obscura, a fossil plant from Nevada, description of ... 210
figure of ... 222
Gneissic series of rocks, Alaska, age and character of ... 356-357, 367, 433
Gold, Alaska ... 373-377, 436-437, 482-485

Page.
Gold and silver contents of veins at Boulder Hot Springs, Montana ... 248-249
Goodpaster River, Alaska, features of ... 352
Goodrich, H. B., Alaskan exploration by ... 342
Gowen coal-mining district, Indian Territory, operations in ... 297
Gowen mine, Indian Territory, thickness and character of coal beds at ... 287
Grand View smelter, Rico Mountains, Colorado, fault near ... 120-122
Granite, Alaska, occurrence and character of ... 360-361, 471-472, 480
Boulder Hot Springs, Montana, encrustation, alteration, and decomposition of ... 241-242, 244-247, 252-253
Granite Creek, Alaska, trail along ... 454
Grave Creek, Alaska, trail along ... 454
Greenstone-schists, Alaska, age and character of ... 358, 367, 433
Ground ice, Alaska, occurrence of ... 366
Gypsum deposits, Rico Mountains, occurrence of ... 49, 53
origin of ... 111

H.

Haines, Alaska, location and importance of ... 390
Haley, J. J., acknowledgments to ... 338
Hanus, G. C., Alaskan exploration by ... 340
Harper, Arthur, Alaskan exploration by ... 340
Harris, G. D., cited on geology of southwestern Arkansas ... 320-321
Hartshorne coals, Indian Territory, occurrence, character, and general features of ... 287-290
vertical sections of ... 287, 289
Hartshorne sandstone, Indian Territory, features of ... 274-275
section of ... 274
Hartshorne, W. O., coal-mining operations in Indian Territory by ... 303, 304
Hayden, F. V., geologic work in Colorado done by ... 15, 17-18
Hayes, C. W., cited on Alaskan geology ... 345, 350, 357, 372, 380, 389, 417, 427, 434, 435, 438
explorations in Alaska by ... 342, 380, 400-401
Hayes River beds, Alaska, age and correlation of ... 367, 433
Hawkins, C. J., acknowledgments to ... 448
Heavener anticline, Indian Territory, coal beds in ... 289-290
features of ... 281-282
Heilprin, Angelo, cited on origin of ash deposit in Alaska ... 365 (note)
Helland, A., cited on origin of glacial cirques ... 173
Hermosa formation, Animas section of ... 48-49
correlation of ... 59
fossils of ... 48, 57, 59, 66
lithology of ... 48
lower beds of ... 50-53
medial division of ... 53-57
Rico section of ... 49-59
sections of ... 52, 53, 55-56, 58
thickness of ... 49
upper division of ... 57-59

Page.
Hermosa Peak, Colorado, views of 18, 20
Hill, R. T., cited on geology of southwestern Arkansas 320, 322
reconnaissance of Choctaw coal field, Indian Territory, made by 264
Hillebrand, W. F., analyses by 82, 86, 207
Hills, R. C., work in Colorado by 18
Holiknuk series of rocks, Alaska, age and correlation of 367, 433
Holmes, W. H., cited on geology of Western United States 95, 96
geologic work in Colorado by 17, 18
Holt, C. G., exploration in Alaska by 400
Horace Mountain, Alaska, diorite at 480, 481
view near 445
Horse Gulch, Rico Mountains, Colorado, center of porphyritic eruptions in 89
landslide areas at and near 130-136, 146, 149
porphyry sheets and dikes in 89
views of 128, 132, 134, 136, 138
Hot waters of mineral springs, Montana, alteration of rock by action of 245-247
character of 237-238
fissure and vein filling by action of 239-244
rock decomposition by 244-245
theory of ore deposition by 249-252
Howe, Ernest, aid by 16
Howe coal mining district, Indian Territory, operations in 300
Hoyn Creek, Alaska, trail along 456
Hunt, T. M., acknowledgments to 337

I.

Iddings, J. P., cited on porphyry from Yellowstone National Park 86
Igneous intrusion, Rico Mountains, Colorado, phenomena connected with 91-94
Igneous rocks, Alaska 360-362, 364, 430, 479-482
Rico Mountains, Colorado 29-32, 79-97, 104-105
Indian Territory, geology of Eastern Choctaw coal fields of 257-311
Indianola Coal and Railway Company, Indian Territory, operations of 301, 304
Insects, Alaska 460
Intrusive rocks, Alaska 360-362, 370
Colorado 29-32, 79-97, 104-105
Iron mine, Rico Mountains, Colorado, fault near 118-119

J.

Jarvis Glacier, Alaska, view of 344
Jarvis, J. P., cited on deposits of copper, lead, and zinc ore in Alaska 378
Jarvis, W. H. P., cited on gold mining on Porcupine Creek, Alaska 375
Jasper and quartz veins, Boulder Hot Springs region, Montana 234-235
Jasperoid, Boulder Hot Springs, Montana, microscopic petrography of 253-254
Jenson Coal Company, Indian Territory, operations of 301-302, 304
Jenson coal-mining district, Indian Territory, operations in 301-302
Johnson River, Alaska, features of 352

Page.
Johnson, W. D., cited on origin of glacial cirques 173, 178
Johnson, ——, discovery of new route from Valdes, Alaska, to Chena River by 403
Jurassic rocks and fossils, Alaska .... 367, 370 (note), 431, 433, 439, 440
Juratrias rocks, Rico Mountains 28-29, 66-77

K.

Kanata River, geology of area near 419
Kansas and Texas Coal Company, Indian Territory, operations of 299, 300, 302, 304
Kaolinite, Boulder Hot Springs, Montana, microscopic petrography of 253
Kashaw River, Alaska, features of 356
Kaskawulsh River, Alaska, features of 349
geology of region near 362, 363
Kenai series of rocks, Alaska, age, character, and correlation of 367, 433, 477
Kennicott Glacier, Alaska, geology of region near 425, 427-428, 431, 432
naming of 406
view of 426
Kennicott Pass, view of mountains near 424
Kennicott series of rocks, age and character of 428, 431, 433
Kerr, M. B., Alaskan exploration by 341
Kilpatrick, R. H., coal-mining operations in Indian Territory by 304
King, Clarence, cited on geology of parts of the Great Basin 64, 204
Kiowa, Indian Territory, syncline near 279-280
Klehini River, Alaska, features of 348
Kletsan Creek, Alaska, copper deposits on 379-381
fossils from limestone on 359
map showing location of copper deposits on 380
Klutena series of rocks, Alaska, age and correlation of 367, 433
Klutlan River, Alaska, features of 351
Knapp, M. A., cited on geology of Esmeralda County, Nevada 198
Knowlton, F. H., determination of Alaskan fossil plants by 448
determination of fossil plants from Nevada by 204
paper on fossil plants of the Esmeralda formation by 209-222
Koidern River, Alaska, features of 351
view of valley of 354
Kolmakof series of rocks, Alaska, age and correlation of 367, 433
Kotlo series of rocks, Alaska, age, character, and correlation of 357-358, 367, 368-369, 433
gold in 376
Kotsina River, Alaska, copper deposits on 437
geology of region near 420-422, 431
trail on 416
Koyukuk Mountain, Alaska, basalt of 481
Koyukuk River, Alaska, coal on 485
course, tributaries, and general features of 467-471

Page.
Koyukuk River—Continued.
Cretaceous rocks on 476-477
distances along (table) 450-452
distances along Middle Fork of (table) 453
distances along South Fork of (table) 453
gold on 483-485
map of portion of 448
natives of region near 457-458
Pleistocene gravels along upper course of 478
routes and trails along 455
view on Middle Fork of 468
views of 456, 458, 468, 478
white population on and near 458
Koyukuk River Basin, Alaska, animals in 459-460
climate in 459
Eocene rocks in 477
gold in 483-485
lacustrine silts and gravels in 479
profile across 468
river gravels in 478
routes and trails in 455-457
timber and vegetation in 460-461
topography and drainage of 464, 467-468
Koyukuk River Valley, profile across 468
Koyukuk and Chandlar rivers, Alaska, map of portions of 448
report of reconnaissance by F. C. Schrader on 441-486
Krause, Arthur, Alaskan exploration by 340
Kuskulana Pass, geology of region near 423-424
Kuskulana River, Alaska, explorations on 406
geology of region near 423-424, 431-432
Kuskulana shales, Alaska, age and character of 423, 424, 433

L.

Laccolithic mountains of Colorado, comparison of Rico Mountains with 94-96
Lake Creek, Alaska, trail along 454
Lake Kluane, deformation of Pleistocene deposits at head of 371-372
features of 350-351
Lake quartzite-schist, Alaska, occurrence and character of 474-475
Landslides, Rico Mountains, Colorado, age of 147-148
character of 146
occurrence of 129-151, 161
origin of 149-151
relations of faults to 148-149
topographic and other relations of 146-147
Landslip Mountain, Colorado, landslide areas at 143, 150
La Plata folio of geologic Atlas of the United States, reference to 19
La Plata formation, Colorado, correlation of 76
definition of 73-74
description of 74-75
distribution and occurrence of 75-76
section of 75
thickness of 66
La Plata Mountains, general features of 19, 100

Page.
Last Chance fault, Rico Mountains, Colorado, features of 119-120
Lavas, Alaska, occurrence and character of 481-482
Lead ore, Alaska 482
Leuciscus turneri, a fossil fish from Nevada, description and figure of 223-226
Libbey, William, Alaskan exploration by 341
Limestone, Alaska 475
Rico Mountains, Colorado 45-47
Lindgren, Waldemar, cited on the term "granodiorite" 95 (note)
notes on microscopic petrography of rocks at Boulder Hot Springs, Montana, prepared by 252-255
Little Missouri River, Arkansas, section on 322
Long Mountain, Indian Territory, vertical sections at 287, 288
Lowe, P. G., Alaskan exploration by 343
Lowe River, Alaska, geology of region near 419
Lucas, F. A., cited on fossil fish from Nevada 204
description of fossil fish from Nevada by 223-226
Luigi Amedeo, Prince, Alaskan exploration by 342
Lynn Canal, features of 344
native inhabitants of region near 388-389

M.

McAlester, Indian Territory, anticline at 280-281
McAlester coal, Indian Territory, occurrence and character of 291-292
McAlester Coal and Mineral Company, Indian Territory, operations of 297, 304
McAlester shale, Indian Territory, features of 275-276
McAlester syncline, Indian Territory, features of 280-281
McArthur, J. J., Alaskan exploration by 342
McCarthy Creek, Alaska, geology of region near 427-428
McCarthy Creek shales, Alaska, age and correlation of 433
faulting and folding in 427-429
occurrence and character of 426-427
McClellan, R. F., aid by 405
McConnell, R. G., cited on geology of parts of Alaska 357 (note), 372, 476
McElmo formation, Colorado, correlation of 77
definition of 76
description and occurrence of 76-77
thickness of 66
McKinley Creek, Alaska, gold on 375, 485
McNeer, A. H., acknowledgments to 399
Mahutzu River, Alaska, features of 352
Martin, Thomas, acknowledgments to 339
Matanuska series of rocks, Alaska, age and correlation of 367, 433
Matthes, F. E., paper on glacial sculpture in the Bighorn Mountains by 167-190

Page.

Mayberry coal-mining district, Indian Territory, operations in 301
Meek, F. B., cited on Permo-Carboniferous 47
Melanocratic dike rocks, Rico Mountains 87-88
Mendenhall, W. C., cited on Alaskan geology 357
Mentasta Range, Alaska, features of 411
Merriam, J. C., cited on age of Esmeralda lake beds, Nevada 203-204
Mesozoic fossils, Alaska 439-440
Metalliferous veins, theories of origin of 249-252
Metamorphism of rocks, Rico Mountains 32
Metasomatic alteration of rocks by action of hot springs 246-247
Mexican Gulf Coal and Transportation Company, Indian Territory, operations of 300, 304
Mica-schist, Alaska, character and occurrence of 473-474
Milby & Dow, coal mining operations in Indian Territory by 300, 304
Milton, Indian Territory, anticline near 283
Mineral spring deposits, Boulder Hot Springs, Montana 233-244, 252-254
Rico Mountains, Colorado 163-165
Mineral vein formation at Boulder Hot Springs, Montana, paper by W. H. Weed on 227-255
Mineral veins, Boulder Hot Springs, Montana, alteration of rocks near 245-247
filling of 240-244
gold and silver content of 248-249
microscopic petrography of filling of 252-255
nature of 234
origin of 234, 248
recent movement or faulting on 249
theory of ore deposition in 249-252
Mission Creek series of rocks, Alaska, age of 370
correlation of 367, 370, 433
Mitchell Basin, Indian Territory, vertical section showing coals and associated rocks in 291
Mitchell Basin coal mining district, Indian Territory, operations in 300
Monocline (The), Nevada, view of 208
Monroe, C. E., assays made by 248
Montana, mineral vein formation at hot springs in 227-255
Monzonite-porphyry, analyses of 86
occurrence of, Rico Mountains 31, 83-86
Monzonites, analyses of 82
occurrence and character of, Rico Mountains, Colorado 30-31, 79-82, 91
Mount Blackburn, Alaska, features of 411
Mount Drum, Alaska, features of 410
Mount Elliott, Colorado, glacial deposits at 158, 161
Mount Regal, Alaska, location of 411
Mount Sanford, Alaska, features of 410
Mount Wrangell, Alaska, features of 410
Muir, John, Alaskan exploration by 340
Myrtle Creek, Alaska, gold on 483-485
views on 468, 476

N.

Page.

Nabesna Range, Alaska, geology of 429
Nabesna River, Alaska, copper deposits on and near 381, 438
course and drainage area of 411
features of 351, 352
Naknek series of rocks, Alaska, age and correlation of 317, 433
Nagaief, exploration in Alaska by 400
Names, geographic, Alaskan (list) 487-509
Nasina series of rocks, Alaska, age and correlation of 367, 433
Native inhabitants, Alaska 388-390
Nelly Bly vein, Rico Mountains, Colorado, fault at 116, 118-119
Nevada, analysis of coal from 207
coal beds in 207
Esmeralda formation in 191-226
fossil plants from 209-222
sulphur deposits in 207-208
Newman Hill, Colorado, Carboniferous rocks at 50-52
contact deposits at 108-110
glacial accumulations at 158
intruded igneous sheet at 30, 104
landslide areas at 143-144
ore-bearing horizon at 50
views of 21, 22, 26
Nigger Baby Hill, Colorado, faults at 118, 119
Nikolai copper vein, Alaska, features of 437
Nikolai greenstone, Alaska, age and correlation of 433
copper vein in 437
occurrence and character of 425, 426
Nilkoka beds, Alaska, age and correlation of 367, 433
Nilkoka River, Alaska, features of 352
Nivation, processes and effects of 179-185
Nizina Glacier, Alaska, features of 406
geology of region near 428
views of 406, 408
Nizina River, Alaska, exploration on 406-407
features of 409-410
geology of region near 425-429, 432, 434
Nulato, Alaska, coal beds near 485-486
Nulato sandstone, Alaska, age and correlation of 367, 433
occurrence of 478
Nushagak beds, Alaska, age and correlation of 367, 433
Nutzotin Mountains, features of 346, 411
geology of 429
Nutzotin series of rocks, Alaska, age, character, and correlation of 359-360, 367, 369, 433
gold in 373

O.

O'Connor, J., acknowledgments to 338
O'Connor Glacier, location of 338
view of 350
O'Connor River, features of 349
Ogilvie, William, Alaskan exploration by 341
Oklune series of rocks, Alaska, age and correlation of 367, 433

Page.
Ola Coal and Mining Company, Indian Territory, operations of 298, 304
Orca series of rocks, Alaska, age and correlation of 367, 433
Ore deposition by hot springs, theory of. 249-252
Ore deposition, Rico Mountains 33-34
Ouachita Mountains region, Indian Territory, geologic structure of 266
Ouachita River, Arkansas, section on 322
Ouray limestone, Rico Mountains .. 41-42, 45-47
Owen, D. D., cited on geology of southwestern Arkansas 320, 323-324
Ozark Coal and Railway Company, Indian Territory, operations of 302, 304

P.

Pack trains, Alaska, use of 418
Paige, Jason, aid by 16
Palisade conglomerate, Alaska, age and corre'ation of 367, 433
Panama coal, Indian Territory, character of 289
equivalents of 288-289
Panola coal mining district, Indian Territory, operations in 298, 302
Papoose Gulch, Colorado, glacial deposits at 158, 161
Peale, A. C., cited on geology of a portion of Colorado 65
Peavey, Alaska, location and importance of 484
view of 456
Permo-Carboniferous rocks of Rico Mountains, Colorado 27-28, 59-66
Peters, W. J., work in Alaska by .. 337, 343, 400
Petroff, Ivan, cited on Alaska .... 340 (note)
Petrography, igneous rocks of Rico Mountains, Colorado 79-88
Phillip, G. S., work in Alaska by 337
Pirsson, L. V., cited on occurrence of monzonite-porphyry 86
Plants, fossil, of the Esmeralda formation, Nevada 209-222
Pleasant Camp, Alaska, location of and buildings at 338, 390
view of 344
Pleistocene deposits, Alaska, occurrence of 363-364, 367, 371-372, 433, 478-479
Pocahontas coal-mining district, Indian Territory, operations in 299
Pocola coal-mining district, Indian Territory, operations in 302-303
Porcupine beds, Alaska, age and correlation of 367, 433
Porcupine Creek, Alaska, gold on 374-376
Porcupine gold district, Alaska, gold in 374-376
map of 374
Porphyries, analyses of 86
occurrence of, Rico Mountains . 29, 30, 83-91
solfataric alteration of 32-33, 91-93
Portage Creek, Alaska, view of 450
Poteau coal-mining district, Indian Territory, operations in 300-301
Poteau Mountain, Indian Territory, syncline near 280
Page.
Poteau syncline, Indian Territory, coal beds in 290, 292, 295
features of 280
Potter mine, Indian Territory, vertical section showing coals and associated rocks in 290
Pratt, J. F., work on Alaska by 340
Prince William Sound, Alaska, climate of. 412
Purington, C. W., geologic work in Colorado by 16
Puzzle mine, Rico Mountains, Colorado, landslide areas near 134-135, 138, 146
Pyramid Harbor, Alaska, map showing route of reconnaissance to Eagle City from 338
report of reconnaissance to Eagle City from 331-391

Q.

Quartz and jasper veins, Boulder Hot Springs region, Montana 234-235
Quartz Creek, Alaska, geology of region near 419
gold on 436-437
Quartz-monzonite, Rico Mountains, analyses of 86
occurrence of 30-31, 79-82
Quartzite-schist, Alaska 474-475
Quartzites, Rico Mountains .. 38, 39, 40-41, 43-45
Quercus argentum, a fossil plant from Nevada, description of 215
figure of 222
Quercus turneri, a fossil plant from Nevada, description of 214-215
figure of 222

R.

Rail Creek, Alaska, gold on 485
Railway routes in Alaska 386-387
Rainy Hollow, Alaska, copper deposits at 378-379
settlement at 390-391
Rampart series of rocks, Alaska, age and correlation of 367, 433
Ransome, F. L., geologic work in Colorado by 16
Rapids schist, Alaska, occurrence and character of 473-474
Redoak coal-mining district, Indian Territory, operations in 298
Reid, H. F., Alaskan exploration by 341
cited on Alaskan geology 362, 369, 370
Rhus nevadensis, a fossil plant from Nevada, description of 218-219
figure of 222
Richardson, G. B., acknowledgments to . 265
Rickard, T. A., cited on geology of portions of Colorado 42, 53, 108-109
geologic work in Rico Mountains, Colorado, by 18-19
Rico, Colorado, strata exposed near 98
Rico-Aspen mine, Colorado, section at ... 52-53
Rico dome, Colorado, erosion of .. 34-35, 152-159
origin of 112-114
profile sections of 102
structure of 98-128
view of 102

Page.
Rico formation, Colorado, correlation of 64-66
definition of 59-60
description of 60-62
distribution of 62-64
fossils of 66
section of 62
Rico Mountains, Colorado, Algonkian rocks of 25, 26, 37-41
alluvial fans in 162-163
Carboniferous rocks of 27-28, 47-66
comparison of laccolithic mountains with 94-97
conglomerates in 38-39
contact metamorphism in 32
Cretaceous rocks of 77-78
Devonian rocks of 26-27, 41-47
dikes in 31-32, 87-90
drainage system of 20
erosion in 34-35, 152-156
faults and fissures in 23-24, 105-112, 114-128
ferruginous deposits in 164-165
gas springs in 165
general description of 19-21
geologic map of In pocket
geologic surveys in 17-19
glaciation of 35, 156-159
gypsum deposits in 49, 53, 111
igneous intrusive rocks of 29-32, 79-97
Juratrias rocks of 28-29, 66-77
laccolithic deformation of 104-105
landslides in 129-151, 161
literature concerning 17-19
location and nomenclature of 15-16
ore deposition in 33-34
Permo-Carboniferous rocks of 27-28, 60-66
profile sections of 102
recent geologic history of 35-36, 152-165
solfataric action in 33, 92-93
stratigraphy of 25-29, 37-76
structure of 21-25, 98-128
surface wash in 161-162
talus in 161
timber and timber line in 20
volcanic phenomena of 32-33
Robert Creek, Alaska, route along 454
view of 445
Robertson River, Alaska, features of 352
Rocky Mountains, Alaska, features of 463
Rohn, Oscar, acknowledgments to 364
Alaskan exploration by 343
report of reconnaissance of Chitina River and Skolai Mountains, Alaska, by 393-440
Rosenbusch, H., cited on formation of sericite 247
Routes and methods of travel in Alaska, 383-387, 415-418, 453-457
Russell, I. C., Alaskan exploration by 341, 342
cited on Alaskan geology 372

S.

St. Elias Range, Alaska, geologic features of 373
profiles of 368
topographic features of 345-346
Page.
Salix angusta, a fossil plant from Nevada, description of 212
figure of 222
Salix vaccinifolia, a fossil plant from Nevada, description of 212-213
figure of 222
Sandstone Mountain, Colorado, landslide areas near 145
section of 55-56
view of 28
views from 128, 130, 140
San Juan Mountains, Colorado, features of 20, 99-100
Sansbois Mountain, Indian Territory, geologic structure near 288
Sansbois syncline, Indian Territory, coal beds in 287-289, 291, 293-294, 295
features of 283
Savanna formation, Indian Territory, features of 276-278
Schanz, A. B., Alaskan exploration by 341
Scheerer, T., analysis by 82
Schists, Alaska 473-475
Rico Mountains, Colorado 39-40, 44-45
Schrader, F. C., cited on Alaskan geography and geology 345, 372, 410, 419, 435
exploration in Alaska by 342, 402-403
report of reconnaissance along Chandlar and Koyukuk rivers, Alaska, by 441-486
Schuchert, Charles, Alaskan fossils identified by 359
Schwatka, Lieut. Frederick, exploration in Alaska by 341, 342, 380, 400-401
Scidmore, E. H., title of paper on Alaska by 340
Scotch Creek, Colorado, sections on 62, 68-69
Seasons and climate, Alaska 412-414
Serebrennikof, exploration in Alaska by 400
Sericite, Boulder Hot Springs, Montana, microscopic petrography of 253
Seton-Karr, H. W., Alaskan exploration by 341
Sheep Creek, Alaska, trails along 454
Sheets, intrusive, Rico Mountains, Colorado, occurrence of 90
Shorty Creek, Alaska, features of 356
gold prospects on 373-374
Silica, fibrous, Boulder Hot Springs, Montana, microscopic petrography of 253
Silok River, Alaska, features of 352
Silurian rocks, Alaska 358, 367, 368, 433, 474-475
Silver and gold content of veins at Boulder Hot Springs, Montana 248-249
Silver Creek, Colorado, evidences of glaciation on 157, 158
faults near 44, 122-126
Silver Glance Shaft, Rico Mountains, Colorado, section at 52-53
Silver Peak Range, Nevada, geologic history of 197
view of lake beds at 202
view showing lacustral marls near 206
Skagway, Alaska, rocks near 361
Skolai Mountains, Alaska, features of 411
geology of 428, 434-435
volcanic rocks of 429-430

Page.
Skolai Mountains and Chitina River, Alaska, report of reconnaissance of.... 393–440
Skolai Pass, Alaska, trail over.... 417
Skwentna series of rocks, Alaska, age and correlation of.... 367, 433
Slate Creek, Alaska, gold on.... 483–485
Slims River, Alaska, deformation of Pleistocene deposits at mouth of.... 371–372
source of.... 351
Smelter fault, Rico Mountains, Colorado, features of.... 120–122
Snowdrifts, topographic effects of.... 179–185
Solfataric action, Rico Mountains, Colorado.... 32–33, 92–94
South Park fault, Rico Mountains, Colorado, features of.... 122–123
Sockrider Peak, Colorado, glacial cirques at.... 156–157
Spathyema nevadensis, a fossil plant from Nevada, description of.... 211–212
figure of.... 222
Spencer, A. C., cited on Devonian rocks in Colorado.... 41
Spencer, A. C., and Whitman Cross, paper on geology of Rico Mountains by.... 7–165
Spring deposits, Rico Mountains.... 163–165
Spruce Gulch, Rico Mountains, faults near.... 114
Spurr, J. E., acknowledgments to.... 399
Alaskan exploration by.... 342
cited on Alaskan geology.... 357, 358, 369, 372, 376, 435, 436, 438, 466, 471, 472, 474, 481
cited on bedding faults.... 107
fossils collected in Nevada by.... 204
Stanton, T. W., fossils identified by.... 72, 423, 424, 428, 439–440, 448
Steamboat Springs, Nevada, ore depositions by hot waters at.... 233
Steiger, George, analyses by.... 93–94, 326
Sterlina Creek, Alaska, copper deposits on.... 437
Stevenson, J. J., survey of Choctaw coal field, Indian Territory, made by.... 264
Stilbite, Boulder Hot Springs, Montana.... 243–244
Stokes, H. N., analyses by.... 82
Stone, G. H., cited on glacial phenomena in Colorado.... 156
Sugarloaf Mountain, Indian Territory, syncline near.... 282
Sulphur, Nevada.... 207–208
Sulphur Bank, California, ore deposition by hot waters at.... 233, 251
Sulphur Creek, Colorado, glacial deposits on.... 159
landslide areas near.... 141–143
Sulphur Springs, Rico Mountains, Colorado.... 33
Sunrise series of rocks, Alaska, age and correlation of.... 367, 433
Sushitna schists, Alaska, age and correlation of.... 367, 433
Swift River, Alaska, trail along.... 454
Syenite-porphyry, Rico Mountains, Colorado.... 87

T.

Page.
Tachatna series of rocks, Alaska, age and correlation of.... 367, 433
Taff, J. A., report on Camden coal field of southwestern Arkansas by.... 313–329
Taff, J. A., and Adams, G. I., paper on geology of Eastern Choctaw coal field, Indian Territory, by.... 257–311
Tahkin River, features of.... 347–348
Tahkandit series of rocks, Alaska, age and correlation of.... 367, 433
Talus deposits, Rico Mountains, Colorado.... 161
Tanana Glacier, Alaska, exploration at and near.... 407–408
geology of region near.... 428, 429
views of.... 406, 408, 410, 412
Tanana River, Alaska, copper deposits near.... 381, 382, 437, 438
explorations on.... 407–408
geology of region near.... 425–429
route to.... 338–339, 384–386
Tanana and White rivers, old stream occupying valleys of.... 354–355
Tanana River Basin, Alaska, features of.... 351–352
Tanana series of rocks, Alaska, age and correlation of.... 367, 433
Tatshenshini River Valley, view in.... 344
geology of region near.... 363
Telescope Mountain, Colorado, fault at.... 126–128
landslide areas at.... 136–137
view from.... 24
view of.... 140
Telluride folio of Geologic Atlas of the United States, reference to.... 19
Terra Cotta series of rocks, Alaska, age and correlation of.... 367, 433
Tertiary rocks, Alaska, occurrence and character of.... 362–363, 367, 370, 372, 433, 477, 478
Timber and vegetation, Alaska.... 387, 414, 460–461
Tok River, Alaska, features of.... 352
Tok sandstone, Alaska, age, character, and correlation of.... 362, 367, 370, 433
Toklat River, Alaska, features of.... 352
Tonsina River, Alaska, trails along.... 415–416
Topham, Edwin, Alaskan exploration by.... 341
Topham, W. H., Alaskan exploration by.... 341
Tordrillo series of rocks, Alaska, age and correlation of.... 367, 443
Tower, G. W., geologic work in Colorado by.... 16
Tozi River, Alaska, route along.... 456
Trails and routes in Alaska.... 383–387, 415–418, 453–457
Tramway Bar, Koyukuk River, Alaska, auriferous gravels at.... 478–479
coal bed at.... 485–486
gold at.... 483
Kenai series at.... 477
Travel in Alaska, routes and modes of.... 383–387, 415–418, 453–457
Triassic rocks and fossils, Alaska.... 426–427, 431, 433, 439, 440
Trotter, Coutts, cited on glaciers.... 185–186

Page.

Turkey Creek coal mining district, Indian Territory, operations in 298-299
Turkey Creek Mining Company, Indian Territory, operations of 298, 304
Turner, H. W., paper on the Esmeralda formation by 191-226
Twelve-mile beds, Alaska, age and correlation of 367, 433
Tyonek beds, Alaska, age and correlation of 367, 433
Tyrrell, J. B., Alaskan exploration by ... 343
cited on Alaskan geology 379

V.

Valdes, Alaska, geology of region near .. 419
topography of country near 408
Valdes series of rocks, Alaska, age and correlation of 367, 433
Van Hise, C. R., acknowledgments to 399
cited on folding 436
cited on origin and age of certain metamorphic rocks of Colorado .. 37
Vegetation, Alaska 387, 414, 460-461
Vein filling at Boulder Hot Springs, Montana, nature of .. 240-244, 248-249, 254-255
origin of 248
Vein formation at Boulder Hot Springs, Montana, paper by W. H. Weed on 227-255
Veins. *See* Mineral veins.
Vogesites, Rico Mountains, Colorado. 31-32, 87-88
Volcanic phenomena, Rico Mountains 32-33
Volcanic rocks, Alaska, occurrence and character of 371, 429-430, 481-482
Volcanic tuff, Alaska, occurrence and character of 365-366
Volkmar River, Alaska, features of 352

W.

Wade Creek, Alaska, gold on 376-377
Walcott, C. D., cited on Permian rocks of Western States 64, 71
Water of Boulder Hot Springs, Montana, alteration of rock by action of .. 245-247
analysis of 238
character of 237-238
fissure and vein filling by action of. 239-244
rock decomposition by 244-245
theory of ore deposition by 249-252
Weed, W. H., paper on mineral vein formation at Boulder Hot Springs, Montana, by 227-255
Wellesley series of rocks, Alaska, age and character of 359, 367, 369, 433
Wells, S. J., Alaskan exploration by ... 341, 342
West Fork series of rocks, Alaska, character and occurrence of 475-476

Page.

White, David, fossils identified by 72, 271
White River, Carboniferous fossils from basin of 359
gneisses on 356-357
greenstone schists in 358
routes to 338-339, 385-386
White River basin, Alaska, features of. 350-351
White and Tanana rivers, old stream occupying valleys of 354-355
copper deposits of 378-382
Wilburton, Indian Territory, geologic structure of beds near 288
vertical section showing coal beds at. 289
Wilburton coal-mining district, Indian Territory, operations in 297-298, 304
Williams, H. S., cited on subdivisions of the Carboniferous 47
Williams, William, Alaskan exploration by 341
Willis, Bailey, acknowledgments to 399
Wister coal-mining district, Indian Territory, operations in 299-300
Witherspoon, D. C., surveys in Alaska by 449
Witteville coal-mining district, Indian Territory, operations in 301
Witteville coals, Indian Territory, occurrence and character of 294-295
Wood, C. E. S., Alaskan exploration by ... 340
Wrangell Mountains, Alaska, features of 410-411
geologic map of 404
Wright, G. F., Alaskan exploration by 341
Wyoming, glacial sculpture in 167-190

Y.

Yellowstone National Park, mineral vein deposits forming in 233
Yentna beds, Alaska, age and correlation of 367-433
Young, S. H., Alaskan exploration by 340
Yukon Flats, Alaska, lacustrine silts of .. 479
topography and drainage of 465-466
Yukon Hills, Alaska, features of 464
Yukon Plateau, Alaska, features of 346-347, 354, 372
granite of 472
topography and drainage of 344-356, 462-464, 465
views of 348
Yukon River, Alaska, coal beds on 485-486
course of 463
Yukon River Basin, Alaska, topography and drainage of 462-464

Z.

Zeolite, Boulder Hot Springs, Montana 243-244

O

ADVERTISEMENT.

[Twenty-first Annual Report, Part II.]

The statute approved March 3, 1879, establishing the United States Geological Survey, contains the following provisions:

"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization; and the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

Except in those cases in which an extra number of any special memoir or report has been supplied to the Survey by resolution of Congress, or has been ordered by the Secretary of the Interior, this office has no copies for gratuitous distribution.

ANNUAL REPORTS.

I. First Annual Report of the United States Geological Survey, by Clarence King. 1880. 8°. 79 pp. 1 map.—A preliminary report describing plan of organization and publications.

II. Second Annual Report of the United States Geological Survey, 1880-'81, by J. W. Powell. 1882. 8°. lv, 588 pp. 62 pl. 1 map.

III. Third Annual Report of the United States Geological Survey, 1881-'82, by J. W. Powell. 1883. 8°. xviii, 564 pp. 67 pl. and maps.

IV. Fourth Annual Report of the United States Geological Survey, 1882-'83, by J. W. Powell. 1884. 8°. xxxii, 473 pp. 85 pl. and maps.

V. Fifth Annual Report of the United States Geological Survey, 1883-'84, by J. W. Powell. 1885. 8°. xxxvi, 469 pp. 58 pl. and maps.

VI. Sixth Annual Report of the United States Geological Survey, 1884-'85, by J. W. Powell. 1885. 8°. xxix, 570 pp. 65 pl. and maps.

VII. Seventh Annual Report of the United States Geological Survey, 1885-'86, by J. W. Powell. 1888. 8°. xx, 656 pp. 71 pl. and maps.

VIII. Eighth Annual Report of the United States Geological Survey, 1886-'87, by J. W. Powell. 1889. 8°. 2 pt. xix, 474, xii pp., 53 pl. and maps; 1 p. l., 475-1063 pp., 54-76 pl. and maps.

IX. Ninth Annual Report of the United States Geological Survey, 1887-'88, by J. W. Powell. 1889. 8°. xiii, 717 pp. 88 pl. and maps.

X. Tenth Annual Report of the United States Geological Survey, 1888-'89, by J. W. Powell. 1890. 8°. 2 pt. xv, 774 pp., 98 pl. and maps; viii, 123 pp.

XI. Eleventh Annual Report of the United States Geological Survey, 1889-'90, by J. W. Powell. 1891. 8°. 2 pt. xv, 757 pp., 66 pl. and maps; ix, 351 pp., 30 pl.

XII. Twelfth Annual Report of the United States Geological Survey, 1890-'91, by J. W. Powell. 1891. 8°. 2 pt. xiii, 675 pp., 53 pl. and maps; xviii, 576 pp., 146 pl. and maps.

XIII. Thirteenth Annual Report of the United States Geological Survey, 1891-'92, by J. W. Powell. 1893. 8°. 3 pt. vii, 240 pp., 2 maps; x, 372 pp., 105 pl. and maps; xi, 486 pp., 77 pl. and maps.

XIV. Fourteenth Annual Report of the United States Geological Survey, 1892-'93, by J. W. Powell. 1893. 8°. 2 pt. vi, 321 pp., 1 pl.; xx, 597 pp., 74 pl.

XV. Fifteenth Annual Report of the United States Geological Survey, 1893-'94, by J. W. Powell. 1895. 8°. xiv, 755 pp. 48 pl.

XVI. Sixteenth Annual Report of the United States Geological Survey, 1894-'95, Charles D. Walcott, Director. 1895. (Part I, 1896.) 8°. 4 pt. xxii, 910 pp., 117 pl. and maps; xix, 598 pp., 43 pl. and maps; xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl.

XVII. Seventeenth Annual Report of the United States Geological Survey, 1895–'96, Charles D. Walcott, Director. 1896. 8°. 3 pt. in 4 vol. xxii, 1076 pp., 67 pl. and maps; xxv, 864 pp., 113 pl. and maps; xxiii, 542 pp., 8 pl. and maps; iii, 543–1058 pp., 9–13 pl.

XVIII. Eighteenth Annual Report of the United States Geological Survey, 1896–97, Charles D. Walcott, Director. 1897. (Parts II and III, 1898.) 8°. 5 pt. in 6 vol. 440 pp., 4 pl. and maps; v, 653 pp., 105 pl. and maps; v, 861 pp., 118 pl. and maps; x, 756 pp., 102 pl. and maps; xii, 642 pp., 1 pl.; 643–1400 pp.

XIX. Nineteenth Annual Report of the United States Geological Survey, 1897–'98, Charles D. Walcott, Director. 1898. (Parts II, III, and V, 1899.) 8°. 6 pt. in 7 vol. 422 pp., 2 maps; v, 958 pp., 172 pl. and maps; v, 785 pp., 99 pl. and maps; viii, 814 pp., 118 pl. and maps; xvii, 400 pp., 110 pl. and maps; viii, 651 pp., 11 pl.; viii, 706 pp.

XX. Twentieth Annual Report of the United States Geological Survey, 1898–'99, Charles D. Walcott, Director. 1899. (Parts II, III, IV, V, and VII, 1900.) 8°. 7 pt. in 8 vol. 551 pp., 2 maps; v, 953 pp., 193 pl. and maps; v, 595 pp., 78 pl. and maps; vii, 660 pp., 75 pl. and maps; xix, 498 pp., 159 pl. and maps; viii, 616 pp.; xi, 804 pp., 1 pl.; v, 509 pp., 38 pl. and maps.

XXI. Twenty-first Annual Report of the United States Geological Survey. 1899–1900. Charles D. Walcott, Director. 1900. 8°. 7 pt. in 8 vol.

MONOGRAPHS.

I. Lake Bonneville, by Grove Karl Gilbert. 1890. 4°. xx, 438 pp. 51 pl. 1 map. Price $1.50.

II. Tertiary History of the Grand Cañon District, with Atlas, by Clarence E. Dutton, Capt., U. S. A. 1882. 4°. xiv, 264 pp. 42 pl. and atlas of 24 sheets folio. Price $10.00.

III. Geology of the Comstock Lode and the Washoe District, with Atlas, by George F. Becker. 1882. 4°. xv, 422 pp. 7 pl. and atlas of 21 sheets folio. Price $11.00.

IV. Comstock Mining and Miners, by Eliot Lord. 1883. 4°. xiv, 451 pp. 3 pl. Price $1.50.

V. The Copper-Bearing Rocks of Lake Superior, by Roland Duer Irving. 1883. 4°. xvi, 464 pp. 15 l. 29 pl. and maps. Price $1.85.

VI. Contributions to the Knowledge of the Older Mesozoic Flora of Virginia, by William Morris Fontaine. 1883. 4°. xi, 144 pp. 54 l. 54 pl. Price $1.05.

VII. Silver-Lead Deposits of Eureka, Nevada, by Joseph Story Curtis. 1884. 4°. xiii, 200 pp. 16 pl. Price $1.20.

VIII. Paleontology of the Eureka District, by Charles Doolittle Walcott. 1884. 4°. xiii, 298 pp. 24 l. 24 pl. Price $1.10.

IX. Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey, by Robert P. Whitfield. 1885. 4°. xx, 338 pp. 35 pl. 1 map. Price $1.15.

X. Dinocerata: A Monograph of an Extinct Order of Gigantic Mammals, by Othniel Charles Marsh. 1886. 4°. xviii, 243 pp. 56 l. 56 pl. Price $2.70.

XI. Geological History of Lake Lahontan, a Quaternary Lake of Northwestern Nevada, by Israel Cook Russell. 1885. 4°. xiv, 288 pp. 46 pl. and maps. Price $1.75.

XII. Geology and Mining Industry of Leadville, Colorado, with Atlas, by Samuel Franklin Emmons. 1886. 4°. xxix, 770 pp. 45 pl. and atlas of 35 sheets folio. Price $8.40.

XIII. Geology of the Quicksilver Deposits of the Pacific Slope, with Atlas, by George F. Becker. 1888. 4°. xix, 486 pp. 7 pl. and atlas of 14 sheets folio. Price $2.00.

XIV. Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, by John S. Newberry. 1888. 4°. xiv, 152 pp. 26 pl. Price $1.00.

XV. The Potomac or Younger Mesozoic Flora, by William Morris Fontaine. 1889. 4°. xiv, 377 pp. 180 pl. Text and plates bound separately. Price $2.50.

XVI. The Paleozoic Fishes of North America, by John Strong Newberry. 1889. 4°. 340 pp. 53 pl. Price $1.00.

XVII. The Flora of the Dakota Group, a Posthumous Work, by Leo Lesquereux. Edited by F. H. Knowlton. 1891. 4°. 400 pp. 66 pl. Price $1.10.

XVIII. Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey, by Robert P. Whitfield. 1891. 4°. 402 pp. 50 pl. Price $1.00.

XIX. The Penokee Iron-Bearing Series of Northern Wisconsin and Michigan, by Roland D. Irving and C. R. Van Hise. 1892. 4°. xix, 534 pp. 37 pl. Price $1.70.

XX. Geology of the Eureka District, Nevada, with Atlas, by Arnold Hague. 1892. 4°. xvii, 419 pp. 8 pl. Price $5.25.

XXI. The Tertiary Rhynchophorous Coleoptera of North America, by Samuel Hubbard Scudder. 1893. 4°. xi, 206 pp. 18 pl. Price 90 cents.

XXII. A Manual of Topographic Methods, by Henry Gannett, Chief Topographer. 1893. 4°. xiv, 300 pp. 18 pl. Price $1.00.

XXIII. Geology of the Green Mountains in Massachusetts, by Raphael Pumpelly, J. E. Wolff, and T. Nelson Dale. 1894. 4°. xiv, 206 pp. 23 pl. Price $1.30.

XXIV. Mollusca and Crustacea of the Miocene Formations of New Jersey, by Robert Parr Whitfield. 1894. 4°. 195 pp. 24 pl. Price 90 cents.

XXV. The Glacial Lake Agassiz, by Warren Upham. 1895. 4°. xxiv, 658 pp. 38 pl. Price $1.70.

XXVI. Flora of the Amboy Clays, by John Strong Newberry; a Posthumous Work, edited by Arthur Hollick. 1895. 4°. 260 pp. 58 pl. Price $1.00.

XXVII. Geology of the Denver Basin, Colorado, by S. F. Emmons, Whitman Cross, and George H. Eldridge. 1896. 4°. 556 pp. 31 pl. Price $1.50.

XXVIII. The Marquette Iron-Bearing District of Michigan, with Atlas, by C. R. Van Hise and W. S. Bayley, including a Chapter on the Republic Trough, by H. L. Smyth. 1897. 4°. 608 pp. 35 pl. and atlas of 39 sheets folio. Price $5.75.

XXIX. Geology of Old Hampshire County, Massachusetts, comprising Franklin, Hampshire, and Hampden Counties, by Benjamin Kendall Emerson. 1898. 4°. xxi, 790 pp. 35 pl. Price $1.90.

XXX. Fossil Medusæ, by Charles Doolittle Walcott. 1898. 4°. ix, 201 pp. 47 pl. Price $1.50.

XXXI. Geology of the Aspen Mining District, Colorado, with Atlas, by Josiah Edward Spurr. 1898. 4°. xxxv, 260 pp. 43 pl. and atlas of 30 sheets folio. Price $3.60.

XXXII. Geology of the Yellowstone National Park, Part II, Descriptive Geology, Petrography, and Paleontology, by Arnold Hague, J. P. Iddings, W. Harvey Weed, Charles D. Walcott, G. H. Girty, T. W. Stanton, and F. H. Knowlton. 1899. 4°. xvii, 893 pp. 121 pl. Price $2.45.

XXXIII. Geology of the Narragansett Basin, by N. S. Shaler, J. B. Woodworth, and August F. Foerste. 1899. 4°. xx, 402 pp. 31 pl. Price $1.

XXXIV. The Glacial Gravels of Maine and their Associated Deposits, by George H. Stone. 1899. 4°. xiii, 499 pp. 52 pl. Price $1.30.

XXXV. The Later Extinct Floras of North America, by John Strong Newberry; edited by Arthur Hollick. 1898. 4°. xviii, 295 pp. 68 pl. Price $1.25.

XXXVI. The Crystal Falls Iron-Bearing District of Michigan, by J. Morgan Clements and Henry Lloyd Smyth; with a Chapter on the Sturgeon River Tongue, by William Shirley Bayley, and an Introduction by Charles Richard Van Hise. 1899. 4°. xxxvi, 512 pp. 53 pl. Price $2.

XXXVII. Fossil Flora of the Lower Coal Measures of Missouri, by David White. 1899. 4°. xi, 467 pp. 73 pl. Price $1.25.

XXXVIII. The Illinois Glacial Lobe, by Frank Leverett. 1899. 4°. xxi, 817 pp. 24 pl. Price $1.60.

XXXIX. The Eocene and Lower Oligocene Coral Faunas of the United States, with Descriptions of a Few Doubtfully Cretaceous Species, by T. Wayland Vaughan. 1900. 4°. 263 pp. 24 pl. Price $1.10.

XL. Adephagous and Clavicorn Coleoptera from the Tertiary Deposits at Florissant, Colorado, with Descriptions of a Few Other Forms and a Systematic List of the Non-Rhyncophorous Tertiary Coleoptera of North America, by Samuel Hubbard Scudder. 1900. 4°. 148 pp. 11 pl. Price 80 cents.

In preparation:

— Flora of the Laramie and Allied Formations, by Frank Hall Knowlton.

BULLETINS.

1. On Hypersthene-Andesite and on Triclinic Pyroxene in Augitic Rocks, by Whitman Cross, with a Geological Sketch of Buffalo Peaks, Colorado, by S. F. Emmons. 1883. 8°. 42 pp. 2 pl. Price 10 cents.

2. Gold and Silver Conversion Tables, giving the Coining Value of Troy Ounces of Fine Metal, etc., computed by Albert Williams, jr. 1883. 8°. 8 pp. Price 5 cents.

3. On the Fossil Faunas of the Upper Devonian, along the Meridian of 76° 30′, from Tompkins County, New York, to Bradford County, Pennsylvania, by Henry S. Williams. 1884. 8°. 36 pp. Price 5 cents.

4. On Mesozoic Fossils, by Charles A. White. 1884. 8°. 36 pp. 9 pl. Price 5 cents.

5. A Dictionary of Altitudes in the United States, compiled by Henry Gannett. 1884. 8°. 325 pp. Price 20 cents.

6. Elevations in the Dominion of Canada, by J. W. Spencer. 1884. 8°. 43 pp. Price 5 cents.

7. Mapoteca Geologica Americana: A Catalogue of Geological Maps of America (North and South), 1752–1881, in Geographic and Chronologic Order, by Jules Marcou and John Belknap Marcou. 1884. 8°. 184 pp. Price 10 cents.

8. On Secondary Enlargements of Mineral Fragments in Certain Rocks, by R. D. Irving and C. R. Van Hise. 1884. 8°. 56 pp. 6 pl. Price 10 cents.

9. A Report of Work done in the Washington Laboratory during the Fiscal Year 1883–'84. F. W. Clarke, Chief Chemist. T. M. Chatard, Assistant Chemist. 1884. 8°. 40 pp. Price 5 cents.

10. On the Cambrian Faunas of North America. Preliminary Studies, by Charles Doolittle Walcott. 1884. 8°. 74 pp. 10 pl. Price 5 cents.

11. On the Quaternary and Recent Mollusca of the Great Basin, with Descriptions of New Forms, by R. Ellsworth Call. Introduced by a Sketch of the Quaternary Lakes of the Great Basin, by G. K. Gilbert. 1884. 8°. 66 pp. 6 pl. Price 5 cents.

12. A Crystallographic Study of the Thinolite of Lake Lahontan, by Edward S. Dana. 1884. 8°. 34 pp. 3 pl. Price 5 cents.

13. Boundaries of the United States and of the Several States and Territories, with a Historical Sketch of the Territorial Changes, by Henry Gannett. 1885. 8°. 135 pp. Price 10 cents. (Exhausted.)

14. The Electrical and Magnetic Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1885. 8°. 238 pp. Price 15 cents.

15. On the Mesozoic and Cenozoic Paleontology of California, by Charles A. White. 1885. 8°. 33 pp. Price 5 cents.

16. On the Higher Devonian Faunas of Ontario County, New York, by John M. Clarke. 1885. 8°. 86 pp. 3 pl. Price 5 cents.

17. On the Development of Crystallization in the Igneous Rocks of Washoe, Nevada, with notes on the Geology of the District, by Arnold Hague and Joseph P. Iddings. 1885. 8°. 44 pp. Price 5 cents.

18. On Marine Eocene, Fresh-Water Miocene, and Other Fossil Mollusca of Western North America, by Charles A. White. 1885. 8°. 26 pp. 3 pl. Price 5 cents.

19. Notes on the Stratigraphy of California, by George F. Becker. 1885. 8°. 28 pp. Price 5 cents. (Exhausted.)

20. Contributions to the Mineralogy of the Rocky Mountains, by Whitman Cross and W. F. Hillebrand. 1885. 8°. 114 pp. 1 pl. Price 10 cents.

21. The Lignites of the Great Sioux Reservation. A Report on the Region between the Grand and Moreau Rivers, Dakota, by Bailey Willis. 1885. 8°. 16 pp. 5 pl. Price 5 cents.

22. On New Cretaceous Fossils from California, by Charles A. White. 1885. 8°. 25 pp. 5 pl. Price 5 cents.

23. Observations on the Junction between the Eastern Sandstone and the Keweenaw Series on Keweenaw Point, Lake Superior, by R. D. Irving and T. C. Chamberlin. 1885. 8°. 124 pp. 17 pl. Price 15 cents.

24. List of Marine Mollusca, comprising the Quaternary Fossils and Recent Forms from American Localities between Cape Hatteras and Cape Roque, including the Bermudas, by William Healy Dall. 1885. 8°. 336 pp. Price 25 cents.

25. The Present Technical Condition of the Steel Industry of the United States, by Phineas Barnes. 1885. 8°. 85 pp. Price 10 cents.

26. Copper Smelting, by Henry M. Howe. 1885. 8°. 107 pp. Price 10 cents.

27. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1884–'85. 1886. 8°. 80 pp. Price 10 cents.

28. The Gabbros and Associated Hornblende Rocks occurring in the Neighborhood of Baltimore, Maryland, by George Huntington Williams. 1886. 8°. 78 pp. 4 pl. Price 10 cents.

29. On the Fresh-Water Invertebrates of the North American Jurassic, by Charles A. White. 1886. 8°. 41 pp. 4 pl. Price 5 cents.

30. Second Contribution to the Studies on the Cambrian Faunas of North America, by Charles Doolittle Walcott. 1886. 8°. 369 pp. 33 pl. Price 25 cents.

31. Systematic Review of our Present Knowledge of Fossil Insects, including Myriapods and Arachnids, by Samuel Hubbard Scudder. 1886. 8°. 128 pp. Price 15 cents.

32. Lists and Analyses of the Mineral Springs of the United States (a Preliminary Study), by Albert C. Peale. 1886. 8°. 235 pp. Price 20 cents.

33. Notes on the Geology of Northern California, by J. S. Diller. 1886. 8°. 23 pp. Price 5 cents.

34. On the Relation of the Laramie Molluscan Fauna to that of the Succeeding Fresh-Water Eocene and Other Groups, by Charles A. White. 1886. 8°. 54 pp. 5 pl. Price 10 cents.

35. Physical Properties of the Iron-Carburets, by Carl Barus and Vincent Strouhal. 1886. 8°. 62 pp. Price 10 cents.

36. Subsidence of Fine Solid Particles in Liquids, by Carl Barus. 1886. 8°. 58 pp. Price 10 cents.

37. Types of the Laramie Flora, by Lester F. Ward. 1887. 8°. 354 pp. 57 pl. Price 25 cents.

38. Peridotite of Elliott County, Kentucky, by J. S. Diller. 1887. 8°. 31 pp. 1 pl. Price 5 cents.

39. The Upper Beaches and Deltas of the Glacial Lake Agassiz, by Warren Upham. 1887. 8°. 84 pp. 1 pl. Price 10 cents.

40. Changes in River Courses in Washington Territory due to Glaciation, by Bailey Willis. 1887. 8°. 10 pp. 4 pl. Price 5 cents.

41. On the Fossil Faunas of the Upper Devonian—the Genesee Section, New York, by Henry S. Williams. 1887. 8°. 121 pp. 4 pl. Price 15 cents.

42. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1885–'86. F. W. Clarke, Chief Chemist. 1887. 8°. 152 pp. 1 pl. Price 15 cents.

43. Tertiary and Cretaceous Strata of the Tuscaloosa, Tombigbee, and Alabama Rivers, by Eugene A. Smith and Lawrence C. Johnson. 1887. 8°. 189 pp. 21 pl. Price 15 cents.

44. Bibliography of North American Geology for 1886, by Nelson H. Darton. 1887. 8°. 35 pp. Price 5 cents.

45. The Present Condition of Knowledge of the Geology of Texas, by Robert T. Hill. 1887. 8°. 94 pp. Price 10 cents.

46. Nature and Origin of Deposits of Phosphate of Lime, by R. A. F. Penrose, jr., with an Introduction by N. S. Shaler. 1888. 8°. 143 pp. Price 15 cents.

47. Analyses of Waters of the Yellowstone National Park, with an Account of the Methods of Analysis employed, by Frank Austin Gooch and James Edward Whitfield. 1888. 8°. 84 pp. Price 10 cents.

48. On the Form and Position of the Sea Level, by Robert Simpson Woodward. 1888. 8°. 88 pp. Price 10 cents.

49. Latitudes and Longitudes of Certain Points in Missouri, Kansas, and New Mexico, by Robert Simpson Woodward. 1889. 8°. 133 pp. Price 15 cents.

50. Formulas and Tables to facilitate the Construction and Use of Maps, by Robert Simpson Woodward. 1889. 8°. 124 pp. Price 15 cents.

51. On Invertebrate Fossils from the Pacific Coast, by Charles Abiathar White. 1889. 8°. 102 pp. 14 pl. Price 15 cents.

52. Subaërial Decay of Rocks and Origin of the Red Color of Certain Formations, by Israel Cook Russell. 1889. 8°. 65 pp. 5 pl. Price 10 cents.

53. The Geology of Nantucket, by Nathaniel Southgate Shaler. 1889. 8°. 55 pp. 10 pl. Price 10 cents.

54. On the Thermo-Electric Measurement of High Temperatures, by Carl Barus. 1889. 8°. 313 pp. incl. 1 pl. 11 pl. Price 25 cents.

55. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1886–'87. Frank Wigglesworth Clarke, Chief Chemist. 1889. 8°. 96 pp. Price 10 cents.

56. Fossil Wood and Lignite of the Potomac Formation, by Frank Hall Knowlton. 1889. 8°. 72 pp. 7 pl. Price 10 cents.

57. A Geological Reconnoissance in Southwestern Kansas, by Robert Hay. 1890. 8°. 49 pp. 2 pl. Price 5 cents.

58. The Glacial Boundary in Western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois, by George Frederick Wright, with an Introduction by Thomas Chrowder Chamberlin. 1890. 8°. 112 pp. 8 pl. Price 15 cents.

59. The Gabbros and Associated Rocks in Delaware, by Frederick D. Chester. 1890. 8°. 45 pp. 1 pl. Price 10 cents.

60. Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1887–'88. F. W. Clarke, Chief Chemist. 1890. 8°. 174 pp. Price 15 cents.

61. Contributions to the Mineralogy of the Pacific Coast, by William Harlow Melville and Waldemar Lindgren. 1890. 8°. 40 pp. 3 pl. Price 5 cents.

62. The Greenstone Schist Areas of the Menominee and Marquette Regions of Michigan; a Contribution to the Subject of Dynamic Metamorphism in Eruptive Rocks, by George Huntington Williams; with an Introduction by Roland Duer Irving. 1890. 8°. 241 pp. 16 pl. Price 30 cents.

63. A Bibliography of Paleozoic Crustacea from 1698 to 1889, including a List of North American Species and a Systematic Arrangement of Genera, by Anthony W. Vogdes. 1890. 8°. 177 pp. Price 15 cents.

64. A report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1888–'89. F. W. Clarke, Chief Chemist. 1890. 8°. 60 pp. Price 10 cents.

65. Stratigraphy of the Bituminous Coal Field of Pennsylvania, Ohio, and West Virginia, by Israel C. White. 1891. 8°. 212 pp. 11 pl. Price 20 cents.

66. On a Group of Volcanic Rocks from the Tewan Mountains, New Mexico, and on the Occurrence of Primary Quartz in Certain Basalts, by Joseph Paxson Iddings. 1890. 8°. 34 pp. Price 5 cents.

67. The Relations of the Traps of the Newark System in the New Jersey Region, by Nelson Horatio Darton. 1890. 8°. 82 pp. Price 10 cents.

68. Earthquakes in California in 1889, by James Edward Keeler. 1890. 8°. 25 pp. Price 5 cents.

69. A Classed and Annotated Bibliography of Fossil Insects, by Samuel Hubbard Scudder. 1890. 8°. 101 pp. Price 15 cents.

70. Report on Astronomical Work of 1889 and 1890, by Robert Simpson Woodward. 1890. 8°. 79 pp. Price 10 cents.

71. Index to the Known Fossil Insects of the World, including Myriapods and Arachnids, by Samuel Hubbard Scudder. 1891. 8°. 744 pp. Price 50 cents.

72. Altitudes between Lake Superior and the Rocky Mountains, by Warren Upham. 1891. 8°. 229 pp. Price 20 cents.

73. The Viscosity of Solids, by Carl Barus. 1891. 8°. xii, 139 pp. 6 pl. Price 15 cents.

74. The Minerals of North Carolina, by Frederick Augustus Genth. 1891. 8°. 119 pp. Price 15 cents.

75. Record of North American Geology for 1887 to 1889, inclusive, by Nelson Horatio Darton. 1891. 8°. 173 pp. Price 15 cents.

76. A Dictionary of Altitudes in the United States (Second Edition), compiled by Henry Gannett, Chief Topographer. 1891. 8°. 393 pp. Price 25 cents.

77. The Texan Permian and its Mesozoic Types of Fossils, by Charles A. White. 1891. 8°. 51 pp. 4 pl. Price 10 cents.

78. A Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1889–'90. F. W. Clarke, Chief Chemist. 1891. 8°. 131 pp. Price 15 cents.

79. A Late Volcanic Eruption in Northern California and its Peculiar Lava, by J. S. Diller. 1891. 8°. 33 pp. 17 pl. Price 10 cents.

80. Correlation Papers—Devonian and Carboniferous, by Henry Shaler Williams. 1891. 8°. 279 pp. Price 20 cents.

81. Correlation Papers—Cambrian, by Charles Doolittle Walcott. 1891. 8°. 447 pp. 3 pl. Price 25 cents.

82. Correlation Papers—Cretaceous, by Charles A. White. 1891. 8°. 273 pp. 3 pl. Price 20 cents.

83. Correlation Papers—Eocene, by William Bullock Clark. 1891. 8°. 173 pp. 2 pl. Price 15 cents.

84. Correlation Papers—Neocene, by W. H. Dall and G. D. Harris. 1892. 8°. 349 pp. 3 pl. Price 25 cents.

85. Correlation Papers—The Newark System, by Israel Cook Russell. 1892. 8°. 344 pp. 13 pl. Price 25 cents.
86. Correlation Papers—Archean and Algonkian, by C. R. Van Hise. 1892. 8°. 549 pp. 12 pl. Price 25 cents.
87. A Synopsis of American Fossil Brachiopoda, including Bibliography and Synonymy, by Charles Schuchert. 1897. 8°. 464 pp. Price 25 cents.
88. The Cretaceous Foraminifera of New Jersey, by Rufus Mather Bagg, jr. 1898. 8°. 89 pp. 6 pl. Price 10 cents.
89. Some Lava Flows of the Western Slope of the Sierra Nevada, California, by F. Leslie Ransome. 1898. 8°. 74 pp. 11 pl. Price 15 cents.
90. A Report of Work done in the Division of Chemistry and Physics, mainly during the Fiscal Year 1890–'91. F. W. Clarke, Chief Chemist. 1892. 8°. 77 pp. Price 10 cents.
91. Record of North American Geology for 1890, by Nelson Horatio Darton. 1891. 8°. 88 pp. Price 10 cents.
92. The Compressibility of Liquids, by Carl Barus. 1892. 8°. 96 pp. 29 pl. Price 10 cents.
93. Some Insects of Special Interest from Florissant, Colorado, and Other Points in the Tertiaries of Colorado and Utah, by Samuel Hubbard Scudder. 1892. 8°. 35 pp. 3 pl. Price 5 cents.
94. The Mechanism of Solid Viscosity, by Carl Barus. 1892. 8°. 138 pp. Price 15 cents.
95. Earthquakes in California in 1890 and 1891, by Edward Singleton Holden. 1892. 8°. 31 pp. Price 5 cents.
96. The Volume Thermodynamics of Liquids, by Carl Barus. 1892. 8°. 100 pp. Price 10 cents.
97. The Mesozoic Echinodermata of the United States, by William Bullock Clark. 1893. 8°. 207 pp. 50 pl. Price 20 cents.
98. Flora of the Outlying Carboniferous Basins of Southwestern Missouri, by David White. 1893. 8°. 139 pp. 5 pl. Price 15 cents.
99. Record of North American Geology for 1891, by Nelson Horatio Darton. 1892. 8°. 73 pp. Price 10 cents.
100. Bibliography and Index of the Publications of the U. S. Geological Survey, 1879–1892, by Philip Creveling Warman. 1893. 8°. 495 pp. Price 25 cents.
101. Insect Fauna of the Rhode Island Coal Field, by Samuel Hubbard Scudder. 1893. 8°. 27 pp. 2 pl. Price 5 cents.
102. A Catalogue and Bibliography of North American Mesozoic Invertebrata, by Cornelius Breckinridge Boyle. 1893. 8°. 315 pp. Price 25 cents.
103. High Temperature Work in Igneous Fusion and Ebullition, chiefly in Relation to Pressure, by Carl Barus. 1893. 8°. 57 pp. 9 pl. Price 10 cents.
104. Glaciation of the Yellowstone Valley north of the Park, by Walter Harvey Weed. 1893. 8°. 41 pp. 4 pl. Price 5 cents.
105. The Laramie and the Overlying Livingston Formation in Montana, by Walter Harvey Weed, with Report on Flora, by Frank Hall Knowlton. 1893. 8°. 68 pp. 6 pl. Price 10 cents.
106. The Colorado Formation and its Invertebrate Fauna, by T. W. Stanton. 1893. 8°. 288 pp. 45 pl. Price 20 cents.
107. The Trap Dikes of the Lake Champlain Region, by James Furman Kemp and Vernon Freeman Marsters. 1893. 8°. 62 pp. 4 pl. Price 10 cents.
108. A Geological Reconnoissance in Central Washington, by Israel Cook Russell. 1893. 8°. 108 pp. 12 pl. Price 15 cents.
109. The Eruptive and Sedimentary Rocks on Pigeon Point, Minnesota, and their Contact Phenomena, by William Shirley Bayley. 1893. 8°. 121 pp. 16 pl. Price 15 cents.
110. The Paleozoic Section in the Vicinity of Three Forks, Montana, by Albert Charles Peale. 1893. 8°. 56 pp. 6 pl. Price 10 cents.
111. Geology of the Big Stone Gap Coal Field of Virginia and Kentucky, by Marius R. Campbell. 1893. 8°. 106 pp. 6 pl. Price 15 cents.
112. Earthquakes in California in 1892, by Charles D. Perrine. 1893. 8°. 57 pp. Price 10 cents.
113. A Report of Work done in the Division of Chemistry during the Fiscal Years 1891–'92 and 1892–'93. F. W. Clarke, Chief Chemist. 1893. 8°. 115 pp. Price 15 cents.
114. Earthquakes in California in 1893, by Charles D. Perrine. 1894. 8°. 23 pp. Price 5 cents.
115. A Geographic Dictionary of Rhode Island, by Henry Gannett. 1894. 8°. 31 pp. Price 5 cents.
116. A Geographic Dictionary of Massachusetts, by Henry Gannett. 1894. 8°. 126 pp. Price 15 cents.
117. A Geographic Dictionary of Connecticut, by Henry Gannett. 1894. 8°. 67 pp. Price 10 cents.
118. A Geographic Dictionary of New Jersey, by Henry Gannett. 1894. 8°. 131 pp. Price 15 cents.
119. A Geological Reconnoissance in Northwest Wyoming, by George Homans Eldridge. 1894. 8°. 72 pp. 4 pl. Price 10 cents.
120. The Devonian System of Eastern Pennsylvania and New York, by Charles S. Prosser. 1895. 8°. 81 pp. 2 pl. Price 10 cents.
121. A Bibliography of North American Paleontology, by Charles Rollin Keyes. 1894. 8°. 251 pp. Price 20 cents.
122. Results of Primary Triangulation, by Henry Gannett. 1894. 8°. 412 pp. 17 pl. Price 25 cents.

123. A Dictionary of Geographic Positions, by Henry Gannett. 1895. 8°. 183 pp. 1 pl. Price 15 cents.

124. Revision of North American Fossil Cockroaches, by Samuel Hubbard Scudder. 1895. 8°. 176 pp. 12 pl. Price 15 cents.

125. The Constitution of the Silicates, by Frank Wigglesworth Clarke. 1895. 8°. 109 pp. Price 15 cents.

126. A Mineralogical Lexicon of Franklin, Hampshire, and Hampden Counties, Massachusetts, by Benjamin Kendall Emerson. 1895. 8°. 180 pp. 1 pl. Price 15 cents.

127. Catalogue and Index of Contributions to North American Geology, 1732–1891, by Nelson Horatio Darton. 1896. 8°. 1045 pp. Price 60 cents.

128. The Bear River Formation and its Characteristic Fauna, by Charles A. White. 1895. 8°. 108 pp. 11 pl. Price 15 cents.

129. Earthquakes in California in 1894, by Charles D. Perrine. 1895. 8°. 25 pp. Price 5 cents.

130. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for 1892 and 1893, by Fred Boughton Weeks. 1896. 8°. 210 pp. Price 20 cents.

131. Report of Progress of the Division of Hydrography for the Calendar Years 1893 and 1894, by Frederick Haynes Newell, Topographer in Charge. 1895. 8°. 126 pp. Price 15 cents.

132. The Disseminated Lead Ores of Southeastern Missouri, by Arthur Winslow. 1896. 8°. 31 pp. Price 5 cents.

133. Contributions to the Cretaceous Paleontology of the Pacific Coast: The Fauna of the Knoxville Beds, by T. W. Stanton. 1895. 8°. 132 pp. 20 pl. Price 15 cents.

134. The Cambrian Rocks of Pennsylvania, by Charles Doolittle Walcott. 1896. 8°. 43 pp. 15 pl. Price 5 cents.

135. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1894, by F. B. Weeks. 1896. 8°. 141 pp. Price 15 cents.

136. Volcanic Rocks of South Mountain, Pennsylvania, by Florence Bascom. 1896. 8°. 124 pp. 28 pl. Price 15 cents.

137. The Geology of the Fort Riley Military Reservation and Vicinity, Kansas, by Robert Hay. 1896. 8°. 35 pp. 8 pl. Price 5 cents.

138. Artesian-Well Prospects in the Atlantic Coastal Plain Region, by N. H. Darton. 1896. 8°. 228 pp. 19 pl. Price 20 cents.

139. Geology of the Castle Mountain Mining District, Montana, by W. H. Weed and L. V. Pirsson. 1896. 8°. 164 pp. 17 pl. Price 15 cents.

140. Report of Progress of the Division of Hydrography for the Calendar Year 1895, by Frederick Haynes Newell, Hydrographer in Charge. 1896. 8°. 356 pp. Price 25 cents.

141. The Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland, and Virginia, by William Bullock Clark. 1896. 8°. 167 pp. 40 pl. Price 15 cents.

142. A Brief Contribution to the Geology and Paleontology of Northwestern Louisiana, by T. Wayland Vaughan. 1896. 8°. 65 pp. 4 pl. Price 10 cents.

143. A Bibliography of Clays and the Ceramic Arts, by John C. Branner. 1896. 8°. 114 pp. Price 15 cents.

144. The Moraines of the Missouri Coteau and their Attendant Deposits, by James Edward Todd. 1896. 8°. 71 pp. 21 pl. Price 10 cents.

145. The Potomac Formation in Virginia, by W. M. Fontaine. 1896. 8°. 149 pp. 2 pl. Price 15 cents.

146. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1895, by F. B. Weeks. 1896. 8°. 130 pp. Price 15 cents.

147. Earthquakes in California in 1895, by Charles D. Perrine, Assistant Astronomer in Charge of Earthquake Observations at the Lick Observatory. 1896. 8°. 23 pp. Price 5 cents.

148. Analyses of Rocks, with a Chapter on Analytical Methods, Laboratory of the United States Geological Survey, 1880 to 1896, by F. W. Clarke and W. F. Hillebrand. 1897. 8°. 306 pp. Price 20 cents.

149. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1896, by Fred Boughton Weeks. 1897. 8°. 152 pp. Price 15 cents.

150. The Educational Series of Rock Specimens Collected and Distributed by the United States Geological Survey, by Joseph Silas Diller. 1898. 8°. 400 pp. 47 pl. Price 25 cents.

151. The Lower Cretaceous Gryphæas of the Texas Region, by R. T. Hill and T. Wayland Vaughan. 1898. 8°. 139 pp. 35 pl. Price 15 cents.

152. A Catalogue of the Cretaceous and Tertiary Plants of North America, by F. H. Knowlton. 1898. 8°. 247 pp. Price 20 cents.

153. A Bibliographic Index of North American Carboniferous Invertebrates, by Stuart Weller. 1898. 8°. 653 pp. Price 35 cents.

154. A Gazetteer of Kansas, by Henry Gannett. 1898. 8°. 246 pp. 6 pl. Price 20 cents.

155. Earthquakes in California in 1896 and 1897, by Charles D. Perrine, Assistant Astronomer in Charge of Earthquake Observations at the Lick Observatory. 1898. 8°. 47 pp. Price 5 cents.

156. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1897, by Fred Boughton Weeks. 1898. 8°. 130 pp. Price 15 cents.

157. The Gneisses, Gabbro-Schists, and Associated Rocks of Southwestern Minnesota, by Christopher Webber Hall. 1899. 8°. 160 pp. 27 pl. Price 45 cents.

158. The Moraines of Southeastern South Dakota and their Attendant Deposits, by James Edward Todd. 1899. 8°. 171 pp. 27 pl. Price 25 cents.

159. The Geology of Eastern Berkshire County, Massachusetts, by B. K. Emerson. 1899. 8°. 139 pp. 9 pl. Price 20 cents.

160. A Dictionary of Altitudes in the United States (Third Edition), compiled by Henry Gannett. 1899. 8°. 775 pp. Price 40 cents.

161. Earthquakes in California in 1898, by Charles D. Perrine, Assistant Astronomer in Charge of Earthquake Observations at the Lick Observatory. 1899. 8°. 31 pp. 1 pl. Price 5 cents.

162. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1898, by Fred Boughton Weeks. 1899. 8°. 163 pp. Price 15 cents.

163. Flora of the Montana Formation, by Frank Hall Knowlton. 1900. 8°. 118 pp. 19 pl. Price 15 cents

164. Reconnaissance in the Rio Grande Coal Fields of Texas, by Thomas Wayland Vaughan, including a Report on Igneous Rocks from the San Carlos Coal Field, by E. C. E. Lord. 1900. 8°. 100 pp. 11 pl. and maps. Price 20 cents.

165. Contributions to the Geology of Maine, by Henry S. Williams and Herbert E. Gregory. 1900. 8°. 212 pp. 14 pl. Price 25 cents.

166. A Gazetteer of Utah, by Henry Gannett. 1900. 8°. 43 pp. 1 map. Price 15 cents.

167. Contributions to Chemistry and Mineralogy from the Laboratory of the United States Geological Survey; Frank W. Clarke, Chief Chemist. 1900. 8°. 166 pp. Price 15 cents.

168. Analyses of Rocks, Laboratory of the United States Geological Survey, 1880 to 1899, tabulated by F. W. Clarke, Chief Chemist. 1900. 8°. 308 pp. Price 20 cents.

169. Altitudes in Alaska, by Henry Gannett. 1900. 8°. 13 pp. Price 5 cents.

170. Survey of the Boundary Line between Idaho and Montana from the International Boundary to the Crest of the Bitterroot Mountains, by Richard Urquhart Goode. 1900. 8°. 67 pp. 14 pl. Price 15 cents.

171. Boundaries of the United States and of the Several States and Territories, with an Outline of the History of all Important Changes of Territory (Second Edition), by Henry Gannett. 1900. 8°. 142 pp. 53 pl. Price 30 cents.

172. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the Year 1899, by Fred Boughton Weeks. 1900. 8°. 141 pp. Price 15 cents.

173. Synopsis of American Fossil Bryozoa, including Bibliography and Synonymy, by John M. Nickles and Ray S. Bassler. 1900. 8°. 663 pp. Price 40 cents.

174. Survey of the Northwestern Boundary of the United States, 1857-1861, by Marcus Baker. 1900. 8°. 78 pp. 1 pl. Price 10 cents.

175. Triangulation and Spirit Leveling in Indian Territory, by C. H. Fitch. 1900. 8°. 141 pp. 1 pl. Price 10 cents.

176. Some Principles and Methods of Rock Analysis, by W. F. Hillebrand. 1900. 8°. 114 pp. Price 15 cents.

In preparation:

—. Bibliography and Catalogue of the Fossil Vertebrata of North America, by Oliver Perry Hay.

WATER-SUPPLY AND IRRIGATION PAPERS.

By act of Congress approved June 11, 1896, the following provision was made:

"*Provided*, That hereafter the reports of the Geological Survey in relation to the gauging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed one hundred pages in length and five thousand copies in number; one thousand copies of which shall be for the official use of the Geological Survey, one thousand five hundred copies shall be delivered to the Senate, and two thousand five hundred copies shall be delivered to the House of Representatives, for distribution."

Under this law the following papers have been published:

1. Pumping Water for Irrigation, by Herbert M. Wilson. 1896. 8°. 57 pp. 9 pl.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis. 1897. 8°. 97 pp. 31 pl.
3. Sewage Irrigation, by George W. Rafter. 1897. 8°. 100 pp. 4 pl.
4. A Reconnoissance in Southeastern Washington, by Israel Cook Russell. 1897. 8°. 96 pp. 7 pl.
5. Irrigation Practice on the Great Plains, by Elias Branson Cowgill. 1897. 8°. 39 pp. 12 pl.
6. Underground Waters of Southwestern Kansas, by Erasmuth Haworth. 1897. 8°. 65 pp. 12 pl.
7. Seepage Waters of Northern Utah, by Samuel Fortier. 1897. 8°. 50 pp. 3 pl.
8. Windmills for Irrigation, by E. C. Murphy. 1897. 8°. 49 pp. 8 pl.
9. Irrigation near Greeley, Colorado, by David Boyd. 1897. 8°. 90 pp. 21 pl.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker. 1898. 8°. 51 pp. 11 pl.
11. River Heights for 1896, by Arthur P. Davis. 1897. 8°. 100 pp.
12. Underground Waters of Southeastern Nebraska, by N. H. Darton. 1898. 8°. 56 pp. 21 pl.
13. Irrigation Systems in Texas, by William Ferguson Hutson. 1898. 8°. 67 pp. 10 pl.
14. New Tests of Pumps and Water-Lifts used in Irrigation, by O. P. Hood. 1898. 8°. 91 pp. 1 pl.
15. Operations at River Stations, 1897, Part I. 1898. 8°. 100 pp.
16. Operations at River Stations, 1897, Part II. 1898. 8°. 101-200 pp.
17. Irrigation near Bakersfield, California, by C. E. Grunsky. 1898. 8°. 96 pp. 16 pl.

18. Irrigation near Fresno, California, by C. E. Grunsky. 1898. 8°. 94 pp. 14 pl.
19. Irrigation near Merced, California, by C. E. Grunsky. 1899. 8°. 59 pp. 11 pl.
20. Experiments with Windmills, by T. O. Perry. 1899. 8°. 97 pp. 12 pl.
21. Wells of Northern Indiana, by Frank Leverett. 1899. 8°. 82 pp. 2 pl.
22. Sewage Irrigation, Part II, by George W. Rafter. 1899. 8°. 100 pp. 7 pl.
23. Water-right Problems of the Bighorn Mountains, by Elwood Mead. 1899. 8°. 62 pp. 7 pl.
24. Water Resources of the State of New York, Part I, by G. W. Rafter. 1899. 8°. 99 pp. 13 pl.
25. Water Resources of the State of New York, Part II, by G. W. Rafter. 1899. 8°. 101-200 pp. 12 pl.
26. Wells of Southern Indiana (Continuation of No. 21), by Frank Leverett. 1899. 8°. 64 pp.
27. Operations at River Stations for 1898, Part I. 1899. 8°. 100 pp.
28. Operations at River Stations for 1898, Part II. 1899. 8°. 101-200 pp.
29. Wells and Windmills in Nebraska, by Erwin H. Barbour. 1899. 8°. 85 pp. 27 pl.
30. Water Resources of the Lower Peninsula of Michigan, by Alfred C. Lane. 1899. 8°. 97 pp. 7 pl.
31. Lower Michigan Mineral Waters, by Alfred C. Lane. 1899. 8°. 97 pp. 4 pl.
32. Water Resources of Puerto Rico, by Herbert M. Wilson. 1899. 8°. 48 pp. 17 pl.
33. Storage of Water on Gila River, Arizona, by Joseph B. Lippincott. 1900. 8°. 98 pp. 33 pl.
34. Geology and Water Resources of SE. South Dakota, by J. E. Todd. 1900. 8°. 34 pp. 19 pl.
35. Operations at River Stations, 1899, Part I. 1900. 8°. 100 pp.
36. Operations at River Stations, 1899, Part II. 1900. 8°. 101-198 pp.
37. Operations at River Stations, 1899, Part III. 1900. 8°. 199-298 pp.
38. Operations at River Stations, 1899, Part IV. 1900. 8°. 299-396 pp.
39. Operations at River Stations, 1899, Part V. 1900. 8°. 397-471 pp.
40. The Austin Dam, by Thomas U. Taylor. 1900. 8°. 51 pp. 16 pl.

In preparation:

41. Experiments with Windmills, by E. C. Murphy.
42. Conveyance of Water, by Samuel Fortier.
43. Profiles of Rivers, by Henry Gannett.

TOPOGRAPHIC MAP OF THE UNITED STATES.

When, in 1882, the Geological Survey was directed by law to make a geologic map of the United States, there was in existence no suitable topographic map to serve as a base for the geologic map. The preparation of such a topographic map was therefore immediately begun. About one-fifth of the area of the country, excluding Alaska, has now been thus mapped. The map is published in atlas sheets, each sheet representing a small quadrangular district, as explained under the next heading. The separate sheets are sold at 5 cents each when fewer than 100 copies are purchased, but when they are ordered in lots of 100 or more copies, whether of the same sheet or of different sheets, the price is 2 cents each. The mapped areas are widely scattered, nearly every State being represented. About 1,100 sheets have been engraved and printed; they are tabulated by States in the Survey's "List of Publications," a pamphlet which may be had on application.

The map sheets represent a great variety of topographic features, and with the aid of descriptive text they can be used to illustrate topographic forms. This has led to the projection of an educational series of topographic folios, for use wherever geography is taught in high schools, academies, and colleges. Of this series the first three folios have been issued, viz:

1. Physiographic types, by Henry Gannett. 1898. Folio. Four pages of descriptive text and the following topographic sheets: Fargo (N. Dak.-Minn.), a region in youth; Charleston (W. Va.), a region in maturity; Caldwell (Kans.), a region in old age; Palmyra (Va.), a rejuvenated region; Mount Shasta, (Cal.), a young volcanic mountain; Eagle (Wis.), moraines; Sun Prairie (Wis.), drumlins; Donaldsonville (La.), river flood plains; Boothbay (Me.), a fiord coast; Atlantic City (N. J.), a barrier-beach coast. Price 25 cents.

2. Physiographic types, by Henry Gannett. 1900. Folio. Eleven pages of descriptive text and the following topographic sheets: Norfolk (Va.-N. C.), a coast swamp; Marshall (Mo.), a graded river; Lexington (Nebr.), an overloaded stream; Harrisburg (Pa.), Appalachian ridges; Poteau Mountain (Ark.-Ind. T.), Ozark ridges; Marshall (Ark.), Ozark Plateau; West Denver (Colo.), hogbacks; Mount Taylor (N. Mex.), volcanic peaks, plateaus, and necks; Cucamonga (Cal.), alluvial cones; Crater Lake special (Oreg.), a crater. Price 25 cents.

3. Physical geography of the Texas region, by Robert T. Hill. 1900. Folio. Twelve pages of text (including 11 cuts); 5 sheets of special half-tone illustrations; 5 topographic sheets, one showing types of mountains, three showing types of plains and scarps, and one showing types of rivers and canyons; and a new map of Texas and parts of adjoining territories. Price 50 cents.

GEOLOGIC ATLAS OF THE UNITED STATES.

The Geologic Atlas of the United States is the final form of publication of the topographic and geologic maps. The atlas is issued in parts, or folios, progressively as the surveys are extended, and is designed ultimately to cover the entire country.

Under the plan adopted the entire area of the country is divided into small rectangular districts (designated *quadrangles*), bounded by certain meridians and parallels. The unit of survey is also the unit of publication, and the maps and descriptions of each rectangular district are issued as a folio of the Geologic Atlas.

Each folio contains topographic, geologic, economic, and structural maps, together with textual descriptions and explanations, and is designated by the name of a principal town or of a prominent natural feature within the district.

Two forms of issue have been adopted, a "library edition" and a "field edition." In both the sheets are bound between heavy paper covers, but the library copies are permanently bound, while the sheets and covers of the field copies are only temporarily wired together.

Under the law a copy of each folio is sent to certain public libraries and educational institutions. The remainder are sold at 25 cents each, except such as contain an unusual amount of matter, which are priced accordingly. Prepayment is obligatory. The folios ready for distribution are here listed.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
1	Livingston	Montana	110°–111°	45°–46°	3,354	25
2	Ringgold	Georgia, Tennessee	85°–85° 30′	34° 30′–35°	980	25
3	Placerville	California	120° 30′–121°	38° 30′–39°	932	25
4	Kingston *a*	Tennessee	84° 30′–85°	35° 30′–36°	969	25
5	Sacramento	California	121°–121° 30′	38° 30′–39°	932	25
6	Chattanooga	Tennessee	85°–85° 30′	35°–35° 30′	975	25
7	Pikes Peak *a*	Colorado	105°–105° 30′	38° 30′–39°	932	25
8	Sewanee	Tennessee	85° 30′–86°	35°–35° 30′	975	25
9	Anthracite-Crested Butte.	Colorado	106° 45′–107° 15′	38° 45′–39°	465	50
10	Harpers Ferry	Virginia, West Va., Maryland	77° 30′–78°	39°–39° 30′	925	25
11	Jackson	California	120° 30′–121°	38°–38° 30′	938	25
12	Estillville	Virginia, Kentucky, Tennessee	82° 30′–83°	36° 30′–37°	957	25
13	Fredericksburg	Maryland, Virginia	77°–77° 30′	38°–38° 30′	938	25
14	Staunton	Virginia, West Va.	79°–79° 30′	38°–38° 30′	938	25
15	Lassen Peak	California	121°–122°	40°–41°	3,634	25
16	Knoxville	Tennessee, N. Carolina	83° 30′–84°	35° 30′–36°	925	25
17	Marysville	California	121° 30′–122°	39°–39° 30′	925	25
18	Smartsville	California	121°–121° 30′	39°–39° 30′	925	25
19	Stevenson	Alabama, Georgia, Tennessee	85° 30′–86°	34° 30′–35°	980	25
20	Cleveland	Tennessee	84° 30′–85°	35°–35° 30′	975	25
21	Pikeville	Tennessee	85°–85° 30′	35° 30′–36°	969	25
22	McMinnville	Tennessee	85° 30′–86°	35° 30′–36°	969	25
23	Nomini	Maryland, Virginia	76° 30′–77°	38°–38° 30′	938	25
24	Three Forks	Montana	111°–112°	45°–46°	3,354	50
25	London	Tennessee	84°–84° 30′	35° 30′–36°	969	25
26	Pocahontas	Virginia, West Va.	81°–81° 30′	37°–37° 30′	951	25
27	Morristown	Tennessee	83°–83° 30′	36°–36° 30′	963	25
28	Piedmont	Maryland, West Va.	79°–79° 30′	39°–39° 30′	925	25
29	Nevada City:					
	Nevada City	California	121° 00′ 25″–121° 03′ 45″	39° 13′ 50″–39° 17′ 16″	11.65	50
	Grass Valley	California	121° 01′ 35″–121° 05′ 04″	39° 10′ 22″–39° 13′ 50″	12.09	
	Banner Hill	California	120° 57′ 05″–121° 00′ 25″	39° 13′ 50″–39° 17′ 16″	11.65	
30	Yellowstone National Park: Gallatin, Canyon, Shoshone, Lake	Wyoming	110°–111°	44°–45°	3,412	75
31	Pyramid Peak	California	120°–120° 30′	44°–45°	932	25
32	Franklin	Virginia, West Va.	79°–79° 30′	38° 30′–39°	932	25
33	Briceville	Tennessee	84°–84° 30′	36°–36° 30′	963	25
34	Buckhannon	West Va.	80°–80° 30′	38° 30′–39°	932	25
35	Gadsden	Alabama	86°–86° 30′	34°–34° 30′	986	25
36	Pueblo	Colorado	104° 30′–105°	38°–38° 30′	938	50
37	Downieville	California	120° 30′–121°	39° 30′–40°	919	25
38	Butte Special	Montana	112° 29′ 30″–112° 36′ 42″	45° 59′ 28″–46° 02′ 54″	22.80	50
39	Truckee	California	120°–120° 30′	39°–39° 30′	925	25
40	Wartburg	Tennessee	84° 30′–85°	36°–36° 30′	963	25
41	Sonora	California	120°–120° 30′	37° 30′–38°	944	25
42	Nueces	Texas	100°–100° 30′	29° 30′–30°	1,035	25
43	Bidwell Bar	California	121°–121° 30′	39° 30′–40°	918	25
44	Tazewell	Virginia, West Va.	81° 30′–82°	37°–37° 30′	950	25
45	Boise	Idaho	116°–116° 30′	43° 30′–44°	864	25
46	Richmond	Kentucky	84°–84° 30′	37° 30′–38°	944	25
47	London	Kentucky	84°–84° 30′	37°–37° 30′	950	25
48	Tenmile District Special.	Colorado	106° 8′–106° 16′	39° 22′ 30″–39° 30′ 30″	55	25
49	Roseburg	Oregon	123°–123° 30′	43°–43° 30′	871	25

a Out of stock.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
50	Holyoke	Mass. / Conn	72° 30′–73°	42°–42° 30′	885	50
51	Big Trees	California	120°–120° 30′	38°–38° 30′	938	25
52	Absaroka: Crandall / Ishawooa	Wyoming	109° 30′–110°	44°–44° 30′	1,706	25
53	Standingstone	Tennessee	85°–85° 30′	36°–36° 30′	963	25
54	Tacoma	Washington.	122°–122° 30′	47°–47° 30′	812	25
55	Fort Benton	Montana	110°–111°	47°–48°	3,273	25
56	Little Belt Mts	Montana	110°–111°	46°–47°	3,295	25
57	Telluride	Colorado	107° 45′–108°	37° 45′–38°	236	25
58	Elmoro	Colorado	104°–104° 30′	37°–37° 30′	950	25
59	Bristol	Virginia / Tennessee	82°–82° 30′	36° 30′–37°	957	25
61	Monterey	Virginia / West Va	79° 30′–80°	38°–38° 30′	938	25
62	Menominee Special	Michigan	(a NW.-SE. area, about	22 m. long, 6½ wide)	150	25
63	Mother Lode	California	(a NW.-SE. rectangle,	70 m. long, 6½ wide)	455	50
64	Uvalde	Texas	99° 30′–100°	29°–29° 30′	1,040	25
65	Tintic Special	Utah	111° 55′–112° 10′	39° 45′–40°	229	25

STATISTICAL PAPERS.

Mineral Resources of the United States, 1882, by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1887, by David T. Day. 1888. 8°. vii, 832 pp. Price 50 cents.

Mineral Resources of the United States, 1888, by David T. Day. 1890. 8°. vii, 652 pp. Price 50 cents.

Mineral Resources of the United States, 1889 and 1890, by David T. Day. 1892. 8°. viii, 671 pp. Price 50 cents.

Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.

Mineral Resources of the United States, 1892, by David T. Day. 1893. 8°. vii, 850 pp. Price 50 cents.

Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

In compliance with this legislation the following reports have been published:

Mineral Resources of the United States, 1894, David T. Day, Chief of Division. 1895. 8°. xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl. Being Parts III and IV of the Sixteenth Annual Report.

Mineral Resources of the United States, 1895, David T. Day, Chief of Division. 1896. 8°. xxiii, 542 pp., 8 pl. and maps; iii, 543-1058 pp., 9-13 pl. Being Part III (in 2 vols.) of the Seventeenth Annual Report.

Mineral Resources of the United States, 1896, David T. Day, Chief of Division. 1897. 8°. xii, 642 pp., 1 pl.; 643-1400 pp. Being Part V (in 2 vols.) of the Eighteenth Annual Report.

Mineral Resources of the United States, 1897, David T. Day, Chief of Division. 1898. 8°. viii, 651 pp., 11 pl.; viii, 706 pp. Being Part VI (in 2 vols.) of the Nineteenth Annual Report.

Mineral Resources of the United States, 1898, by David T. Day, Chief of Division. 1899. 8°. viii, 616 pp.; ix, 804 pp., 1 pl. Being Part VI (in 2 vols.) of the Twentieth Annual Report.

The money received from the sale of the Survey publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps. All remittances, therefore, must be by MONEY ORDER, made payable to the Director of the United States Geological Survey, or in CURRENCY—the exact amount. Correspondence relating to the publications of the Survey should be addressed to—

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

WASHINGTON, D. C., *December*, 1900.