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

MAP OF ALASKA

SHOWING KNOWN GOLD-BEARING ROCKS

WITH

DESCRIPTIVE TEXT

CONTAINING SKETCHES OF THE

GEOGRAPHY, GEOLOGY, AND GOLD DEPOSITS

AND

ROUTES TO THE GOLD FIELDS

PREPARED IN ACCORDANCE WITH PUBLIC RESOLUTION NO. 3 OF THE FIFTY-FIFTH CONGRESS SECOND SESSION, APPROVED JANUARY 20, 1898

PRINTED IN THE ENGRAVING AND PRINTING DIVISION OF THE
UNITED STATES GEOLOGICAL SURVEY
WASHINGTON, D. C.
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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 2, 1898.

SIR: In accordance with your instructions, I have somewhat hastily brought together in the following pages such facts as seem likely to prove of immediate use to the prospectors and miners who may visit Alaska.

Messrs. W. H. Dall and F. C. Schrader, both of whom have personally studied the region, have rendered efficient aid in this work.

Very respectfully,
Your obedient servant,

S. F. EMMONS,
Geologist.

HON. CHARLES D. WALCOTT,
Director United States Geological Survey.

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MAP OF ALASKA, WITH DESCRIPTIVE TEXT.

INTRODUCTION.

Alaska was first visited by a Russian expedition under Bering in 1741. In 1799 the territory was granted to a Russo-American fur company by the Emperor Paul VIII, and in 1839 the charter was renewed for twenty-four years. In 1867 it was ceded to the United States for a money payment of $7,200,000. The treaty was signed on March 30 and ratified on June 20, 1867; on the 18th of October following, formal transfer of the country was made to the military force of the United States at New Archangel, now called Sitka.

For a long time the wisdom of the purchase of this bleak tract of unknown land lying largely within the Arctic Circle was seriously questioned, and Mr. Seward, under whom, as Secretary of State, the negotiations for its purchase were conducted, was subjected to some criticism, even ridicule, in consequence. But the energy of the American people would not allow even so unpromising a region to remain idle. First, the seal fisheries on the Pribilof Islands were made to yield a considerable revenue to the Government. Then valuable gold mines were discovered and successfully worked in the islands of the Alexander Archipelago and along the adjoining coast, where the climate was found to be relatively mild and the proximity to deep and well-protected harbors facilitated the cheap mining and reduction of the ores. Gradually a few venturesome prospectors found their way across the mountains into the higher and far colder regions of the interior. The first mining excitement in the interior was in the Cassiar mining district in British Columbia around Dease Lake, near the head of the Stikine River, from 1871 to 1887. Later, prospectors found their way into the more northern regions and down the valley of the Yukon into American territory, where they discovered valuable placers on Birch Creek, Mission Creek, and Forty-mile Creek, small southern tributaries of the Yukon. In the autumn of 1896 still richer discoveries were made a short distance east of the boundary, along the Klondike River, and a great rush of miners to these now famous diggings set in the following spring. Within a single year the yield from this region has exceeded in amount the purchase money for the entire Territory of Alaska, and though a large portion of the gold has come from territory within the Canadian lines, American miners for the most part have taken it out.

Accurate data with regard to the geography of Alaska it is as yet difficult to obtain. The immediate coast-line and the many islands which border it have been mapped by the United States Coast and

Geodetic Survey, and the course of the great Yukon River, comparable in size to the Mississippi, was determined by the Western Union Telegraph Company's expedition in 1867 and by an expedition in 1869 under Lieut. C. W. Raymond, of the United States Engineers. What other information has been obtained with regard to the interior is derived from route and sketch maps made from time to time by individual explorers, who generally followed the valleys of the larger streams. Vast tracts of mountain land between these streams are yet practically unknown. Hence the accompanying map, which is a copy of part of Chart T of the Coast Survey, in which have been embodied some details derived from maps of special localities, makes no attempt to show the general distribution of the mountain ranges in the interior, but confines itself to a delineation of the courses of the known streams. In some cases even these tracings of stream courses are known to be inaccurate, but until a general survey of the interior is made it will be impossible to correct them.

Ketchum and Lebarge, of the Western Union telegraph expedition, were apparently the first white men to traverse the entire length of the Yukon River. They traveled on ice and snow from St. Michael to Fort Yukon in the winter of 1866–67, and in the following summer made their way to Fort Selkirk and back, joining on their return W. H. Dall, who had charge of the scientific work of the expedition, and who, with Frederick Whymper, had ascended to that point by water. In later years scientific explorations of the interior have been made by members of the Canadian and of the United States geological surveys. In 1887 Dawson and McConnell, of the Canadian Survey, ascended the Stikine to the Liard, the former going northwestward by the Frances and Pelly to Fort Selkirk, the latter descending the Liard to the Mackenzie and the following season crossing from the Mackenzie to Fort Yukon by the Porcupine River and ascending the Yukon to its southwestern sources. William Ogilvie, of the same corps, entered the Yukon district in 1887 and has been there most of the time since, engaged in route and boundary surveys. In 1889 I. C. Russell, of the United States Geological Survey, in company with a boundary party of the Coast Survey, ascended the Yukon River from its mouth to the head of boat navigation, coming out over the Chilkoot Pass. In 1891 C. W. Hayes, of the United States Geological Survey, accompanied Schwatka's expedition up the White, across Scolai Pass, and down the Copper River. In the summer of 1895 G. F. Becker and W. H. Dall, under orders of the Director of the United States Geological Survey, made examinations of the coastal regions with reference to gold and coal; and in 1896 J. E. Spurr, assisted by H. B. Goodrich and F. C. Schrader, made a reconnaissance of the gold-bearing rocks of the Yukon district.

WORKS CONTAINING GENERAL USEFUL INFORMATION ABOUT ALASKA.

Travel and Adventures in the Territory of Alaska, by Frederick Whymper. Harper and Brothers, New York, 1869.

Alaska and Its Resources, by W. H. Dall. Lee and Shepard, Boston, 1870.

Along Alaska's Great River, by Frederick Schwatka. Cassell and Co., New York, 1886.

Alaska, Its History and Resources, Gold Fields, Routes and Scenery, by Miner Bruce. Lowman and Hanford Stationery and Printing Co., Seattle, 1895.

Coal and Lignite of Alaska, by W. H. Dall: Seventeenth Ann. Rept. U. S. Geol. Survey, Part I, Washington, 1896.

Reconnaissance of the Gold Fields of Southern Alaska, by George F. Becker: Eighteenth Ann. Rept. U. S. Geol. Survey, Part III, Washington, 1898.

Geology of the Yukon Gold District, Alaska, by J. E. Spurr: Eighteenth Ann. Rept. U. S. Geol. Survey, Part III, Washington, 1898.

GEOGRAPHICAL SKETCH.

Alaska has an area of 580,107 square miles. It is roughly quadrangular in outline, with a pan-handle extension in the southeast along the coast and a peninsula stretching out into the ocean on the southwest, which continues in the chain of the Aleutian Islands that separate Bering Sea from the Pacific Ocean. Its eastern boundary is formed by the 141st meridian of longitude west from Greenwich, and the westernmost portion of its mainland, Cape Prince of Wales, is on the 168th meridian, or within 54 miles of the easternmost point of Asia. In latitude it extends from 54° 40′, the southern point of Prince of Wales Island, to Point Barrow, in 71° 23′ north latitude, far within the Arctic Circle. Its greatest extent in a north-south line is thus 1,100 miles, and from east to west 800 miles.

The coast-line is much broken by arms of the sea, reaching far inland, either as open bays, as sounds or submerged river valleys, or as fiord-like inlets. Its length is estimated at 18,211 miles, which is greater than that of the entire coast-line of the United States. The coast also abounds in islands, which cover an aggregate area of 31,205 square miles and which as a rule are very mountainous. The chain of the Aleutian Islands, reaching nearly 1,500 miles into the Pacific Ocean, is largely of eruptive origin and contains many volcanic craters, some of which are yet active. They rise very abruptly from the sea, often to an elevation of several thousand feet, one on Unimak Island reaching a height of 8,955 feet.

The Alexander Archipelago and the adjoining coast strip, the best-known and most frequented part of the Territory, resembles the submerged portion of a narrow and precipitous mountain system. The archipelago consists of 1,100 islands, the largest and most southern of which is Prince of Wales Island. It is intersected by deep and relatively narrow waterways, which often run far inland and bear

evidence of previous occupation by glaciers. In some cases, as at Glacier Bay, enormous living glaciers are found at their head. The islands themselves are steep-sided and rise to an average elevation of 2,500 feet. On the seaward side of Baranof Island, one of the outer tier, on which Sitka is situated, is a volcanic crater, called Mount Edgecumb, 2,855 feet high. Further northwestward, forming part of the same mountain-line, the St. Elias Range, which follows the immediate coast, contains many high mountains and culminates to the north in Mount St. Elias at an elevation of 18,024 feet. Mount Logan, further inland, is supposed to be still higher, and explorers report that far in the interior, between Copper River and the Lower Yukon, there is a group of mountains, extending in the same general direction, of equal or perhaps even greater elevation, the highest point of which has been designated Mount McKinley.

RIVERS.

The rivers entering into the waters of the Alexander Archipelago are generally short, and only two, the Stikine and the Taku, are known to head beyond the crest of the mountains immediately adjoining the coast. The Chilkat River is a considerable and rapid stream entering the head of Lynn Canal from the northwest; it is probably less than 100 miles in length. The next river northward is the Alsek, about which little is known, but it is supposed to head on the east side of the St. Elias Range, in the vicinity of Mount Logan.

Copper River is a larger stream than any of those thus far mentioned, and heads in a mountainous country, little known, except by the Indians, who have a village above the canyon which extends northward from its mouth. Rolled masses of native copper, of which their knives were made, were obtained somewhere in this region. A northwestern branch of this stream is said to head between the Sushitna and the Tanana rivers, possibly in the lake which on the map is represented as being drained by the Sushitna. The Sushitna also is an important stream, emptying into the head of Cook Inlet, very wide and difficult of navigation near its mouth owing to the great rise and fall of the tide. Its sources are in a high mountainous region, a main northwestern branch being supposed to head near Mount McKinley.

The next large river, the Kuskokwim, is the second largest in the Territory, its length being estimated at 500 to 600 miles. It drains a high mountainous region difficult of access. The Russians ascended it in boats as far as the Redoubt Kolmakof or crossed from the Yukon by a portage near Oknagamut. The currents of the lower stream are rapid. A winter route was also used from Fort Alexander up the Nushagak and down the Chulitna; in summer the morasses along this route may not be passable.

Beyond Norton Sound, into which empties the great Yukon, that drains the whole interior region, the principal streams of known importance are the Kowak and the Noatak, which flow into Kotzebue Sound. The Colville River, which empties into the Arctic Ocean, is supposed to head in the same general region as the two just mentioned.

The Yukon River has an estimated length of 2,000 miles, of which three-fourths is continuously navigable for river steamers. It empties into Norton Sound through a wide delta in four principal mouths 50 to 64 miles in length. For about a hundred miles above the delta it has a general northwest course, then bends at right angles and has a southwest direction up to the bend at Fort Yukon, just within the Arctic Circle. Here it receives the waters of the Porcupine, a stream having the same general southwest course and heading near the mouth of the Mackenzie River. Fort Yukon is distant in a direct line about 650 miles from the mouth of the river. Above this point the general direction of the river is again northwest, but a short distance east of the international boundary it turns to a north-south course, which it maintains for nearly a hundred miles, through the Upper Ramparts. It is at the bend below this north-running stretch that the Klondike River enters from the east, above which, and more or less parallel, are the Indian and Stewart rivers, all famous as draining a region phenomenally rich in gold. Near the upper end of this north-south course the White River enters in the same direction from the south. Above this the Yukon resumes its northwest course and maintains it to Fort Selkirk, which is near the head of navigation. At Fort Selkirk it splits into two main branches: the Pelly, which drains the Rocky Mountain regions to the northeast, and the Lewes, which in several branches drains the region to the southwest and the many lakes on the eastern side of the Coast Ranges.

The principal tributaries of the Yukon from Fort Selkirk to Fort Yukon are, on the south side, in descending order, White, Sixtymile, Fortymile, Mission, Seventymile, and Charlie rivers, and on the north, from Dawson at the mouth of the Klondike downward, the Chandindu, Tatonduc, Tahkandit, and Kandik rivers. From Fort Yukon to the open country near the mouth of the river the longer streams coming from the southeast are Birch Creek, Beaver, Tanana, and Nowikakat rivers; from the north come the Dall, Tozikakat, Melozikakat, and Koyukuk rivers, the latter one of the largest tributaries and said to be 500 to 600 miles in length.

The Yukon is generally a broad and muddy stream, flowing with a current of 3 to 9 miles an hour. Occasionally it runs in a narrow, rocky canyon cut through lava, or across low mountain ranges, and such stretches are locally called "ramparts." For the most part, however, its valley is wide, and the stream often spreads out into

many channels with low wooded islands between, the whole covering a width said to reach 10 miles in places. Dry spruce is practically the only fuel available for steamers along the Yukon, and the supply is limited and difficult to obtain. Although the river is frozen up during eight months of the year, from October to June, its importance as a means of transporting supplies can hardly be overestimated. In the early years, when the connection between the upper and lower portions of the river was not absolutely known, the Hudson Bay fur traders were in the habit of taking their peltry from Fort Selkirk down to the mouth of the Porcupine and up that stream to the Mackenzie, preferring to make this long and circuitous journey rather than encounter the difficulties of a more direct route across the mountains to the eastward.

CLIMATIC CONDITIONS.

From the point of view of climatic conditions Alaska may be divided into three provinces: the southeastern coast strip, the Aleutian region, and the interior or Yukon region. In the former there is an abundant rainfall and a temperate climate. The rainfall at Sitka is 60 to 95 inches per annum, and the mean annual temperature is 42°, the average in winter being 31° and in summer 55°, a very narrow range. In the interior the climate is arid and the ranges of temperature are consequently wide. The Aleutian district presents various means between these extremes. The rainfall of the Yukon district has been given, necessarily from very imperfect data, as 13 inches. The temperature is known to have been 112° in the shade at Fort Yukon in the summer, and 68° below zero in winter, as extremes, but averages have not yet been obtained by continuous series of observations. The rivers, being fed mainly by melting snow and ice, are very high in early summer, and fall during the rest of the year, at times with great rapidity. The cold, being dry, is not necessarily difficult to bear for well-clothed and robust men. Fur clothing and loose non-conducting foot-wear are desirable for winter travel. Indian snowshoes are preferable to the Norwegian. The most favorable months for traveling are March and April. In May the snow is wet and travel is heavy, and mosquitoes begin to appear. During the summer these swarm in clouds and render life almost unbearable. They are the most hardy specimens of the tribe, and during their brief season a brisk wind furnishes the only relief. Their activity often extends late into frosty nights. Some protection in the form of face-covering and leather gloves is an absolute necessity. The Indians smear their faces with a mixture of grease and charcoal, and paddle with a smudge on a square of turf in the bow of the canoe.

As a result of climatic conditions the coastal regions support a most luxuriant forest growth, comparable to that of western Oregon and

Washington. This extends westward as far as Kadiak Island, and then suddenly stops, the region west of that being practically treeless. Going into the interior from the coast, one reaches the upper limit of timber growth, or the timber-line, as it is popularly called, at 2,300 to 2,500 feet elevation. Within the arid region there is no dense forest growth. Trees grow along the valleys of the principal streams, but the species are generally different from the coast growths and of inferior quality for timber. The rock surface to a considerable height on the mountain slopes is covered with a dense blanket of moss, beneath which the soil is permanently frozen, thawing only for a few feet downward in the summer months. The actual depth of frozen ground has not yet been determined, but there is reason to believe that it is as much as 100 feet. Such ground can not be broken by explosives, which simply tear a small hole without shattering the surrounding mass to any considerable extent. Thus far fire, as it was used by ancient miners before the introduction of gunpowder, has proved the most effectual agent in mining.

The following table gives temperature observations, in Fahrenheit degrees, made by Ogilvie's party at the town of Fortymile during the year December, 1895, to November, 1896.

	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.
Lowest temperature..	-55°	-68°	-64°	-37°	-38°	-5°	30°	33°	27°	5°	1°	-38°
Highest temperature .	6°	6°	32°	40°	49°	62°	80°	81°	76°	63°	51°	22°

Ice in Fortymile River broke up.....May 11, 1896.
Ice in Yukon River broke up.....May 17, 1896,
and ran thickly until.....May 23, 1896.
Ice formed on the Yukon.....Sept. 28, 1896,
and broke again, and finally set.....Nov. 5, 1896.

ROUTES TO KLONDIKE.

The following routes to the Klondike gold fields have come into general notice, and some are already in practical use:

Yukon or all-water route.
Skagway or White Pass route.
Dyea or Chilkoot Pass route.
Dalton or Chilkat Pass route.
Stikine route.
Taku route.
Edmonton route.
Copper River route.

The Yukon or all-water route.—This route is by ocean steamer from Seattle or San Francisco to St. Michael, near the mouth of the Yukon; thence by river steamboat up the Yukon to Dawson. The length of

this route is about 4,000 miles, it being nearly 2,700 from Seattle to St. Michael and about 1,300 up the Yukon to Dawson. Those taking this route should aim to leave St. Michael early in July, in order to avoid the delays in upstream progress caused by sandbars at low stages of water later in the season. The time from Seattle to St. Michael is about twenty days, and that from St. Michael to Dawson the same, making about forty days for the trip. Under favorable weather and circumstances it may be made in less time. The usual first-class fare is about $150. Though this route is the one over which commercial companies operating in the Yukon country transport their goods, it is seldom used by miners who wish to enter in the spring, since at that season it takes several weeks longer to make the trip by this route than it does to make it by some of the trails mentioned below. It is, however, highly advantageous for persons unfitted to rough it on the trails.

The Skagway or White Pass route.—From Seattle to Skagway, a distance of 1,115 miles, the route is by ocean steamer northward along the coast, and finally up Lynn Canal. It is practically a still-water route, being protected from the swells of the ocean by an almost continuous barrier of densely wooded islands. The trip requires about three and one-half days. The first-class rate is quoted at $50; freight, $13 a ton. Skagway is located on the east side of Dyea Inlet, a branch of Lynn Canal. Its population, which is much increased by people who have been unable to get across the trail, is said to be about 8,000. Dyea is situated 4 miles north of Skagway, west of the mouth of Dyea River and at the head of Dyea Inlet. The rise and fall of the tide in this inlet is about 24 feet. At Skagway steamers find good anchorage within half a mile of the beach, to which freight is taken in lighters at high tide, which are unloaded when the tide recedes. Several newly built wharves are said to be now in practical use, and the facilities for landing cargoes are greatly superior to those at Dyea. From Skagway the trail leads northeastward up the valley of the Skagway River, crossing the mountains at White Pass and running thence northward to the head of Lake Bennett, whose waters flow into the Yukon. The summit of White Pass is 2,400 feet above sea-level, and its distance from Skagway is 18 miles. For the first 4 or 5 miles there is a good wagon road, which crosses the river several times by ford. At high stages of water, however, freight must be packed across on foot bridges. Beyond this are long stretches of very miry and rocky ground, where a loaded man will sink knee-deep in the mud. There are also several steep and rough ascents, of which Porcupine Hill is the sharpest. The last 2 miles before reaching the summit is a steady, hard climb, but presents no cliffs or precipices. Many horses have been killed or have died on this trail. Seventy-five to 100 pounds make a good load for the ordinary packer. From

the summit to Lake Bennett, 17 miles, the trail improves, although still bad. It is for the most part gradually downhill, over an undulating, rocky surface. The timber-line is reached again at The Meadows, about 5 miles beyond the pass, which is the ordinary camping-place. The trail passes the two small lakes known as Summit and Middle lakes, on which ferriage may be secured when the water is not frozen. Midway between the latter and Lake Lindeman, about 3 miles before reaching Lake Bennett, the Canadian custom-house officials have put up a large log cabin, which is used as a place of shelter by those crossing the trail. At this point a trail branches off to the right down to Tooshhie Lake; but as there are 7 miles of impassable river between Tooshhie and Tagish lakes, travelers bound for the Yukon are warned from taking this route. At the head of Lake Bennett the Skagway joins the Chilkoot trail. The Skagway trail is somewhat longer than that over the Chilkoot Pass, but the pass is much lower. It requires, however, considerable improvement in bad and swampy places. This route has been recently recommended by the United States Quartermaster's Department of Puget Sound.

The Dyea or Chilkoot Pass route.—This is the old trail used by the Indians for generations, and until a year ago was practically the only route followed by miners and prospectors who entered the interior. It is the shortest route to the headwaters of the Yukon.

Dyea (or Taiya) is the Indian word meaning *pack* or *load*. Owing to the extensive shoals at the head of Dyea Inlet the conditions for anchorage and discharging cargoes from ocean vessels are less favorable than at Skagway. They are either unloaded by means of lighters or put upon a rocky point about a mile from the beach, whence they are hauled off in wagons. Dyea trail runs northeastward up the Dyea River and across the Chilkoot Pass, at an elevation of 3,500 feet, to the head of Lake Lindeman, a total distance of 28½ miles. The summit is 13 miles from Dyea, the first 6½ miles following a comparatively open valley in which there is a good wagon road. Owing to the windings of the stream within the walls of the valley, the river must be crossed several times, by fords in summer, by ferries in spring when the water is deep. The trail then enters a narrow canyon with steep, rocky walls, which it follows to Sheep Camp, at timber-line, 4½ miles further on. Through the canyon the trail is rougher, but horses have been successfully used for several years in packing to Sheep Camp. Good camping-places are found all along the route from Dyea to Sheep Camp, and at several points refreshments may be obtained. Sheep Camp is the last camping-place on the west side of the range, as from there on there is no timber or fuel until Deep Lake, on the other slope, 12 miles distant, is reached. From Sheep Camp to Scales, where packs are weighed by the Canadian authorities, a distance of 3¼ miles, the rise is about 1,800 feet. The trail is free

from mud, and traveling is not difficult, though in places the ground is covered with bowlders. From Scales to the summit of the pass the ground rises 1,000 feet in a distance of about half a mile, and masses of broken rock or talus make the climb very difficult, and impossible for pack animals. The building of an aerial or wire tramway, with buckets carrying 400 pounds of freight, has been contemplated for this portion of the route. From the summit of Chilkoot Pass to Lake Lindeman, a distance of 15½ miles, the trail descends first very steeply to a small lake called Crater Lake, and thence more gradually along the drainageway of a chain of lakes known as Long, Canyon, and Deep lakes, which are connected with one another and finally with Lake Lindeman by small streams. Till late in spring the whole of this drainageway is frozen over, and one travels from the summit to Lake Lindeman by sled. On either side of the pass, especially on the south, snow sometimes accumulates to a depth of 50 or 60 feet, forming a sort of névé of limited extent. Late in the season, when the drainage is open, a ferry sometimes plies on Long Lake, a distance of 4 miles. The rate for packing from Dyea to Lake Lindeman is 40 cents a pound, and rates are proportional for intermediate points. When the ice has broken up, Lake Lindeman may be traversed by ferry, a distance of 4½ miles, at $2 a passenger. From the foot of Lake Lindeman there is portage past the rapids to the head of Lake Bennett, where the Dyea and Skagway trails meet.

From the head of Lake Bennett to Dawson, 548 miles, there is a continuous waterway through lakes and rivers, which may be followed in summer by boat and in winter on the ice. Long stretches are navigable by light-draught steamers. Boats may be procured or built at the head of the lake, but in some respects the most advantageous method is to start early enough to travel on the ice as far as the foot of Lake Lebarge, where timber for boat-building is abundant, as in this way the dangerous passage of the White Horse Rapids is avoided. Lake Bennett is 26 miles in length, narrow and canyon-like in form, and deep at the lower end. Fifteen miles below the bend, where the southwest arm comes in, strong winds often prevail, producing a rough sea that is dangerous for boats, and parties are often storm-bound there for several days. A sluggish stream 2½ miles long and often not more than 3 feet deep, known as Caribou Crossing, extends from the foot of Lake Bennett to Tagish Lake. Thence there is clear sailing 19 miles down Tagish Lake and 5 miles along a river deep enough for ordinary river steamers to Marsh or Mud Lake. The Canadian customs officers and mounted police are stationed on this river 1½ miles below Tagish Lake. Marsh Lake is 19 miles long and empties into Fiftymile River, whose current averages 3 to 4 miles an hour. About 25 miles down, the river enters Miles Canyon, a chasm about 100 feet wide and five-eighths of a mile

long, between perpendicular walls of basalt 80 to 100 feet high. The swift, turbulent current carries a boat through this canyon in about three minutes. For a fair-sized boat, not too heavily loaded, which is kept under steerageway by one or more good oarsmen and follows the middle of the stream, so as not to be dashed against the steep rocks on either side, the passage is quite practicable. At the foot of the canyon one must keep to the left until the heavy swells are passed, then turn sharply to the right and land on the east or right bank. A safer course, which is followed by many, is to portage one's load along the right side of the canyon, over a hill about 200 feet high, and run the boat through empty.

Three-eighths of a mile below this canyon are rapids about half a mile long, which, though very rough, are not dangerous. A half mile below these are the White Horse Rapids, the most dangerous on the whole river. They are about one-third of a mile long and are confined between low basaltic walls. Near their foot the walls close together, forming a chasm only 30 yards wide, while the bed of the stream drops suddenly, so that the river rushes wildly through, leaping and foaming in a cataract. Many boats have passed successfully through, but others have been swamped, with loss of outfits and sometimes of life. The safer plan is to portage around the rapids and let the boat down by line. The portage is on the west shore, but on either side a tramway could be constructed without great difficulty.

Lake Lebarge, which is 60 miles below the White Horse Rapids, is 31 miles long and easily navigable by steamers. There is abundant good timber at its foot. The river below Lake Lebarge, as far as Fort Selkirk, is known as the Lewes, and is also navigable for 160 miles, down to the Five Finger Rapids. Here a rock of conglomerate rises up from the river bottom, forming several islands and backing up the river a foot or two, so as to produce a strong swell below. Steep cliffs of the same rock on either bank render a portage at this point impracticable. With proper steerageway and care, however, an ordinary boat may run the rapids safely. The right or east side is followed by most Yukon travelers, but Ogilvie, of the Canadian Survey, from actual experience pronounces the channel along the west bank as also passable. For 6 miles below the Five Finger Rapids the current is swift, and then occur the Rink Rapids, which extend halfway across the river from the western bank, producing a decided riffle. On the east side, however, the water is comparatively smooth and safe. Below this the river is practically free from rapids and navigation is unimpeded. Fort Selkirk, where the Pelly and Lewes unite to form the Yukon, is 65 miles below. Thence it is about 95 miles to the mouth of White River, 10 miles further to the mouth of the Stewart, thence 22 miles to Sixtymile River, and 45 miles further to Dawson, at the mouth of the Klondike.

Dalton or Chilkat Pass route.—This is an overland route following a direct course, more or less independent of waterways, from the head of Chilkat Inlet to Fort Selkirk. It has been used by J. Dalton, a trader, for some time as a pack-train route and for driving in cattle. But little is definitely known of its geography. It ascends first the Chilkat and Klahoela rivers, crossing the pass in 45 miles at an elevation of 3,000 feet and thence descending into the drainage of the Tahkeena River at Lake Arkell. From Lake Arkell the trail is said to pass over an undulating plain, well timbered in the valleys and with grass on the slopes. The distances from the head of the inlet are given as 75 miles to the watershed and 100 miles to Dalton's trading-post. From there to the Pelly the distance is 200 miles, or 300 miles in all to the Pelly, and 350 to 400 to Fort Selkirk.

The Stikine route.—By this route one travels by boat from Fort Wrangell 150 miles up the Stikine River to Telegraph Creek, and thence, a little to the west of north, 150 miles to the head of Teslin Lake. The ascent of the Stikine River is tedious and sometimes dangerous, the current being swift and rapids numerous. It is, however, the route that was followed in former days by miners going to the Cassiar district. From Telegraph Creek to Teslin Lake the trail is said to pass through a gently undulating and well-timbered country which presents no obstacles to the building of a railroad. Lake Teslin is said to be about 80 miles long and bounded on both sides by high mountains. From its foot down to the Lewes runs the Teslin (or Hootalinqua) River, which is navigable except for two small rapids, one near its head, the other further down. In its lower course the Teslin spreads out into many channels, occupying a total width of 2 or more miles. This route appears promising, but is as yet only prospective.

The Taku route.—This route ascends the Taku Inlet and River and crosses directly to Lake Teslin or Aklen, a distance of 185 miles from Juneau. Thence it is identical with the Stikine route. By this route one travels by steamer from Juneau 18 miles up the Taku Inlet to the foot of a large glacier, which is often very dangerous to boats, even at a distance of several miles, by reason of the ice masses that break off from it; then by boat 60 miles up the Taku River to the head of canoe navigation. The portage which follows is for the first 20 miles through the canyon-like valley of an eastern branch, then for 50 miles in broad valleys of the upper Taku, 3,500 to 5,000 feet above sea-level. For the last 15 miles the route is in the densely wooded valleys of Teslin Lake, among many small ponds. This route is said to be not impracticable for a railroad, and a charter for one has already been granted by the Canadian Government. Its merits, however, have not yet been thoroughly tested. Both this and the Stikine route have the undoubted advantage of avoiding the dangerous White Horse Rapids.

The Edmonton or inland Canadian route.—By this route one travels by the Canadian Pacific Railway to Calgary and thence by branch road to Edmonton, on the Saskatchewan River. From Edmonton there are 40 miles of staging to Athabasca Landing, on the Athabasca River, and thence a canoe journey of 1,850 miles down the Athabasca, Slave, and Mackenzie rivers to Fort McPherson. The only portage of any importance is one of 16 miles at Smith Sound, where the Hudson Bay Company has a tramway. This has been the regularly traveled route of the employees of the Hudson Bay Company for nearly a century; and the canoe trip to Fort McPherson is made in about sixty days. From Fort McPherson one must ascend the Peel River southeastward, and then travel several hundred miles through an unknown country between Peel River and the Klondike, packing one's outfit. Though advantageous for mining districts along Peel River, this route can hardly be recommended at present to anyone bound for the Klondike region.

The Copper River route.—This is only a proposed route, and as yet presents little to recommend it. It would strike inland from near the mouth of the Copper River and follow a general northeasterly course toward the Klondike, thus crossing a great mountain range whose rough topography and many glaciers that fill the valleys and passes render general travel difficult if not impracticable. Orca, the only settlement on the coast nearby, is 50 miles beyond the mouth of Copper River and 700 miles from Sitka. In 1897 it had a population of 22 whites. It is the first post-office west of Sitka. During the last summer several unsuccessful attempts were made to ascend Copper River. According to C. W. Hayes, there are impassable rapids formed by a moraine below the Miles Glacier, over which the river descends about 100 feet; there are also rapids lower down at the Childs Glacier, and the broad stretch of river between is rendered dangerous for navigation by floating ice. According to reports of natives, confirmed by Lieutenant Allen, who crossed over to the Tanana in 1885, the better way is to start inland from Valdes Inlet, on Prince William Sound, and, crossing the Valdes Glacier, strike Copper River 180 miles above its mouth, thus avoiding the gorge and the most dangerous rapids. The best time to enter the region is in January or February, when the snow filling the crevasses in the glacier has become packed; at any other time it is difficult and dangerous to cross. From the Copper River basin an advisable route would seem to be over the Scolai Pass and down White River; but from observations made by Hayes it appears that the pass, which has an elevation of over 5,000 feet, is occupied by a glacier 300 to 400 feet thick, and that White River abounds in rapids too rough for a loaded boat. I. C. Russell, who visited the Mount St. Elias region in 1890 and 1891, reports a mountainous region to the northward occupied by huge glaciers.

GEOLOGICAL SKETCH.

In mining for gold man reverses the order of the natural processes which have produced such concentrations of this and other metals in the earth's crust as can be worked by him at a profit. In the solid rocks the useful metals were first concentrated in interstitial spaces, generally cracks or fissures, where they filled the vacant spaces and sometimes impregnated or replaced to a certain extent the adjoining rock. Such concentrations constitute original ore deposits. In these the metallic minerals are generally accompanied by some earthy minerals; and as, in the case of gold deposits, this earthy mineral is nearly always quartz and the most common place of deposit is a vein or fissure, the term *quartz vein* has come to be almost universally used among mining men to designate original deposits of gold-bearing ores, even when the spaces filled were not strictly fissure veins. This generic use of the term quartz vein will be followed in the succeeding pages.

In the ordinary processes of nature, after rocks have been formed and consolidated they are folded, crushed, and lifted up into mountain ranges, and then worn down and distintegrated by cold, heat, rain, and other destructive agencies, and finally transported by running water and rearranged and distributed in river valleys or on beaches. During this transportation and rearrangement the heavy particles in the detrital material, or gravels, naturally settle to the bottom in the valleys or on the beaches; hence, where these detrital materials come from the wearing down of rocks containing gold deposits there results a concentration of the gold at favorable points, and a later class of deposit is formed, which is called by the generic name *placer*.

In placer deposits, where nature has already done part of the work of separating the gold from its matrix, man finds the readiest remuneration for his labor, but in searching for deposits of this character he must be guided by such knowledge as is attainable with regard to the source of the concentrated gold. Although very finely divided gold may be transported long distances in the sands of large rivers and may settle in considerable quantities at favorable localities, the coarser gold, which yields the greatest remuneration, is rarely carried far; hence the richest deposits must be sought near the source of the gold. In the following statement of what is known with regard to the economic resources of Alaska, therefore, there will first be given such ideas as may be deduced from the incomplete observations that have been made in this vast region with regard to its geological structure and the probable position and extent of the rocks containing the original deposits of gold, and then a description of its various forms of placer deposits.

PHYSICAL DESCRIPTION.

Alaska may be divided topographically into a coastal and an interior region. The international boundary between American and Canadian territory has no relation to the physical structure of the region; hence, in this description that portion of British Columbia which lies opposite the Alexander Archipelago and the coastal strip of American territory southeast of Mount St. Elias will be considered as part of the general province of Alaska. The known portions of the interior region, which lie mainly south of the Arctic Circle, belong to the drainage system of the Yukon River. This stream with its various tributaries drains the northwestern portion of the cordilleran system included between the coast and the Mackenzie River Valley, which are about 700 miles apart and approximately parallel. The Mackenzie River flows from Great Slave Lake into the Arctic Ocean. The Yukon has a general northwest course for about 700 miles (neglecting curves), and then, at its junction with the Porcupine, bends abruptly to the southwest, reaching Bering Sea at a distance of about 650 miles in a straight line from the bend. Its earlier or northwest course, which is also that of many of its principal tributaries, is evidently dependent upon the older features of the mountain structure, but the change to a direction transverse to this may have been determined in a comparatively recent geological period. To one tracing the broader features of physical structure northwestward from the United States through British Columbia, it would seem that the mountainous region between the Yukon and the Mackenzie represents the Rocky Mountains proper, and the Alexander Archipelago and adjoining coast slopes the Coast Ranges. The basin of the Upper Yukon (the river above the great bend) would then be the representative of the Great Basin region in the United States, since north of the 49th parallel the uplift of the Sierra Nevada has merged with that of the Coast Ranges into one general system.

The Yukon River is characterized by a great volume of water, which carries with it large quantities of detrital material that in the lower reaches forms considerable bars and islands. Its valleys are alternately very broad and very narrow. The broad stretches often contain modern lakes, or, as the stratified gravels on the sides show, occupy ancient lake basins, now drained; in the narrow stretches the river is frequently confined within vertical canyon walls, in which it is sometimes cutting through transverse mountain ranges, sometimes through fields of lava, generally basaltic, that have spread across its track. The greatest of the open valleys is known as the Yukon Flats, which include the region of the great bend, commencing near Circle City. Much of the Lower Yukon runs also through more or less open valleys, low table-lands, or mesa regions, whose surface is occupied by nearly horizontal beds of Tertiary or even more recent age. At

places it cuts down through these and exposes older rocks forming parts of partially submerged mountain ranges, as the so-called Lower Ramparts.

Little is known of the structure of the coastal region beyond the immediate coast-line except the narrow strip of territory known as Southeastern Alaska. The mountainous islands of the Alexander Archipelago are supposed to constitute part of the range which culminates in Mount St. Elias and beyond splits into two ranges, one trending westward with the bend of the coast, the other continuing in a northwesterly direction and probably forming the southern watershed of the Tanana River. The Coast Range proper is a broad elevated belt with many scattered peaks, but not differentiated into continuous ranges. Oceanward it presents an abrupt, rugged front, cut by fiord-like valleys. To the east is a plateau-like region which descends gradually to the north from an elevation of 5,000 feet in the upper lake region to 3,000 feet in the lower Lewes and Pelly river valleys. The river valleys in this stretch often lie 2,000 to 2,500 feet below the general plateau level.

The coastal belt of southeastern Alaska and westward to Kadiak Island has the abundant precipitation and consequent luxuriant forest growth which characterize the northwest coast regions as far south as Puget Sound, and hence the rock surface is deeply covered and the underlying rocks are decayed so as to make prospecting extremely laborious. But west of Kadiak Island, along the coast, there is no timber.

In the interior region the precipitation is comparatively slight, and considerable portions are above or north of the limits of timber growth. The precipitation is, however, chiefly in the form of snow, and the soil is frozen for a large portion of the year, so that there is comparatively little rock decay. Where there is no timber the surface is generally covered with an abundant growth of moss. This, wherever the surface material is sufficiently compact to become impervious to water by freezing, produces large areas of swampy tracts, even on sloping ground, which, except in the glaciated regions or when cut through by large streams, obscure the rock surface and render difficult the work of the prospector.

It is not perhaps generally known that the theory of an arctic ice sheet extending outward from the polar regions has been proved by investigations of recent years to be fallacious. Many persons, including some who might be supposed to speak with scientific authority, have committed the error of ascribing to the placer deposits of the Yukon a glacial origin. It is now known that the great continental glaciers of former times spread out in every direction from certain elevated regions peculiarly subject to great accumulations of ice and snow, and that one such centered in the mountains of British Columbia

between latitudes 53° and 59° N. and had a northwestward as well as a southward movement from that central region. The limit of the extent of this northward-moving ice sheet was readily recognized by the various geologists who have visited the region in recent times, and is roughly defined as crossing the Lewes River just above the mouth of the Big Salmon, and the White River near the Donjek, or following approximately the 62d parallel, so that the Yukon Basin below these points has not been affected by any general glaciation.

ORIGINAL DEPOSITS, OR QUARTZ VEINS.

COASTAL REGION.

At present, so far as known, it is only in the coastal region that deep mining is being carried on in gold-bearing veins. Here it has become a well-established industry, and many large quartz mills are running on the ore extracted from these veins. The principal deposits are found in a belt somewhat over 100 miles in length on the seaward slope of the mainland, reaching from Sumdum on the southeast past Juneau to Berners Bay near Seward on the northwest. This belt may be also considered to include the deposits on the shoreward side of Admiralty and other islands. A second belt, further west, is represented by the deposits on the western side of Baranof Island, not far from Sitka. The ores, though not always exceptionally rich, are worked at a good profit because of the natural facilities of the region for cheap reduction. The most notable instance of this is the great Alaska-Treadwell mine, which has extracted over seven million dollars' worth of gold from an ore carrying $3.20 a ton, which is worked at an average cost of $1.35. Such conditions can not be expected to obtain in the interior.

These deposits occur in metamorphic slates, diabases, and granites, all similar to the rocks of the auriferous belt of California, and probably, like those, they are of post-Jurassic age. Owing to the dense covering of living and fallen forest trees in this region, prospecting is extremely difficult, and it is probable that future exploration will prove the extent of these gold belts to be much greater than at present appears. The gold-bearing beach sands from Lituya Bay to Yakutat Bay along the west foot of the St. Elias Range, and the placers at the head of Cook Inlet, around Turnagain Arm and on the Kaknu River, may have been derived from the wearing down of rocks of similar age and composition on the Kenai Peninsula.

At Uyak Bay, on Kadiak Island, gold deposits in slates are being worked, and the gold-bearing beach sands of the western end of that island and at Portage Bay and the Ayakulik River on the neighboring mainland are apparently derived from metamorphic slates associated with granite, so that it is possible that these more recent gold-bearing rocks extend that far westward. On Unga Island, of the Shumagin

group, still further west, gold occurs in eruptive andesites of Tertiary age, and several mines have been opened on these deposits, the most important of which is the Apollo, one of the most successful in the province. As the Alaska Peninsula and the Aleutian Islands are largely made up of recent eruptive rocks, this is an important indication, showing the possibility of the occurrence of valuable deposits in such rocks. Some mining and prospecting has already been done on the island of Unalaska, at the extreme point of the peninsula.

INTERIOR REGION.

In the Yukon Basin the gold, so far as known at present, is derived from a much older series of rocks, for the gold-bearing slates of the coastal region have not yet been recognized there. While the exact age of these gold-bearing rocks has not yet been determined, they are known to be older than the limestones supposed to represent the Carboniferous and Devonian formations of the cordilleran system; hence they are probably pre-Paleozoic, and in part are possibly as old as the Archean. The grounds for assuming this derivation are that these rocks contain abundant auriferous quartz veins, and that the richest placers thus far discovered are so situated that they must have been derived from them. These rocks are classified by Spurr as follows, commencing at the base:

Basal granite-schist.—This, so far as known, is the fundamental rock formation of the region. The granite has characteristically a somewhat schistose or gneissic structure, thus showing evidence of having been subjected to dynamic action or intense compression, and it may pass into a gneiss, or even a mica-schist, where this action has been most energetic. On the other hand, it is sometimes massive, showing no parallel structure planes, and then is with difficulty distinguishable from the massive younger granites, which are also of frequent occurrence in the region in the form of dikes and intrusive masses cutting across older rocks. As distinguished from the granites of the coastal region, which are intrusive, these older granites are generally of reddish color and crumbly nature, while the later ones are dark gray from the abundance of hornblende as a constituent mineral.

Birch Creek series.—Resting upon the fundamental granite is a series of rocks, roughly estimated as possibly 25,000 feet in thickness, named the Birch Creek series, from the place of their typical occurrence. They consist mainly of quartzitic rocks, generally thin bedded or schistose, so that they pass into mica-schists; in some places they contain carbonaceous matter and develop graphitic schists. There are also bands which probably originated as intrusive rocks but which by compression have become schistose like the other members. These rocks have abundant quartz veins; they are generally parallel to the schistosity or bedding, small, and not persistent, but some cross the

bedding and are then wider. They carry gold with abundant pyrites, and sometimes galena. They are often broken and faulted.

Fortymile series.—Younger than the Birch Creek series, but in general closely associated therewith, is another thick series of rocks, called the Fortymile series because of their development on Fortymile Creek. They are characterized by alternations of beds of marble, from a few inches up to 50 feet in thickness, with quartzitic and other schists, which may be micaceous, hornblendic, or garnetiferous, and sometimes graphitic. They are traversed by abundant dikes of eruptive rock, mostly granites and diorites. Two sets of quartz veins are developed in these rocks: (1) an older set, which are generally parallel to the schistosity or lamination, like those in the Birch Creek series, and like them are broken by later movements and carry pyrite and occasionally galena; (2) a set of larger veins, which form an apparent transition from dikes of aplite, a rock consisting of quartz and feldspar. They cut across the bedding and are not disturbed by later rock movements, hence are younger in age.

Rampart series.—This still later series is primarily distinguished from the preceding by the darker color of its rocks, which are dark green when fresh and become a dark red by weathering. They consist largely of basic eruptive materials, beds of diabase and tuffaceous sediments, with hard green shales and some limestones containing glauconite, or green silicate of iron. They also contain novaculites, or fine-grained quartzitic slates, and jasperoids, or iron-stained quartzose rocks. Serpentine and chlorite, noticeable by their softness and green color, are frequent alteration products. These rocks also contain a few quartz and calcite veins, which are generally developed along shear zones, or places where by rock movement and compression a series of closely appressed parallel fractures are developed. The basic character of these rocks and their large content of pyrite seem favorable to the concentration of ore deposits; they present, moreover, certain analogies, both in composition and in geologic position, with the copper-bearing rocks of Lake Superior. But the observed veins are younger than the joints and shear planes, which were probably produced by the rock movements that crushed the veins of the older series, and assays of their ores have as yet shown but insignificant amounts of gold and silver. These veins, as well as those in the granite, are, moreover, much less abundant than those in the Birch Creek and Fortymile series; hence it is thought that the latter are probably the principal source of gold in the placers.

The younger rock series noted are, briefly, the following:

Tahkandit series.—This consists of limestones, sometimes white and crystalline, generally green or black, alternating with shales. In certain localities, notably on the Tahkandit River, it has conglomerates carrying greenish pebbles supposed to be derived from the rocks of

the Rampart series. In the beds of this series have been found fossils of Carboniferous age and plants of Devonian aspect.

Mission Creek series.—Later than the Tahkandit series, but, like it, not very well defined, is the Mission Creek series, consisting of shales and thin-bedded limestones with gray sandstones. Locally there are thin beds of impure lignite and at the base a conglomerate ("cement rock" of the miners) containing pebbles not completely rounded derived from older rocks in the neighborhood, which sometimes carries gold. The beds of this series are sometimes altered and sharply upturned and folded, but generally have a rather fresh appearance. In the neighborhood of shear zones they are impregnated with pyrite and carry small quartz veins. The limited exploration of these rocks has developed no important deposits of mineral. The age of the beds is as yet uncertain, but they are in part as late as Cretaceous.

Kenai series.—Next above the Mission Creek rocks, and not always readily distinguishable from them, is a great thickness of rather loosely consolidated conglomerates, shales, and sandstones, generally greenish in color, which are the coal-bearing rocks of the region; they everywhere contain plant remains, and rest unconformably upon the older rocks. They have, however, been folded to a certain extent, and stand upturned at angles of 20° to 60°. They are supposed to be of Eocene Tertiary age.

Later Tertiary beds.—Other and more recent Tertiary beds have been observed, generally in the more open country of the Lower Yukon, which have little economic importance, though they sometimes contain thin lignitic seams. They are variously known from the localities where they have been observed, as the Nulato sandstones and the Twelvemile and Porcupine beds, the two last named being assumed to belong to the same series.

The more recent formations, silts and gravels, will be considered under the heading "Detrital or placer deposits."

DISTRIBUTION OF GOLD-BEARING ROCK FORMATIONS.

The most definite facts with regard to the occurrence of the gold-bearing formations, the Birch Creek, Fortymile, and Rampart series described above, were obtained by the reconnaissance made by members of the United States Geological Survey in the summer of 1896, under the charge of J. E. Spurr, in the American portion of the Yukon district, and the exposures of these rocks as shown on the maps of his report have been indicated in colors on the accompanying map. Data gathered by earlier geologists, notably those of the Canadian Survey and of C. W. Hayes and I. C. Russell of the United States Geological Survey, have provided suggestions as to the extent of these rocks in outside areas, but the reader need only bear in mind the enormous area, the difficulties of exploration, and the want of

accurate maps of the region, to realize that generalization must as yet be very tentative and liable to future change.

As shown by the map, the belt in which these rocks have been found extends about 500 miles in a general northwest-southeast direction, but there are indications that the actual extent of these exposures may be twice as great.

The best-known exposures of these rocks occur along the northeastern flanks of a broad belt of fundamental granites and crystalline schists which apparently form the central nucleus or backbone upon which they rest. This belt is known in a general way to extend up the Tanana River from near its mouth southeastward across the White River below the Donjek. In the latter region C. W. Hayes reports quartzites and limestones resembling the Birch Creek and Fortymile series on the southern flanks of the granite, but the width of the belt, and whether there is any considerable extent of the gold-bearing formations along its southern flanks, is as yet unknown. It may not improbably extend into the high range south of Tanana of which Mount McKinley is the culminating point and in which the Kuskokwim and Sushitna rivers of western Alaska take their rise, for from the reports of Moravian missionaries and of the traveler Dickey it appears that gold occurs in the sands of each of these streams. To the westward the granite backbone appears to pitch gently downward, as its surface area narrows, and no exposures are known west of the Yukon River. It is probably not a continuous mass of granite on the surface, but contains smaller areas of the later rocks folded in with it. East of the international boundary the area in which the granite occurs apparently widens, but its exposures are less continuous, the overlying rocks not yet having been worn away. One granitic axis appears to extend eastward from the Fortymile district through the Klondike region in a nearly east-west direction, which is that of the prevailing strike of the sedimentary rocks. The Canadian geologists report a second granite axis on the Dease River just below Dease Lake, which may belong to the older granites, though they do not make the same distinction that Spurr does between the older granites and the later intrusive rocks.

Rocks of the various gold-bearing series above the granite are reported at the following localities: Their first appearance, to one ascending the Yukon from the sea, is near the mouth of the Nowikakat. From here up to the Tanana River, rocks of the Birch Creek series outcrop frequently along the river, when not concealed by Tertiary sandstones and conglomerates, and the range of low mountains on the north side and parallel to the river is probably formed of these and Fortymile rocks. About 3 miles above the mouth of the Tanana, granite is exposed on an island in the Yukon, and 12 miles higher calcareous quartzitic schists of the Fortymile series appear under the

Tertiary conglomerates. From the mouth of the Tanana up to Fort Hamlin, at the lower end of the Yukon Flats, the river runs in a canyon-like channel, known as the Lower Ramparts, cut through a low range of mountains which consist principally of the dark greenish and reddish rocks of the Rampart series, except where these are buried under Tertiary conglomerates. The latter rocks occur immediately above the exposures of Fortymile rocks, and again from Mynook Creek up beyond the mouth of Hess Creek. Higher up on these streams the Rampart rocks come to the surface, and the Fortymile rocks are supposed to be uncovered at their very heads. Between the two areas of Tertiary rocks the Rampart rocks occupy a belt 15 to 20 miles wide along the river, and are cut by great dikes of intrusive granite.

From Fort Hamlin up to near Circle City, a distance, neglecting curves, of about 200 miles, the river flows through a perfectly flat region covered by fine silts and gravels, known as the Yukon Flats, in which no outcrops of solid rock have been observed. In the Birch Creek district, around the headwaters of Birch Creek and southwest of Circle City, the Birch Creek series occupy a broad area; their general strike is east and west, curving at either end to the northward, and the prevailing dip is between 5° and 30° to the south. There is, however, evidence of a northern dip as well, and the Fortymile schists and marbles rest upon them along the trail to Circle City. Marbles, probably belonging to the Fortymile series, are also reported in the hills between Birch Creek and the Tanana to the southward.

At the crossing of Birch Creek by the trail from Circle City, and along the Yukon River for 30 or 40 miles above the Yukon Flats, rocks with the characteristic dark coloring of the Rampart series are exposed. From these up to the mouth of Mission Creek rocks of the Tahkandit, Mission Creek, and Kenai series occupy the banks of the river. On Mission Creek itself only these later formations are found, but the gold in the gravels is supposed to come from the conglomerates ("cement rock") of the Mission Creek series, which contain pebbles of the older rocks. On American Creek, the main branch of Mission Creek which comes in from the south, the dark rocks, shales, limestones, and tuffaceous beds which form the bed-rock are supposed to belong to the Rampart series, which also occur along the Yukon River from 5 to 10 miles above Mission Creek to within 25 miles of the mouth of Fortymile Creek. Above this to some distance above Fortymile Creek the river runs in beds of the Mission Creek series.

It is in the Fortymile district and the adjoining mining district on tributaries of Sixtymile Creek that the relations of the different gold-bearing series are best seen. Here there is an east-west axis or backbone running parallel to the upper part of Fortymile Creek and along the divide between it and Sixtymile Creek, with quartzite-schists of

the Birch Creek series resting immediately on it both to the north and to the south. Above these on either side are the marbles and alternating schists of the Fortymile series. Fortymile Creek below the forks runs for a considerable part of its course along the junction between these two series, on the northern flank of the anticline. Dikes of various eruptive rocks, including intrusive granite, are very abundant, especially on the South Fork. On the upper part of this fork are green tuffs and slates of the Rampart series, overlain unconformably by conglomerates, sandstones, and coaly shales of the Mission Creek series. Both the South Fork and Sixtymile Creek are supposed to head in a backbone of granite around Sixtymile Butte, which is surrounded by quartzite-schists of the Birch Creek series. These regions lie partly in American, partly in Canadian territory.

CANADIAN TERRITORY.

The Canadian area has not been studied by American geologists, except in wayside observation along such routes of travel as necessarily lay through it. The Canadian geologists, on the other hand, did not in their earlier and published observations recognize any subdivisions in the older rocks such as have been made by Spurr. Hence it is not possible to attempt even a proximate outline of the Canadian gold-bearing rock formations. General geological data and local discoveries of gold-bearing gravels indicate that the gold-bearing area is very large, and may be roughly defined as reaching from Dease River to the boundary, with a width of 200 to 300 miles or more. The recent enormously rich discoveries have, however, been confined to a more limited area around the Klondike and Stewart River districts, over which it has been possible to extend, with a reasonable degree of probability, the colors indicated on the map for adjoining American areas. Thus it is assumed that the east-west uplift of fundamental granite and overlying rocks extends eastward into the Klondike district, and that a second uplift in a southeasterly direction extends from upper Fortymile Creek toward the valley of Stewart River.

Spurr noted outcrops of the schistose quartzites of the Birch Creek series for a large part of the distance from the mouth of Fortymile Creek up to the junction of the Pelly and the Lewes at Fort Selkirk; also granites at various points, in some cases schistose like the fundamental granite, in others fresh and massive like intrusive granite. There were also occasional belts of marble belonging to the Fortymile series, notably one 5 or 6 miles above the mouth of Sixtymile Creek, not far from that of Stewart River. These observations afford a rough section across the belt of crystalline schists mentioned by the Canadian geologists as stretching eastward and southeastward along the upper Pelly and adjoining streams and across to the Frances River. Along the eastern edge of the crystalline belt they also recognized rocks of

a general greenish color, made up largely of altered volcanic rocks, which would answer to the description of the Rampart series. Similar rocks were also noted at various points on the Lewes above its junction with the Pelly, notably in the Seminow Hills near the Big Salmon River, which may represent the development of the Rampart series on the south flanks of the crystalline belt.

DETRITAL OR PLACER DEPOSITS.

FOSSIL PLACERS.

Intermediate between detrital materials of the present surface and original deposits in rock-in-place are conglomerate or cement beds, derived from older rocks, but subsequently hardened into a rock mass. These deposits, where gold-bearing, are generally known as *fossil placers*. The cement beds of the Black Hills of Wyoming and the "banket" reefs of the Transvaal are prominent types of such deposits.

Similar formations have been noted in the Yukon district, but more study must be given them before one can judge whether they are likely to prove of great economic importance. Basal conglomerates derived from the wearing down of the older rocks occur in the Mission Creek and also in the Kenai series. On Napoleon Creek in the Forty-mile district a coarse basal conglomerate referred to the former series consists of materials derived from the Birch Creek, Fortymile, and Rampart series. It dips steeply up the valley, and gravels of the stream that cuts across it are barren above and rich in placer gold below it, showing that the gold is derived from this bed.

Steeply dipping conglomerates, thought to belong to the Kenai and containing abundant pebbles of rolled quartz and other rocks, occur at the richest portion of the Koyukuk Valley, about 300 miles above its mouth, and the gold there obtained is supposed to be derived in great measure from them.

RECENT PLACERS.

Recent placer deposits may be divided into *beach* gravels and *stream* gravels, and the latter may be formed as deposits either from ancient or from modern streams.

BEACH GRAVELS.

Auriferous sands have long been known to exist along the California coast, and are found to be quite extensively developed along the coast of Alaska, as has already been briefly indicated. So far as known, such placers have not yet been worked at a profit to any considerable extent, on account of their want of permanence. A sudden storm may so shift the sandbars in which the gold is found as to render futile a great part of the labor already done in preparing to work them. Fossil placers are in most cases beach deposits, for deposits of any

considerable areal extent must necessarily have been spread out by ocean waters.

ANCIENT STREAM GRAVELS.

The most notable instances of ancient stream beds that have been profitably worked are the old river beds on the western slopes of the Sierras in California, where they have been preserved from modern erosion by being covered by flows of hard lava rocks. Similar lava flows are not uncommon in the interior of Alaska. They have been noted on St. Michael Island and at Anvik, near the mouth of the Yukon; on the Yukon near the mouth of the Koyukuk, where they form bluffs 700 feet high; at various points on the Porcupine River; on Chicken and Napoleon creeks, in the upper part of Fortymile district; near the junction of the Pelly with the Lewes River and for 10 miles below; in Miles Canyon between Lake Marsh and Lake Lebarge; and on the Pelly near the mouth of the Hoole River. One instance only has been noted—in the Stikine Valley, between Telegraph Creek and the Tahltan River—where basalt has filled an old river channel and covered auriferous gravels in its bottom. In this case the bars of the present river, whose bed is for the most part cut below that of the ancient stream, were notably richer along the stretches where these ancient gravels were exposed. In none of the other localities were any underlying gravels observed, nor is it likely that in the interior region, especially in the more northern part, any such gravels, even if they exist, will be exposed, since, owing to the peculiar climatic conditions existing there, the modern rivers have not cut the deep valleys seen where the climate is warmer and the river gradient steeper, as in California. The lava flows noted above are all supposed to be of pre-Glacial age, and are basaltic, thus differing from the recent volcanic rocks along the Alaska Peninsula and the Aleutian Islands, which are mostly andesitic.

Silts.—One of the most striking features of stream deposits in the Yukon district is the great accumulation of fine silts in the broader reaches of the valleys. The greatest of these is the Yukon Flats, an area nearly 100 by 200 miles in extent, through which the Yukon River meanders for about 250 miles, from Circle City to Fort Hamlin, and which stretches 40 miles up the Porcupine, where it is estimated to be 90 miles wide in places. In this flat region the Yukon River spreads out to a width of many miles, filling numerous channels, with an archipelago of broad, low islands of silt between them. The main stream generally follows the right bank, which it is rapidly cutting down, and is thus moving its bed gradually to the northward. On the southwest the flat extends to Birch Creek, which below Circle City also meanders in it. Its general level is hardly more than 30 or 40 feet above the river at low stages, but other portions are higher

and evidently above the level of overflow in the present condition of the river. Similar flats, but of more moderate dimensions, occur along the Yukon between Fort Hamlin and Mynook Creek, at the mouth of the Tanana and for some distance up the valley of the latter stream, for 35 miles above the mouth of the Koyukuk River, and at various points below this river down to the Yukon delta. These silts contain abundant driftwood, and sometimes standing trees buried in place; also shells of living species; and in silt deposits above the conglomerates of the Palisades, 35 miles below the mouth of the Tanana, parts of the skeletons of mammoths and other animals have been found mixed with driftwood. The silts are also found in the lake valleys and broader river valleys of the upper tributaries of the Yukon, even within the region of glaciation. Here they are above the till or bowlder-clay, which is the characteristic base deposit in a glaciated country, and are hence assumed to have originated since the retreat of the continental glacier and to be made up largely of the fine rock material ground up by that glacier. The fineness of their material suggests that they must have been deposited in quiet water, either lakes or very sluggishly moving streams; the more rapidly moving streams of the present day are mostly cutting down and carrying away, except on the Yukon delta. In such deposits the gold that is brought down would be in the finest state of division and so generally disseminated as not to be likely to form workable placers. The stream gravels in the Upper Yukon are found to be more recent than these silts, and rest upon them.

Gravel terraces.—The gravels of a modern stream are not necessarily confined to the present bottom of its valley, for, as is well known, the stream is cutting down its bed and reaching a lower level from year to year; moreover, in the existing bottom its ordinary water channel, in which the cutting is done, is constantly changing from side to side. At high stages of water the stream may fill the entire valley, bringing down in its rapid course more material than it can carry away, and when it dwindles again to a comparatively narrow stream it leaves benches or bars of coarser material on either side, which in the course of its subsequent meandering it does not completely remove. Thus there are often found on the sides of the valley, sometimes at considerable heights above the present bottom, gravel benches or terraces which are relics of such flood-plain deposits, left there in high stages of the river, and when the valley bottom stood at about that level. Such gravel terraces are quite common along the Upper Yukon and its various tributaries, sometimes standing several hundred feet above the present stream. Where not too high the terrace gravels often yield gold in paying quantities; but the quantity of this gold will necessarily be dependent, first, upon the gold-bearing quality of the rocks from which they were derived, and, second, upon the distance

they have been carried and the configuration of the bed-rock, which might or might not favor the concentration of the gold in certain spots. The successively higher terraces spread over broader and broader areas, but in a broad body of water the chances for concentration are less favorable than in one confined within a narrow valley or gorge. In some of the older mining districts, notably the Cassiar district, around Dease Lake and the head of Stikine River, from which over seven million dollars' worth of gold was taken, a considerable portion is said to have been derived from terrace gravels. In general, however, they can not be expected to be as rich as the gulch gravels; but when collected in sufficient quantities and in such situations that it is possible to bring a considerable head of water to bear upon them, they may be profitably worked by the hydraulic process, as their elevation renders easy the carrying away of the tailings from the sluices. They may, moreover, have furnished important additions to the gold contents of stream gravels, where they would have been reassorted and concentrated by the action of water.

The same general remarks may be applied to gravel terraces about lake basins which may have been formed at higher stages of the lake waters. In the Silver Bow basin, near Juneau, which was once occupied by a lake, the lake beds have been found gold-bearing only on the side receiving drainage from an area where the rocks are known to be gold-bearing.

RECENT STREAM GRAVELS.

Recent stream gravels may be divided into two chief classes, *bars* and *gulch gravels*.

Bars.—In the larger streams accumulations of gravel and sand are made in places of slackening current, such as the inner side of curves, or at points where considerable coarse material is brought into the main stream by more rapid tributaries. Such accumulations are called "bars," and often contain much gold. In some cases practically the entire mass of gravel and sand in a river bed contains enough gold to pay working by mechanical processes which admit of the handling of large amounts of material at a very small cost. In earlier times the stream or river was sometimes turned from its course in order to admit of handling such materials. At the present day it has been proved that in most cases such gravel bars can be worked more effectually and cheaply by floating dredges, which raise the gravels to suspended sluices. It is not known whether the bars of the Yukon have yet been tested for gold, but there can be little doubt that they contain it in considerable amount, and it seems probable that those in the upper stretches of the river, especially near streams that drain known gold-bearing areas, will be found to be rich. Whether climatic and other conditions are such that dredging can be carried on with success must be determined by practical experiment.

Gulch gravels.—Coarse gold can not, under ordinary circumstances, be carried very far by running water; hence it is in the gulches that the rich deposits of coarse gold are ordinarily found, and in the side gulches that it is generally the coarsest, as in them the gravel is nearest its source. It is not always actually running water that has concentrated the gold; the metal is so much heavier than rock material that a relatively slight disturbance of loose material, if continued long enough, will result in settling most of the large particles at or near the bed-rocks. Still, that running water is the most important factor in the concentration of gold is shown by the fact that this concentration is greatly dependent on the nature of the bed-rock; where this presents a rough, ragged surface, especially where ridge-like protrusions run across the stream, like the riffles in a sluice box, the gold is more readily caught and the gravels resting in it are much richer than where the surface is smooth, even, and without many cracks. Thus the experienced miner knows that where there is a narrow dike of harder rock, or, still better, a series of hard schistose rocks standing on edge that cross the gulch in which he is working, he is liable to find the richest concentration of gold, and that in the latter case it may even settle down into the cracks of the bed-rock for several feet. The lowest channel does not necessarily correspond with that of the present stream, since the latter, as already noted, is frequently changing its course within the material accumulated in the long years during which it has been flowing, and it may have been pushed to one side or the other of the valley by landslides. The actual pay dirt is generally confined within comparatively few feet of the bed-rock. Sometimes the miner finds what he calls a false bed-rock, which is generally a clayey seam that marks some special stage in the history of the stream. The amount or depth of gravel in the bottom of a gulch or valley is dependent on its size and shape, and the experienced eye can estimate approximately what it is by mentally carrying down the outlines of the rock surface on either side of the valley to a meeting under the gentler-sloping valley bottom. It is also, naturally, much thinner near the head of a gulch, and in this region, where these heads are frequently occupied by glaciers or bodies of perennial ice and snow, they generally have a rounded, amphitheater-like shape, the breaking down of the rock occurring mainly at its contact with the ice. In the great diurnal changes of temperature of the short summer months of this region the water seeping into rock cracks by day is frozen at night, and by its expansion pries off fragments from the cliffs. The material thus loosened gradually slips down; but, as a rule, not until it has been moved for a considerable distance, ordinarily some miles down the valley, is the gold thoroughly settled to the bottom along the bed-rock surface.

The general character of the gravel, and of the gold itself in the

gulches that have been studied, such as those in the Fortymile and Birch Creek districts, shows that the gravels have not been carried very far. The rock fragments are not completely rounded; they are generally rather angular, and often quite flat. The gold also is not completely rounded.

CHARACTERISTICS AND DISTRIBUTION OF KNOWN PLACERS.

The extraordinarily rich placer deposits of the gulches tributary to the Klondike River above Dawson, and of similar gulches of the nearby Indian Creek and Stewart River, have been so recently opened that no detailed geological description of these localities has yet been received. In his report, however, Spurr had shown that the strike of the gold-bearing rocks in the Fortymile district, and the exposures observed along the Yukon, indicated that their gold must have been derived from the same gold-bearing formations that had furnished the richest placers in the districts visited by him. A brief statement of the prominent characteristics of these districts as given by him will therefore probably be of value to the prospector. Geology can give only general indications and point out where gold may be found. The actual location of rich concentrations must be determined by the miner himself.

The hills surrounding the gulches of the Little Mynook and Hunter creeks, on the Lower Yukon, are formed of rocks of the Rampart series. The bed-rocks are of diabase, tuffs, impure shales, and quartzites, and in the bottoms of the gulches there is from 10 to 20 feet of gravel. The gravel consists in part of angular fragments of rocks that form the walls of the gulch, in part of waterworn pebbles of Birch Creek schist, schistose granite, and other rocks. The gold is generally in rounded, bean-shaped grains and nuggets, and less frequently in unworn particles. This points to a two-fold origin of the gold, as derived in part from the rocks immediately about and in part from distant and older rocks, which may have been worn down, possibly along an old seashore, into terrace gravels, and then by subsequent erosion brought into the present stream beds. Further exploration in the hills to the south may disclose the true source of these pebbles and of the gold that accompanies them. On American Creek, in the Mission Creek district, the gold-bearing placers are also derived from rocks of the Rampart series—quartzitic schists, serpentines, and chloritic rocks—and the gold is said by Spurr to have been derived mainly from the schistose zones in the bed-rock.

The richest gravels have been found in the Birch Creek and Fortymile districts. In the entire Birch Creek district, which lies south of Circle City, and on Miller, Glacier, Poker, and Davis creeks of the Fortymile district, near the international boundary, the bed-rocks are always the quartzite-schists of the Birch Creek series, containing veins

of quartz. The gravels rest, as a rule, directly on the schist, though in some cases, as on Harrison and Eagle creeks in the Birch Creek district, there is clay beneath the gravels, and the gold as a rule does not extend into the bed-rock but occurs chiefly at the top of the clay. Generally, however, the schist is rotted and reddened from oxidation for a few inches to several feet below the surface, and in this part the gold has settled into the cracks and joints. The pay gravels lie mostly next the bed-rock, in an average thickness of perhaps 2 feet, though sometimes up to 10 feet, while the overlying gravels average 8 or 10 feet, with a maximum of 25 feet. In the gravels the schist is in quite large, flat fragments, and the quartz is in bowlders of varying size. The schist fragments lie flat, and are mixed with sand, showing that the sorting action of running water has not been carried far. In the concentrates from the sluice boxes the heavier minerals associated with the gold—galena, magnetite, limonite, hornblende, and garnet—are in each case such as are found in the neighboring schists, and the nuggets of gold often have pieces of quartz still adhering to them. All these facts are evidence that the gold is derived from rocks in the vicinity, and is not brought from a great distance, perhaps by glaciers, as some erroneously suppose.

The rocks of the Fortymile series in the Fortymile district, as already stated, form the west bank of Fortymile Creek, and south of the South Fork cross the divide between Franklin Gulch and Napoleon Creek, where they are overlain by green slates of the Rampart series, which in turn are overlain by conglomerates of the Mission Creek series. In Franklin Creek the bed-rocks are marbles interbedded with mica- and hornblende-schists; the gravel contains fragments of marble, quartzite, mica-schists, and vein quartz. At one point a quartz vein is found in the bed-rock, and below it native silver has been found in the gravels, which apparently came from this vein. It is the schistose rocks that mostly carry the gold, as the marbles do not show much evidence of veins. In this gulch are two levels; the higher one, at the head of the gulch, had not been worked, while the pay gold had been found mainly at the lower level, near the mouth of the gluch.

Chicken Creek, so called because its gold occurs in grains the size of chicken feed, drains a wide area toward the Ketchumstock Hills to the southwest, and the actual source of the gold is less readily defined. The gravel contains fragments of granite, quartzite, schist, and marble.

On Napoleon Creek conglomerate forms the bed-rock near the mouth. The gravels contain fragments of quartzite, vein quartz, hornblende-granite, and various eruptive rocks, and the source of the gold is assumed to be the conglomerate, which is made up of fragments of the older rocks, for the rocks higher up the gulch above the conglomerates have not been found to carry much gold.

The most trustworthy reports from the Klondike region indicate that the exceptionally rich placer gravels thus far found occur in side valleys entering the main Klondike Valley from the south, such as Bonanza, Eldorado, and Hunker creeks, and in some gulches across the divide tributary to Indian or Stewart rivers. No gold in paying quantities had been found on the Klondike itself. The placer deposit generally consists of 10 to 15 feet of frozen muck and decayed vegetation at the surface, then a gravel bed that rarely pays; below that a clay selvage, under which is pay dirt from 1 to 5 feet in thickness resting on the upturned edges of the schist, from which it is separated by a clay selvage. The pay streak or bottom of the old channel is usually very regular and straight, not following the bends of the present stream. It is said to average 60 cents to the pan, and may yield $1 to $3. Only very exceptionally rich gravel can be worked at all under present conditions.

PROBABLE EXTENT OF GOLD-BEARING DEPOSITS.

In a new country gold is first sought in the stream gravels, and thence traced up to its source. Very fine gold may be carried long distances by river waters; hence it is only when it becomes relatively coarse, or at any rate carries coarse particles, that the source may be considered necessarily near at hand. Fine gold is found in almost all the rivers of Alaska; even the silts of the Yukon yield it in places. Gold has been found along the whole length of the Lewes, the Teslin, the Big Salmon, the Pelly, the Stewart, and the Selwyn, and on the Yukon River almost continuously from the junction of the Lewes and Pelly downward. Still further east, Frances and Dease rivers, the main branches of Liard River, which flows into the Mackenzie, carry gold. In the Cassiar district, on the Dease River, gold was discovered as early as 1861. The district was actively worked as a placer camp from 1873 to 1887, during which time it yielded about five million dollars' worth of gold dust. These upper regions are distant about 1,000 miles in a straight line from the known outcrops of gold-bearing rocks in the Rampart Mountains on the Lower Yukon, and are within areas either in which exposures of the gold-bearing rocks as defined above are actually known to exist or in which the similar lithological character of rocks described renders it probable that in some part of the area they may be exposed.

There is also some evidence of the extension of rocks of the gold-bearing series to the northwest of the Lower Yukon, though it is as yet impossible to determine whether the primitive gold-bearing rocks of the Birch Creek and Fortymile series there come to the surface, or whether it is simply the fossil placers or gold-bearing conglomerates of later formations, where made up of fragments of these older rocks, that have furnished the gold of modern streams.

In this region gold has been found extensively along the Koyukuk, and most abundantly, as already mentioned, where the valley cuts through conglomerates, supposed to belong to the Kenai series. This is at the forks, about 300 miles above the mouth, below which the country is low and swampy. Above the forks the mountains close in and the sides of the valleys become precipitous. The gold in the bars is said to be coarse, suggesting nearness to the source, and has yielded as much as $100 per day by use of the rocker. Prospectors are said to have explored to considerable distances above the forks, up to 500 miles from the mouth, and to have recognized rocks similar to those of the Birch Creek and Fortymile districts. This, if true, is important as an indication of still further extensions of the area of exposures of the older gold-bearing rocks.

Further east, at the head of Dall River, low, broken hills, apparently composed of schists and quartzose rocks, extend northeastward to the Romanzof Mountains. The latter are snow covered in summer, and form the northern boundary of a low plain that lies to the north of Porcupine River. These mountains are likewise said to be made up of metamorphic schists and quartzites.

Still further northwest, in the country to the northeast of Kotzebue Sound, gold has been reported from the Kowak and Noatak rivers. It is possible that the older series of rocks is exposed in the mountains of this region, but more probable that the gold is derived from the conglomerates of the Mission Creek series, which, as already shown, afford gold on Napoleon Creek and in the Mission Creek district.

Gold is also reported by prospectors from a belt of country which is generally parallel to the known gold belt but set off to the southwest, and which corresponds to the supposed southwestern flank of the granite backbone. Such discoveries have been reported from Fish Creek, which flows into Norton Sound north of St. Michael, and from the upper Kuskokwim River, which flows into Bering Sea. On the Sushitna River, which flows into Cook Inlet, W. A. Dickey reports colors of fine gold in the sands all along the stream, and platinum on the upper river, where veins of white quartz carrying gold, silver, and copper were found in slates asssociated with granite and porphyry. Gold and copper have been reported by various persons from the region about the sources of the Copper and White rivers. It is thus evident that the elevated region along the heads of these various streams, and between them and the waters of the Tanana, possesses great possibilities in the way of mineral development, but from all accounts it is a region exceptionally difficult of access, and it may well be questioned whether it is advisable to attempt its exploration until facilities for travel and obtaining supplies in the Yukon region have been increased, as they undoubtedly will be in the near future.

More accessible is the region immediately north of the Tanana

River known as the Tanana Hills and Ketchumstock Hills, which from reports appears to be mainly a granite region, but in which it is likely that outliers or patches of the gold-bearing schists will be found inclosed within the granite area.

Late reports by prospectors in the Tanana region state that the river has slack water, navigable for steamers 150 to 200 miles above its mouth; above that the current is swift. Mountains border the river on the north side from the mouth up; on the south they are far distant. Colors are found in all the creeks; those heading toward Fortymile and Seventymile offer best promises, but no important prospects have been found. Toward Circle City the creeks do not freeze up, and a hot spring was found in one of the gulches.

In the mountain region to the northeast of the Yukon River immediately above the bend, such observations as have been made do not offer much promise of exposures of the older gold-bearing schists. Older limestones occur there, but, though important gold deposits are known to occur in limestones, in the Yukon country the general rule appears to prevail that gold is concentrated mainly in the siliceous rocks. It may well be, however, that in the conglomerate or cement deposits of the coal-bearing formations that are known to occur in this northeastern region there are portions sufficiently rich in gold to make payable placers by their wearing down. In searching for such places the prospector should study the character of the pebbles that make up the conglomerate. It is only when these include fragments of the gold-bearing rocks, and occasionally of vein quartz, that they are likely to be productive.

For the region east of the international boundary, Spurr had already pointed out, as a result of his observations in the summer of 1896, that the Klondike and Indian Creek regions were likely to show rich placers, because the schists of the Birch Creek series, and to some extent the marbles of the Fortymile series, formed the bed-rock.

George M. Dawson reports bars of fairly coarse gold on the Pelly all the way up to Hoole River. Just below the mouth of the McMillan the river has cut a canyon through gray granite hills, below which are dark crystalline schists with east-west strike and northerly dip, associated with which are alternating marbles and chloritic schists, probably of the Fortymile series. Granite occurs again near the junction with the Lewes. Of the valley of the McMillan nothing was known. The Pelly above the detour or bend had a similar series of quartzite-schists, with interbedded limestones on the north, while the Glenlyon Hills to the south were of granites. Above these are sandstones supposed to belong to the coal-bearing series and dipping 45° S. Still higher up in Hoole Canyon are marbles again, associated with schists and volcanic rocks, possibly of the Rampart series. Still further northeast, in the middle canyon of the Frances River, Dawson found

marbles again, while in the Tootsha Range to the east were seen granites and schists with abundant quartz veins.

All along the summit of the Coast Range the prevailing rocks are granites, cut by later porphyry dikes. They form a belt 20 to 80 miles wide, and are generally of the hornblende or intrusive type. On the Dyea and Skagway trails they extend down on the northeast side to the mid-length of Lake Bennett. In the range of hills between Miles Canyon and the Teslin River are diabasic or dark eruptive rocks and limestones, which may belong to the Rampart series, though Dawson considers the limestones to be probably Carboniferous.

Along the region of Rink and Five Finger rapids, below the Big Salmon, are infolded masses of Cretaceous rocks (Kenai?) with conglomerate at the base, overlain in places by lavas. Below these are greenish eruptive rocks, and then near the mouth of the Pelly is granite again, succeeded below the Pelly by basalt flows. Twenty-five miles below the Pelly granitic rocks again appear, and are succeeded by crystalline schists of various kinds, which constitute the prevailing rock down nearly to Fortymile.

OTHER METALS THAN GOLD.

In the sands of some of the streams along the Yukon, and of the Sushitna River, platinum has been noted, and may be much more common than yet appears, as miners do not as a rule pay much attention to this metal owing to its want of bright color. Native silver and arquerite, or silver amalgam, have also been noted, the latter in the Cassiar district. Native copper was among the first metals reported from this region, it having been in use to a certain extent among the Indians, who claimed to have obtained it near the head of the Copper River, to which circumstance that river doubtless owes its name. Specimens have been brought in from there in recent years, but it does not appear that the deposits from which they came have yet been discovered. Native copper was also found in some of the placers of the Cassiar district.

Necessarily, in so early a stage of development as the present, little is known of minerals occurring in the original or vein deposits, as under present conditions they can not be profitably worked. Yet it is on them, rather than on placer deposits, that a permanent mining industry must eventually be founded. The few that have already been noted, mainly by Spurr and his associates, will be briefly mentioned.

On the Lower Yukon 35 miles below Tanana Post, one of the narrow veins of the Birch Creek series had been driven on for 110 feet in a tunnel; it is much pinched and faulted and carries small amounts of gold and silver. In the Rampart series some auriferous quartz veins have been prospected, but the principal mineral development is along shear zones, sometimes of great width, which contain copper and iron

pyrite, often with gold and silver in small amount. The copper is frequently altered to the green silicate.

On the trail from Circle City to Birch Creek district, 15 miles from the former, is a quartz vein showing much free gold and said to be 10 feet wide. On Deadwood Creek in this district is a wide vein rich in galena and silver. At the head of Eagle and Golddust creeks are wide quartz veins, one being said to be 150 feet wide, of common rusty quartz. Some fragments from wide veins crossing the schists show beads of gold.

In the Fortymile district opposite the mouth of Clinton Creek is a mineralized zone in limestone, more or less silicified and stained dark red, known as Cone Hill. It is 200 to 300 feet wide and is supposed to be auriferous. Green-stained specimens from it were found to contain small amounts of nickel, chromium, arsenic, and antimony. Traces of gold and silver were found in the sandstone overlying this deposit. A small vein of argentiferous galena crosses Fortymile Creek a few miles above its mouth. Between Fortymile and Fort Reliance copper pyrites occur at several points, impregnating the schists, and opposite the mouth of Klondike Creek a tunnel had been driven into a wide body of ore in the schistose rocks which was said to assay $36 in gold and $18 in silver to the ton.

It is not thought worth while to describe, or even enumerate, all the known mines now being worked in the coastal region, as they bear no geological relation to the deposits of the interior, and their general characteristics have already been mentioned.

COAL AND LIGNITE.

COASTAL REGION.

The following synopsis of what is known in regard to the coal and lignite of Alaska is condensed from the fuller report on the same subject by W. H. Dall, printed in the Seventeenth Annual Report of the United States Geological Survey, Part I.

The coal of Alaska so far examined, whether in the interior or on the seacoast south of Bering Strait, is of Eocene or early Tertiary age and belongs without exception to varieties of lignite, brown coal, or glance coal. North of Bering Strait, in the vicinity of Cape Lisburne, is a coal field of considerable extent containing a fuel which is believed to be of greater geological age, perhaps similar to that so extensively mined at Nanaimo and other points in British Columbia. As rocks of Carboniferous age occur in close proximity to this coal, it was long supposed to belong to the Paleozoic coal measures, like that of Pennsylvania, but an examination of the fossil plants actually associated with it has shown this opinion to be erroneous.

The various coals of Alaska occur in beds interstratified with sandstone, shale, conglomerate, and clay, these rocks usually containing

numerous fossil plants, leaves, cones, and amber derived from the fossilization of resin from the ancient coniferous forests.

Like all Tertiary coals, the Alaska mineral is light in proportion to its bulk, burns rapidly with little smoke, and has a tendency to break up into small pieces under the action of the weather. The glance coal is brilliant and clean to handle, like anthracite, for which it is often mistaken, but which, bulk for bulk, is considerably heavier. The brown coal gives a brown instead of a black streak when scratched, has the appearance of fossil wood, and in drying splits up into chip-like pieces. The geological formation containing the coal and leaf-bearing shales is called the Kenai formation, and is usually covered by beds of sandstone containing fossil oysters and other shells belonging to the Miocene or middle Tertiary.

Many coal seams have been partially explored, and a much larger number have been reported but not examined by experts. Of the former the following beds promise to have some commercial importance, though none has been thoroughly explored in a scientific manner.

Admiralty Island coal field.—The broken mass of land named Admiralty Island is penetrated by a complex system of waterways known as Kootznahoo Inlet. The land is comparatively low, and in places on the shores coal seams and leaf-bearing shales crop out, of which a number have been prospected. Many of the beds are broken up by faults and fractures, but these conditions are less conspicuous in the eastern part of the area surrounding the inlet. The most promising deposits are at the extreme east, at the head of a body of water called Davis Creek, about 10 miles by water from the entrance of the inlet. About 100 tons of coal have been taken out here by the proprietor of the mine, who has found a ready sale for it. It is not a coking coal. The locality is situated about 40 miles northeast from Sitka, near the Killisnoo village.

Cook Inlet or Kenai coal field.—This is the largest and most important coal field known in Alaska. It is situated on the Kenai Peninsula, forming the eastern shore of Cook Inlet north of Kachemak Bay, where the coal seams are exposed in high bluffs rising to nearly 2,000 feet above the sea. From these bluffs the coal extends northward, with gentle undulations, and finally dips below the sea-level near Cape Kussilof, covering an area about 70 miles long and 30 miles wide. At Kachemak Bay, where the best outcrops and the only good harbor are found, there are six or seven beds, one above another, the thickest being 4 feet thick, and the best coal coming from the lowest beds. A good deal of prospecting has been done here and several shiploads of coal have been taken out. The Cook Inlet coals have about the average amount of moisture, less than the average amount of ash, remarkably little sulphur, and more than the average amount of volatile combustible matter. When all the conditions are taken into account, the

Cook Inlet coal field is by far the most promising commercially of all Alaskan coal deposits.

Amalik Harbor coal seam.—This is situated on the south side of Alaska Peninsula, in longitude 154° 30′ W. The seam is small at the outcrop and has not been explored, but the coal is of very excellent quality, coking well, and larger seams may exist in the vicinity.

Unga Island coal seams.—These are on the shores of Zacharefskaia Bay, on the north side of the island of Unga, Shumagin group, and have been worked more or less since 1865. The coal is of poor quality and contains an excessive amount of sulphur, but has been utilized to some extent for local purposes.

Chignik Bay coal seam.—This is situated on a river flowing into Chignik Bay, on the south side of Alaska Peninsula, in about longitude 158° 33′ W. The coal is of good quality, and several hundred tons have been mined for use in the local salmon cannery, where it is reported to give satisfaction.

Herendeen Bay coal field.—This is situated on the north side of Alaska Peninsula, on a point which separates Herendeen and Moller bays. The field is about 4 miles square, but there are several volcanoes in the vicinity and the rocks are more or less faulted. Some hundreds of tons were taken out from a mine near the head of Herendeen Bay, but the mine is no longer in operation.

Cape Lisburne coal field.—This deposit, before alluded to, is situated on the Arctic coast, extending in a general way from a point a few miles eastward from Cape Lisburne to Cape Beaufort, a distance of over 25 miles. Its inland extension is unknown, and whether the coal which occurs on the same coast further north is of the same age or not is likewise unknown. The Cape Lisburne coal has been used extensively by the steam whaleships, but no regular mining operations have been undertaken.

Coal (or strata of the Kenai formation which usually contain more or less coal) has been reported from the following localities, but the character, extent, and availability of such deposits are unknown or problematical.

ALEXANDER ARCHIPELAGO.

St. John Baptist Bay, about 16 miles in a northwesterly direction from Sitka.

Surprise Harbor, near Point Gardner. This is at the southern extreme of the Admiralty group of islands, on Frederick Sound.

Port Camden. This bay penetrates Kuiu Island from the northeast. The coal is on the east side of the bay, 7 miles from the entrance.

Whale Bay, Baranof Island. This is about 23 miles southeast from Sitka.

West coast of Kuiu Island. Coal in latitude 56° 25′.

Lindenberg Peninsula. Coal or lignite on the northern shore of Kupreanof Island.

Chichagof Island, at the southeastern extremity, on Chatham Strait.

Hood Bay, on the opposite shore of Chatham Strait from the last locality.

Prince of Wales Island, near Kasahan Bay.

Seymour Canal, Admiralty Island, near its western part.

COAST BETWEEN CAPE SPENCER AND COOK INLET.

Lituya Bay. Exact locality not known.

Yakutat Bay. On the northeastern shore, near Disenchantment Bay.

Port Graham. At the southeast entrance to Cook Inlet.

Copper River delta. Petroleum in considerable quantity, as well as lignite, is reported hereabouts.

ALASKA PENINSULA AND ALEUTIAN ISLANDS.

Cape Douglas, at west point of entrance of Cook Inlet.

Katmai. On the portage across the peninsula from this bay, both coal and petroleum are reported.

Uganuk Bay, Kadiak. Also on Uganuk Island, in the Bay.

Red River, Kadiak.

Sitkinak Island. Southwest of Kadiak.

Yantarnie Bay. South side of Alaska Peninsula, in longitude 157° 10′ W.

Cold Bay. South side of the peninsula, in longitude 155° 25′ W.

Coal Cape. South side of the peninsula, in longitude 159° W.; also:

Coal Bay and Portage Bay, near by.

Pavlof Bay. West shore, near Pavlof Mountain.

Akun Island.

Amber Lake, Unalaska. Near the center of the island.

Umnak Island. Northwestern extreme.

Sandy Bay, Atka Island.

Kirilof Bay, Amchitka Island.

COAST AND ISLANDS OF BERING SEA.

Point Vancouver.

Unalaklik River, Norton Sound.

Topanika, Norton Sound.

Ulukak River Valley, Norton Sound.

LOWER YUKON RIVER VALLEY.

Andreafski Post.

Kaltag village.

Nulato. Seven miles below the post, on right bank of the Yukon; also above the post on the same bank, for several miles.

Melozikakat. On the left bank, 20 miles below the settlement at the mouth of the Melozikakat.

There are other localities reported further up the river, chiefly in Canadian territory.

ARCTIC COAST AND RIVERS.

Kowak River, Kotzebue Sound. Seventy-five miles above the mouth is a coal field 30 miles wide.

Wainwright Inlet, Arctic Ocean. On the banks of a river entering the inlet.

In conclusion it may be said that the tests of Alaskan coals so far made give a fuel value for the best Alaskan lignite from Cook Inlet of 0.927, when the Wellington coal of British Columbia is rated at 1.351, the Nanaimo at 1.306, the Seattle at 1.229, and the Bellingham Bay at 1.148.

INTERIOR REGIONS.

From the reports of Spurr and of the Canadian geologists the following data are gleaned:

Hess Creek.—On the right bank of the Yukon just below the mouth of Hess (also called Whymper) Creek frequent seams of lignitic coal are exposed in the shales of the Kenai series, which here stand nearly vertical. The shales alternate with conglomerates, grits, and impure limestones. Three seams have been opened by Oliver Miller, one of which is 2 feet thick; another shows 3 to 4 feet of mixed coal and coaly shale, with 18 inches clear coal. The coal is brittle and contains specks of amber; an average sample shows 18 per cent of ash and 7 to 8 per cent of moisture.

Coal Creek.—Coal Creek enters the Yukon from the east 8 to 10 miles below the mouth of Fortymile Creek, and hence is within Canadian territory. Two 4-foot seams of coal are reported in sandstone about 12 miles above the mouth of this stream, from which coal has been taken. It has a brilliant luster and a conchoidal fracture, is rather light in weight, and carries some pyrite and amber in small specks. It apparently contains less ash and a higher percentage of carbon than the Miller mine coal, but is of the same general lignitic character.

Other localities.—Coal of a similar quality occurs on a small creek entering the Yukon from the same side a few miles below Coal Creek; also on Chandindu Creek, about 8 miles above the mouth.

Beds having a composition similar to that of the beds enclosing the coal seams, and like them carrying impressions of fossil plants, are reported from various points in the country northeast of the Yukon River, notably up the Tatonduc and Kandik rivers and on Big Black River, and it may be assumed that a belt of these coal-bearing rocks

stretches through this region in a northwest-southeast direction, generally parallel with and often very close to the Yukon.

An area of the same rocks has been noted on the Lewes River, in Canadian territory, where several seams of coal are exposed in a bluff on the right-hand side a few miles above the Rink Rapids, one of which is 3 feet thick, affording about 18 to 20 inches of clear coal; the others are somewhat thinner.

The rocks of this formation are generally steeply inclined and often much folded, hence not favorably situated for mining, and the coals thus far known are of light weight and rather low grade, and do not bear distant transportation.

On American Creek, and on Napoleon Creek near the head of Fortymile Creek, are seams of impure lignite within the Mission Creek beds, a series of thin-bedded limestones, shales, sandstones, and conglomerates which are assumed to be of earlier age than the Kenai series. The developments are not sufficient for a determination of the economic value of these older coals.