MINERAL DEPOSITS OF THE YAKATAGA DISTRICT.

By A. G. Maddren.

INTRODUCTION.

The Yakataga district, where gold placers have been mined and petroleum seepages and coal beds have been found, lies on the central Pacific seaboard of Alaska in front of the western part of the great St. Elias Range, whose crest line stands from 10,000 to 18,000 feet above sea level, within 30 to 40 miles of the ocean. The shore line, which forms the southern boundary of the district, follows approximately the sixtieth parallel of north latitude (Pl. IV, p. 130). The coastwise extent of the district from east to west is about 60 miles, from 141° 40′ to 143° 20′ west longitude, and at its opposite extremities it is delimited by two of the largest piedmont glaciers in Alaska. On the west is Bering Glacier, named for the discoverer of the country, and on the east Malaspina Glacier, named for one of the earlier explorers of this coast. Its inland boundary is ill defined, but it can be regarded as including the front range of the St. Elias Mountains, here termed the Robinson Mountains, whose main crest line lies 10 to 15 miles from the coast.

The region thus outlined contains about 1,000 square miles. Though its shore line was well known to prospectors, some of whom had journeyed far inland, the region had until 1913 been relatively little explored. Surveys of the coast line and inland as far as the petroleum seepages were made in 1898 and 1899 by J. L. McPherson in the interest of oil claimants. The resultant data have been embodied on various official maps. Mr. McPherson and Mr. F. H. Shepherd also made geologic observations in this district, which they did not publish themselves but generously turned over to members of the Survey, and these have been recorded in various official publications, as follows:

Eldridge, G. H., The coast from Lynn Canal to Prince William Sound. In Maps and descriptions of routes of exploration in Alaska in 1898: U. S. Geol. Survey Special Pub., p. 104, 1899.

Spurr, J. E., A reconnaissance in southwestern Alaska: U. S. Geol. Survey Twentieth Ann. Rept., pt. 7, p. 264, 1900.

Martin, G. C., Cape Yakataga placers: U. S. Geol. Survey Bull. 259, pp. 88–89, 1905.

Martin, G. C., Geology and mineral resources of the Controller Bay region, Alaska: U. S. Geol. Survey Bull. 335, pp. 26, 63, 114, 115, and 118, 1908.

The Yakutat Bay region and the slopes of St. Elias, lying 20 to 40 miles east of Yakataga, have long been a field of scientific exploration. A large number of publications relate to St. Elias, but few of them contain geologic data. The publications of I. C. Russell, however, are an exception, for his investigations in 1890 and 1891 did much to elucidate the stratigraphy of the St. Elias region as well as the glacial geology. Much additional information was obtained by R. S. Tarr, who in 1905 and 1906 made a comprehensive study of the glacial geology of this region, in the course of which he obtained much new information concerning the bedrock geology. The geology of the Controller Bay region, 60 miles to the west, has been studied in detail by G. C. Martin. Therefore, though the geology of the Yakataga district was until 1913 but little known, the region is flanked on both sides by areas that had been investigated. The principal reports dealing with these adjacent regions are listed below:

RUSSELL, I. C., An expedition to Mount St. Elias: Nat. Geog. Mag., vol. 3, pp. 53-203, 1891.

RUSSELL, I. C., Second expedition to Mount St. Elias: U. S. Geol. Survey Thirteenth Ann. Rept., pt. 2, pp. 1-92, 1893.

FILIPPO DE FILIPPI, The ascent of Mount St. Elias by H. R. H. Prince Luigi Amedeo di Savoia, Duke of the Abruzzi, 1900.

TARR, R. S., The Yakutat Bay region, Alaska: U. S. Geol. Survey Prof. Paper 64, 1909.

TARR, R. S., and MARTIN, LAWRENCE, The earthquakes at Yakutat Bay, Alaska, in September, 1899: U. S. Geol. Survey Prof. Paper 69, 1912.

MARTIN, G. C., Geology and mineral resources of the Controller Bay region, Alaska: U. S. Geol. Survey Bull. 335, 1908.

About two months was employed in the field investigations on which this report is based. This time was devoted not only to a study of the geology and mineral resources but also to making a topographic exploratory survey of the area. Besides traversing the shore line the inland region was penetrated at several places for a distance of 5 to 25 miles. Heavy vegetation on lower slopes and ice covering at higher altitudes masks much of the bedrock, and this fact, combined with the physical obstacles to travel indigenous to a region of glacial streams, strong relief, and without trails, made the geologic observations difficult. The conclusions reached must, therefore, be regarded as tentative. Only the salient features of the geology and mineral resources will here be set forth, the more elaborate discussions being reserved for another report, now in preparation, that will be more fully illustrated. The writer was fortunate in having the efficient assistance of E. O. Blades throughout the field work. He is also under obligations to the prospectors and miners of the district for information and aid given in various ways. Special acknowledgment should be made to Mr. V. Blodgett, who furnished valuable data about the White River gold placers.

TOPOGRAPHY.

RELIEF.

The main crest line of the St. Elias Range, though unexplored, probably lies 30 to 40 miles inland from the beach at Yakataga. Between these mountains and the sea lies another range forming a westward extension of what Russell[1] termed in the St. Elias region the "Robinson Hills." As this highland mass is rugged, with peaks from 5,000 to 10,000 feet high, it is more properly designated the Robinson Mountains and forms the front range of the St. Elias chain. The two ranges are separated by a field of ice that is tributary to the Bering and Guyot glaciers. The Robinson Mountains form a highland belt extending from the vicinity of Icy Bay on the east to Bering Glacier on the west.

Both ends of the range terminate in areas of lesser relief which are deeply buried in great piedmont glaciers. These glaciers are fed by the ice and snow fields of the St. Elias Range and extend practically to the coast. They form an ice barrier that is nowhere less than 10 miles broad and many miles in aggregate length, which practically isolates the Yakataga district on the west, north, and east. Only a narrow strip of unstable glacial outwash coastal plain, 2 to 5 miles wide and 30 miles long, extending westward between the southern edge of Bering Glacier and the ocean to Controller Bay district, affords any land connection whatever with contiguous areas. All approaches to the district from any other overland direction are barred by wide ice fields.

The Robinson Mountains are made up of three parallel ridges whose trend is a few degrees north of west, and thus slightly oblique to the coast line. The first or southernmost of these mountain ridges fronts the ocean, in close proximity to the shore, from Icy Bay to Yakataga Reef, its western terminus. The second and third successively higher inland ridges are not so distinctly separated from each other as the first or coastal ridge is from them, and both these inland ridges extend farther west than the front one. Here they form the mountain abutments to the eastern margin of Bering Glacier. In the far eastern part of the district all three of these ridges of the Robinson Mountains are high and merge into one mountain mass, forming a highland area whose general altitude is about 5,000 or 6,000 feet above sea level and whose summits rise to elevations of 7,000 to 9,000 feet. Westward from this highland area these mountain ridges become more separated and distinct, especially the southernmost and the one next north from it, and two valley basins of considerable

[1] Russell, I. C., Second expedition to Mount St. Elias: U. S. Geol. Survey Thirteenth Ann. Rept., pt. 2, Pl. IV and p. 17, 1893.

length and breadth lie between them. The easternmost of these valleys is 7 or 8 miles in length from east to west and is largely occupied by a glacier named White River Glacier from the stream that drains it. Westward from this valley basin is another, the largest and most open one in the district, about 20 miles long and 5 to 7 miles broad, that comprises the general continuation, in this direction, of the depression between the coastal and inland mountain ridges. Large glaciers occupy the head of this valley, but its lower part is free from ice. It is drained by Yakataga River, a large glacial stream about 10 miles long, which discharges into the ocean about 2 miles west from Yakataga Reef.

There is a gradual lowering of these mountain ridges and summits from east to west. Thus the summits on the coastal front ridge descend from altitudes of 5,000 to 6,000 feet on the east to 2,000 feet immediately back of Yakataga Reef through a distance of about 30 miles. The peaks along the second ridge descend from about 7,500 to 3,000 feet through a distance of about 35 miles from east to west, and those which mark the third and highest ridge descend in altitude from about 9,000 to 4,000 feet in the same direction along a distance of about 40 miles. With the decrease in elevation of the Robinson Mountains from east to west their crests become somewhat less rugged in form, their slopes more gentle, and in general they appear more openly spaced, with broader valley areas between them.

From Yakataga Reef eastward for about 35 miles the base of the seaward slopes of the southernmost ridge of Robinson Mountains stands within one-half to 1 mile of the beach. The present beach along this part of the coast is narrow, ranging from 200 to 600 feet in width, and its inner limit is marked by a cut bank from 5 to 50 feet in height that is formed by the undermining and consequent caving caused by the storm surges at high-tide level. West of Yakataga Reef the coastal plain expands to a width of 5 miles and more. Inland the coastal plain merges with the broader valleys. The coastal plain is entirely built of unconsolidated outwash sediments from these valleys, all of which carry streams derived from glaciers.

COAST LINE.

From Cape Suckling on the west to Icy Bay on the east the strand line is remarkably even. With the exception of two small rocky reefs there are no irregularities in the shore line of the Yakataga district, its immediate strand being wholly formed of a direct and regular ocean beach of sands and gravels without any bays or inlets. Although high tides back up into the mouths of several of the larger glacial rivers of the district and form shallow lagoons of some extent, none of these lagoons deflect the regular direction of the strand line, which is built across their entrances in the form of spits and shallow surf-bound bars. Cape Suckling is a rocky headland from which a ridge about 1,200 feet high extends inland for about 10 miles to the Bering Glacier. This ridge separates a lowland surrounding Controller Bay from the coastal plain stretching eastward along the shore to Yakataga.

The larger of the two small areas of rocky shore is named Yakataga Reef (Cape Yakataga) and the other Umbrella Reef. Yakataga Reef is situated about midway of the coastal length of the district, and the rocks forming it extend south from the beach into the ocean about half a mile. It is essentially a wave-cut rock platform about 1,500 feet wide, whose surface stands at the level of mean tide, above which rise two ridges of harder rock that flank its east and west margins. Portions of these ridges stand 10 to 20 feet above the general surface of the platform.

Umbrella Reef lies about 15 miles east of Yakataga Reef. It is a narrow ledge of rock about one-eighth of a mile wide and three-fourths of a mile long that lies parallel with the shore. Little of it stands above high-tide level; consequently for the most part it is surf swept, except at the lowest stages of tide in calm weather.

Icy Bay is an indentation of the coast line at the eastern end of the district. Its entrance is marked by low sand spits, beyond which it extends inland about 10 miles and is about 7 miles wide. Guyot Glacier discharges into the head of the bay, which has been formed recently by the retreat of this glacier. Its availability as a port is discussed on pages 150–151.

DRAINAGE.

Much of the precipitation in the mountains occurs in the form of snow and is carried to lower altitudes by the glaciers. East of Yakataga Reef numerous small watercourses drain directly into the sea, the mountainous parts of their valleys being rather narrow defiles. Of these streams White River is the largest. This river springs from a glacier of the same name, flows westward for about 5 miles, then bends sharply to the south and reaches the sea about 10 miles from its source. Its lower valley is a narrow canyon that has been incised in an old valley floor, now left as a series of gravel-covered benches. White River is important because its gravels contain gold placers. Certain recent changes of drainage of this river will be described in the account of gold placers which is given on page 137.

The drainage west of Yakataga Reef is carried to the sea by several rivers of considerable size. Of these Yakataga River, which rises in a glacier of the same name, flows through a broad valley with rather gentle slope, though broken by gravel benches, for about 10 miles, where it debouches on the coastal plain. The next stream to the west is Duktoth River, which also has a glacial source, but whose headwaters have not been surveyed. The drainage of the western end of the Robinson Mountains is carried by Kaliek River, which has a southeasterly course and empties into a lagoon about 15 miles west of Yakataga River. Between this river and Cape Suckling the many small streams which drain the southern margin of the Bering Glacier empty into the sea.

CLIMATE.

The Yakataga region falls into two climatic provinces. Most of the area standing above 3,000 or 4,000 feet may be said to have an alpine-boreal climate, but the climate of the coastal lowland is temperate. Evidence of this alpine-boreal climate is found in the widespread and, over large areas, almost continuous development of actual glaciation or at least strong incipient glacial conditions in the form of perpetual névé fields. A probable estimate is that half of this part of the Pacific seaboard is now under actual glacial conditions. It may be remarked that these conditions extend below the level of 3,000 feet over considerable areas at many places, especially just east and west from Yakataga district, where the expansive Malaspina and Bering glaciers extend practically to the ocean.

Throughout the district precipitation is excessive. Practically all of it occurs in the form of snow in the higher mountains and chiefly in the form of rain along the narrow coastal plain. These two forms of precipitation dominate their respective zones throughout the year, and both their vertical and horizontal distribution is maintained within quite stable limits. Thus precipitation in the form of rain is rare above an elevation of 5,000 feet, and below that altitude snow falls only during the coldest winter months. The lower limit of perpetual snow is probably a thousand feet below this altitude on many parts of the inland slopes.

There are no meteorologic records for any part of the district. The nearest station is Katalla, where observations of two years indicate a total precipitation of 125 inches. It is safe to assume that at Yakataga the total precipitation is at least 100 inches. This amount is believed to be the minimum annual average for many localities, and in some parts of the province an annual precipitation of 150 to nearly 200 inches probably occurs. During the winter months much of the precipitation in the coast zone occurs in the form of damp snow and sleet. As a rule October is the month of greatest rainfall for the year, and January and February probably have the greatest number of clear days.

The coldest temperatures along the immediate coast are about zero (Fahrenheit), but inland a few miles it is often 10° or 15° colder, especially in the vicinity of large glaciers. Ponds and lakes in the coastal plain freeze permanently late in December, and the larger streams freeze and thaw alternately throughout the winter months.

There is practically no freezing of the ocean water, except occasionally along the beach between tide levels, during extremely cold snaps, and in the shallow brackish tidal estuaries or embayments on the outer margin of the coastal plain. From October to April the average maximum temperature is about 45°, the average minimum about 10°, and the average of monthly means about 30°. During this part of the year there are more distinctly clear days than during the summer, but the average precipitation is about the same. From April to October there are few wholly clear sunny days, most of the days being cloudy or foggy and more than half of them rainy. The precipitation for this period is heavy, amounting to over 50 inches of rainfall. Few of the clear summer days may be considered hot, although the maximum temperature may occasionally rise to possibly 80° for short intervals, during which the great humidity produces a sultry effect if the air is calm. The average maximum summer temperature of this coast zone from April to October is about 70°, the average minimum about 35°, and the average of monthly means for this period about 50°.

VEGETATION.

In the coastal belt, especially below the altitude of 2,500 feet, there is a heavy growth of coniferous trees and deciduous brush wherever the lower slopes, valley bottoms, and coastal plain are of stable character; that is, where the slopes are not so steep as to consist of bare bedrock or rock slides and where the flatlands are of sufficient age for vegetation to have gained a foothold. In favorable localities, both on the coastal plain and along the base of the mountains, where there is good soil and protection from cold winds and flooding by the silt-charged glacial streams, the growth of coniferous trees attains the standing of a forest in size, number, and vigor of individuals. Because of the generally unfavorable conditions for the accumulation of good soil the amount of such timber in Yakataga district is small and scattered in widely separated localities.

Sitka spruce and western hemlock are the chief forest trees. Spruce is usually dominant on the coastal plains and along the broader valley bottoms, where individuals commonly attain basal diameters of 5 or 6 feet and heights of 80 to 125 feet. Hemlock is most abundant on the mountain slopes, especially toward timber line. A few yellow cedar or Alaska cypress trees also are present in the Yakataga district, and large cottonwood trees form considerable groves along open parts of the coastal plain, especially along the moist bars of the larger streams.

Sitka alder, willows, salmonberry, and blueberry comprise the principal brush growth of the district, especially where tree growth is absent or sparse and about the borders of heavily timbered areas. Within the shade of heavy timber growth these brush plants are more or less abundant, but in such situations the prickly devil's-club is most commonly found. A thick growth of rank bracken ferns also occurs wherever the ground is constantly moist, especially in the shade of forest growth. Some sedge grass grows in the lowlands in scattered patches and also a little redtop. These grasses have been cut for hay, though they are of indifferent quality and difficult to cure because of the wet summers. The wild strawberry grows abundantly along many parts of the coastal plain and seems to favor particularly warm sandy soil, such as accumulations about dune tracts.

GEOLOGY.

GENERAL FEATURES.

Three geologic provinces can be recognized in the Yakataga district. First, there is the main St. Elias Range, probably made up of closely folded, more or less metamorphosed rocks, together with igneous intrusives. That part of the St. Elias Range lying north of the Yakataga district is unexplored, but its geology is inferred from what is known of the Yakutat and Controller Bay region. These oldest rocks will not here be further considered. The second province includes the Robinson Mountains, and these are built up of Tertiary and some Pleistocene sediments. This great series of rocks contains fossils, assigned by W. H. Dall to formations ranging in age from Oligocene to Pleistocene and Recent, besides which there is a coal-bearing formation believed to be of Eocene age. These rocks are thrown into a series of folds, in part open, in part closely compressed, whose axes trend about N. 70° W. In certain localities there has been pronounced faulting. No igneous rocks have been found in this series. A third province includes the coastal plain, built up largely of glacial overwash gravels. This report is chiefly concerned with the Tertiary and Quaternary deposits, which contain the known mineral resources of the region.

The Robinson Mountain section comprises a great variety of deposits, most of which are of marine origin. Shales, fine and gritty sandstones, shales and sandstones containing scattered pebbles, pebble conglomerates with a considerable proportion of shaly and sandy matrix, and pebble and cobble conglomerates with little finer-grained matrix comprise all the strata in some form of development. Sandstones form the most massive and shales the thickest and most consistent members of the section. The only limestones observed are thin bands in some of the thicker shale members, several of which are somewhat calcareous throughout several hundred feet of beds, but even in these sandy and gravelly layers are numerous. In general calcareous and sandy shales are more abundant in the lower part of the section, but conglomerate and sandstone beds are also developed there. Thick shale members are likewise present toward the top of the section and thinner layers of shale are interbedded with many of the conglomerates. Some of the pebble beds have a shale matrix containing marine shells.

So far as is now known, with the exception of the bowlder-bearing Pleistocene terrane these variously textured beds of marine sediments can not be arranged into definite lithologic groups. Finer and coarser phases are more or less repeated throughout the thickness of 7,000 or 8,000 feet by vertical alterations and in some localities along the same bed. This horizontal change is most striking in conglomerate beds, which appear to be lenses. Some of the conglomerate members do indicate erosional unconformity, but their development as stratigraphic horizon markers is not persistent for any distance.

The following table is a provisional attempt to subdivide these rocks. It may require some modification when the geologic notes have been more exhaustively studied.

Provisional stratigraphic sequence in Robinson Mountains.

Age.	Lithology.	Approximate thickness.	Remarks.
		Feet.	
Pleistocene	Bowlder-bearing sandstone and shales.	2,000–4,000	This is the same formation described by Russell as the "Pinnacle system." Contains Pleistocene fossils.
Pliocene	Shales and flaggy sandstones and conglomerates.	2,000+	Contains some marine Pliocene fossils.
Upper Miocene	Buff-colored sandstone and shales with beds of conglomerate.	1,000–1,500	A bed of sandstone with some shale about 500 feet thick is included, which contains fossils identified by W. H. Dall as species occurring in the Empire formation (Miocene) of Oregon.
Miocene and Oligocene.	Sandstones and shales and some thin beds of conglomerate. Calcareous shales, thin limestone beds, and some thin beds of conglomerate.	3,000	Contain Miocene and Oligocene marine fossils.
Eocene	Gray fine-grained arkose and black shale and some beds of coal.	2,000±	Probably the equivalent of Kushtaka formation of Controller Bay.

The age assignments in the above table are by no means definitely determined. Though many of the beds carry invertebrate fossils, these are in part so crushed as to be difficult to determine. Moreover, the conditions of the field work did not permit making and transporting large collections. No doubt detailed stratigraphic work and large collections would account for some apparent inconsistencies in the age determinations of certain beds, as noted in the appended list of fossils. It should also be noted that some of the fossils were float material. The determinations of the fossils in the list were made by W. H. Dall.

6678. Bluff at Camp Gulch, northwest side of Icy Bay, about 4 miles northeast of Big River:

Venericardia subtenta Conrad. Miocene.

Tellina (Angulus) cf. albaria Conrad. Miocene.

6679. Float at foot of bench bluffs about 3 miles southwest from west foot of Guyot Glacier, northwest of Icy Bay:
Terebratalia transversa Sowerby. Recent.

6680. Float from Big River outwash flats, probably out of Big River valley, northwest side of Icy Bay:
Priene pacifica Dall. Empire formation (Miocene), Coos Bay, Oreg. Purisima formation, California, upper or Pliocene part.

6681. Float from mouth of Johnston Creek:
Cardium cf. coosense Dall. Miocene.

6682. Float from Johnston Creek below oil seepage:
Mya truncata Linné (?). Recent. Protothaca sp. indet.

6683. Upper Johnston Creek within one-fourth mile of glacier, from angular talus blocks in creek bed:
Spisula precursor Dall. Miocene.
Venericardia castor Dall? Miocene.
Polinices galianoi Dall. Miocene, Pliocene. Astoria, Coos Bay, Oreg.

6684. Johnston Creek, from bluff on west bank about one-fourth mile below glacier and about three-fourths of a mile above oil seepage:
Nucula sp. cf. townsendi Dall. Miocene.
Crenella or Cardium sp.

6685. Bed of Poule Creek, from a spherical concretionary cobble:
Aturia angustata Conrad. Oligocene or lowest Miocene. Astoria, Oreg.

6686. Umbrella Reef, about one-half mile east of mouth of Lawrence Creek, at mean low-tide level:
Chrysodomus oncodes Dall. Recent.

6687. Float from bed of Lawrence Creek near mouth:
Spisula precursor Dall. Miocene.

6688. Float bowlder from bed of Lawrence Creek near mouth:
Spisula precursor Dall. Miocene.
Cardium cf. coosense Dall. Miocene. Coos Bay, Oreg.
Cardium cf. ciliatum Fabricius. Recent.
Fusinus corpulentus Conrad. Miocene. Astoria, Oreg.

6689. Float along bed of Lawrence Creek between foothill entrance to gorge and Fossil Creek:
Priene pacifica Dall. Miocene and Pliocene.
Chrysodomus sp. indet.
Polinices galianoi Dall. Miocene.
Dentalium cf. conradi Dall. Miocene.
Venericardia cf. subtenta Conrad Miocene.
Cardium cf. meekianum Gabb. Miocene.

6690. Float from bed of Lawrence Creek one-fourth mile below mouth of Fossil Creek:
Cardium cf. ciliatum Fabricius. Recent.
Indeterminable bivalve.

6691. Exposures of mouth of Fossil Creek, tributary to Lawrence Creek:
Amauropsis oregonensis Dall. Miocene.
Polinices galianoi Dall. Miocene.
Dentalium cf. conradi Dall. Miocene.
Cardium sp. indet.
Protocardia cf. richardsonii Whiteaves. Recent.

6692. From talus near source of Fossil Creek, derived from bedrock:
Priscofusus geniculus Conrad. Miocene.
Eudolium petrosum Conrad. Miocene.
"Cerithium"? mediale Conrad. Miocene.
Amauropsis oregonensis Dall. Miocene.

Spisula precursor Dall. Miocene.
Phacoides acutilineatus Conrad. Miocene.
Glycymeris cf. gabbi Dall. Younger Miocene.
Tellina (Angelus?) cf. arragonia Dall. Miocene.
Cardium cf. ciliatum Fabricius. Recent.
Thyasira? sp.

6693. Bluff on south bank of White River one-half mile below foot of glacier:
Pecten propatulus Conrad. Miocene.

6694. Mouth of large gulch on south slope of White River valley at foot of glacier; from talus but nearly in place:
Pecten parmeleei Dall. Pliocene. California.
Phacoides acutilineatus Conrad. Miocene.
Cardium sp. indet.
Acila conradi Meek.
Mya truncata Linné. Recent. Macoma sp.
Turritella cf. oregonensis Conrad. Miocene.
Polinices cf. galianoi Dall. Miocene.
Chrysodomus cf. ithius Dall. Recent.
Pleurotoma cf. cammani Dall. Miocene.
Fusinus cf. coosensis Dall. Miocene. Coos Bay, Oreg.
Venericardia crassidens Brodrip and Sowerby. Recent.
Yoldia impressa Conrad. Miocene.
Cancellaria n. sp.
Corbula? sp. indet.

6695. From sandy shale at intake tunnel of the White River Mining Co.'s flume, North Fork of White River:
Pecten purisimaensis Arnold. Pliocene.
Leda cf. minuta Fabricius. Recent.
Mya truncata Linné. Recent.
Thyasira? sp.
Cardium cf. decoratum Grewingk. Pleistocene.
Lysonia sp.
Lepton? sp. ind.
Periploma sp. Recent (?)

6696. One-fourth mile up North Fork of White River above intake tunnel of White River Mining Co.'s flume.
Leda fossa Baird. Recent.
Tellina cf. arctata Conrad. Miocene.
Cardium cf. coosense Dall. Miocene.
Mya truncata Linné. Recent.
Chione securis Shumard. Miocene (Empire formation). Oregon.

6697. Talus material (recent slide) from south face of Island Mountain, north side of main lobe of White River Glacier:
Mya truncata Linné. Recent.
Acila conradi Meek. Miocene.
Chione securis Shumard. Miocene.

6698. Yakataga Reef, shaly and sandy layers just above a massive sandstone member:
Rhynchonella psittacea Gmelin. Recent.
Terebratalia transversa Sowerby. Recent.
Laqueus californicus Koch. Recent.
Astrangia sp.
Gastropod, indeterminable.

6699. Yakataga Reef, from shale 30 to 40 feet stratigraphically above locality 6698:
- Chrysodomus postplanatus Dall. Miocene.
- Chrysodomus sp. indet. (fragments).
- Leda fossa Baird. Recent.
- Cardium sp. indet.
- Arca sp. indet.

6700. West bank Eightmile River, near mouth, near Controller Bay:
- Fusinus cf. geniculus Conrad. Miocene.
- Dentalium cf. conradi Dall.
- Acila conradi Meek. Miocene.
- Macoma cf. calcarea Gmelin. Recent.
- Marcia oregonensis Conrad. Miocene to recent.

6701. Cape Suckling, near Controller Bay:
- Wood with Xylotrya borings.
- Fusinus sp. (fragment).
- Marsia oregonensis Conrad. Miocene to Recent
- Venus cf. parapodema Dall. Miocene.

EOCENE ROCKS.

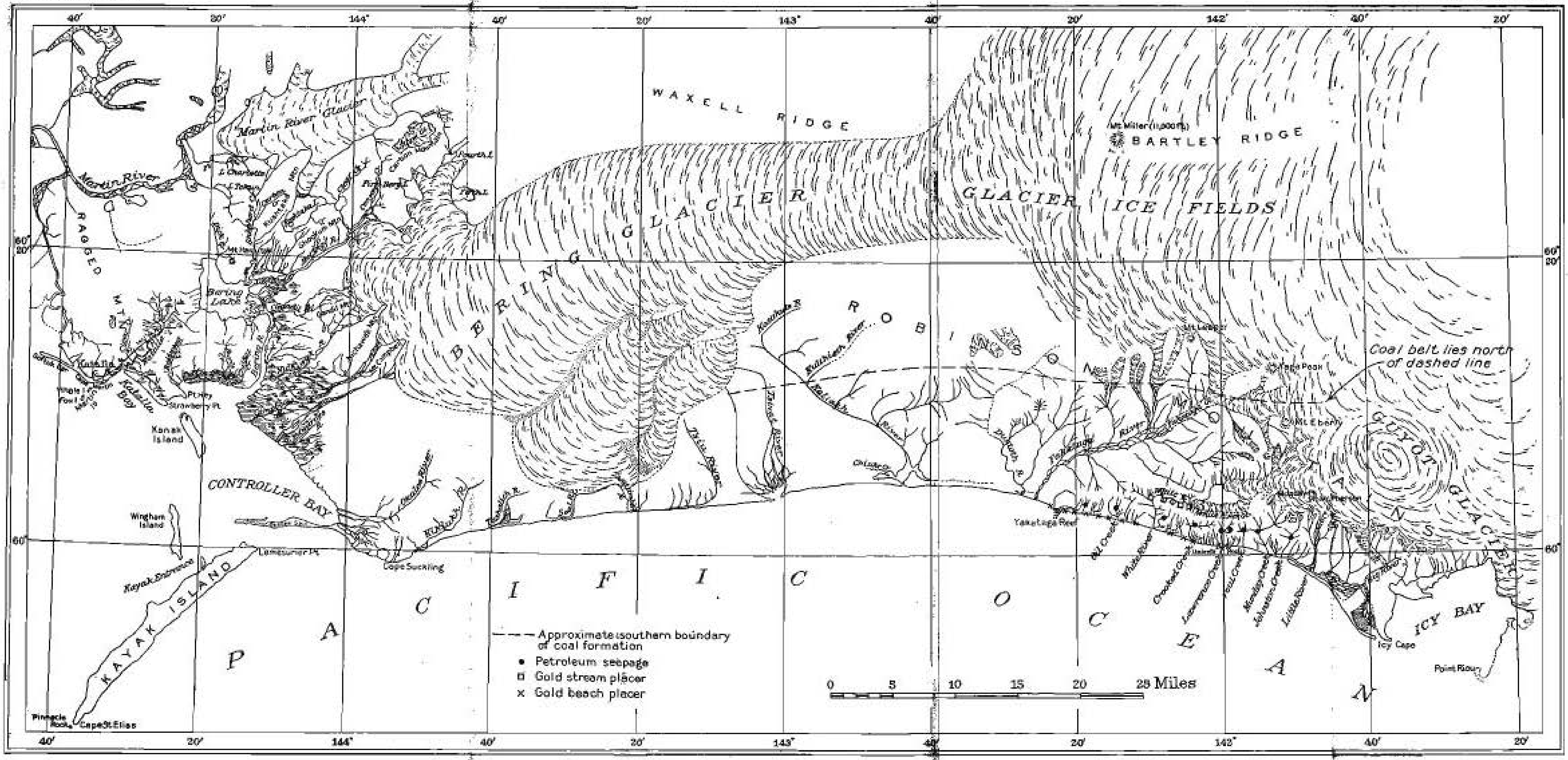
The area believed to be occupied by sediments assigned to the Eocene lies in the northern and least accessible part of the district. Therefore but few field observations were made in this series. So far as known it is made up of fine-grained arkoses or sandstones and black and gray shales and contains some beds of coal. The arkoses probably predominate over the shale. Though no accurate observations in thickness were obtained the entire Eocene series probably measures 2,000 feet. These coal measures are believed to occupy the northern part of the district. The approximate southern boundary is indicated on the accompanying map (Pl. IV). This southern boundary is a fault line along which the coal measures have been thrust up over the younger Pliocene sediments. The northern boundary of the formation lies in the unsurveyed portion of the district.

No fossils were obtained from these Eocene rocks. They have, however, a strong lithologic similarity to the Kushtaka formation of Controller Bay region[1] to the west, with which they are correlated. The Kushtaka carries fossil plants, which the recent studies of Arthur Hollick have shown to be of Kenai age (Eocene).

OLIGOCENE AND LOWER MIOCENE ROCKS.

A belt of what are believed to be Oligocene or lower Miocene marine sediments stretches eastward from Yakataga Reef, marked by a series of oil seepages. This belt consists of calcareous shales and thin limestones, with some interbedded sandstones and a few thin beds of conglomerate. It is essentially a calcareous series. The structure is anticlinal. The evidence of the fossils, which consist of

[1] Martin, G. C., Geology and mineral resources of the Controller Bay region: U. S. Geol. Survey Bull. 335, pp. 31-35, 1908.



MAP SHOWING MINERAL RESOURCES OF THE YAKATAGA REGION.

marine invertebrates, indicates that these beds are either Oligocene or lower Miocene.

These beds are succeeded by a great series of sandstones and shales with some beds of conglomerate, which goes to make up the lower part of the ridge separating the White River valley from the coastal plain and also occurs to the west of the White River valley and near Icy Bay. Similar rocks are found in the second ridge from the coast, separating the valley of White River from that of Yakataga River. At several localities marine invertebrates were found in association with these beds, which led to their provisional assignment to the Miocene.

UPPER MIOCENE AND PLIOCENE ROCKS.

About 1,000 to 1,500 feet of buff-colored sandstone occurs in the upper part of the ridge lying between the coast and White River valley, and similar rocks occur in the two ridges to the westward. In this sequence is included a sandstone member that carries some shale, in which marine fossils were found which were identified by Mr. Dall as species occurring in the Empire formation of Oregon.

This sandstone is succeeded by a great series of buff-colored sandstones and shales, with some conglomerate beds more than 2,000 feet in thickness. These rocks form the ridge between the valleys of White and Yakataga rivers, and also occur in the next ridge to the north, where they are overlain by the Eocene coal measures, brought up by a great thrust fault. Some of these beds carry fossils, on the basis of which the entire series has been provisionally referred to the Pliocene.

PLEISTOCENE DEPOSITS.

The post-Eocene Tertiary rocks that have been described are essentially shallow marine deposits. In Pleistocene time the conditions changed, for the deposits of that epoch in the Yakataga region show the effect of glaciation. These Pleistocene beds constitute a remarkable terrane, whose thickness in the Robinson Mountains is at least 2,000 feet, but may be as much as 4,000 feet, according to local development along its strike. In places this terrane, as now exposed, may be only 1,000 feet thick, but this is probably due to the removal of part of its original thickness by erosion since its uplift into the mountains. This upper part of the Robinson Mountain section is, without doubt, Russell's "Pinnacle system," described [1] by him as occurring in the Chaix Hills and Pinnacle Pass, eastward from Robinson Mountains along the inner border of the Malaspina Glacier. His descriptions of its lithologic character, which is the most distinguishing feature of the

[1] Russell, I. C., An expedition to Mount St. Elias: Nat. Geog. Mag., vol. 3, pp. 170-173, 1891; also Second expedition to Mount St. Elias: U. S. Geol. Survey Thirteenth Ann. Rept., pt. 2, pp. 24-26, 1893.

formation, correspond with its general development in the Robinson Mountains, and the marine fossils he collected from the Pinnacle Pass and Chaix Hills sections also agree faunally with those obtained from the section in Robinson Mountains.

The Pleistocene of the Robinson Mountains section may be briefly described as comprising a thickness of 2,000 to 4,000 feet of massively bedded marine shales and sandstones containing a great number of large and moderate-sized bowlders of granite, greenstone, gneiss, schist, and crystalline limestone of glacial derivation, which apparently have been dropped without arrangement or assortment of any kind from icebergs given off into the ocean by tidal glaciers. These bowlders are embedded in a scattered manner throughout several thousand feet of silty sandstones and shales. This formation occurs at Umbrella Reef on the coast and also in the ridge west of White River valley. Though no evidence of a stratigraphic break was observed between the Pleistocene and the underlying Pliocene, an unconformity might be suspected from the change of physical conditions.

STRUCTURE.

Nothing is known of the structure of the main St. Elias Range. The Robinson Mountains consist, so far as determined, of a series of folds whose axes trend about N. 70° W. A closely compressed fold is marked by the minor valleys along which the petroleum seepages are located. This anticline pitches to the west, its nose being at Yakataga Reef. The northern limb of this anticline includes the rocks west of the White River valley, beyond which there is a syncline. The anticlinal fold is marked by the broad ridge south of Yakataga Valley, and the valley itself occupies a synclinal trough. The next highland mass to the north is anticlinal. There is a great thrust fault along the western limb of this anticline, which has thrust the Eocene over other sediments which are probably Pliocene. These structures are believed to dominate throughout the area, though the possibility of the presence of other extensive faults is not excluded.

The striking tectonic feature exhibited by the district is the fact that the deformation is so recent. Pleistocene beds of glaciofluviatile origin are involved in this folding. Moreover, the topography is largely structural, many of the valleys occupying synclines and the ridges anticlines. The only striking exception to this rule is the erosion along the crest of the first anticline north of the coast

MINERAL RESOURCES.

The known mineral resources of the Yakataga district are placer gold, coal, and petroleum. Gold mining has been carried on in a small way since about 1899. The auriferous beach sands were probably known to prospectors as early as 1897, and the petroleum seepages were discovered about the same time. Surveys have been made of petroleum claims and assessment work has been done, but there has been no drilling. Coal has long been known to be present in the less accessible inland parts of the district, but has received relatively little attention.

PLACER GOLD.

OCCURRENCE.

The developed gold deposits of the Yakataga district comprise beach placers and stream placers. It is known that the gravels of which the coastal plain is built are more or less auriferous, but these deposits have not yet been mined. Nearly all the gold thus far obtained has been recovered by beach mining, though some important developments of the stream placers of the White River valley are under way.

The auriferous area as now known stretches 15 or 20 miles along the coast, but its extent inland is not known except in the White River valley. It is therefore confined to the coastal slope of the southernmost ridge of the Robinson Mountains.

METHODS OF RECOVERY.

As stated above, gold was first found in the beach sands of Yakataga about 1897 or 1898. In 1899 several men began working the beach sands with rockers, amalgamating on copper plates or in the absence of these on silver coins. Mining of this simple character was continued for the next three years at various places along the beach. In 1903 an unsuccessful attempt was made to mine the beach sands with a 6-inch centrifugal pump, the plan being to lift the sand with the gold to boxes for washing and amalgamation. During the autumn of 1903 about 40 men mined the beach sands by hand, using rockers and long toms with copper plates. It is said all these workers did well, the lowest yield for each man being about $600 or $700 and that of a few as much as $2,000 or $3,000. Most of this mining was done along the 4 miles of beach east of Yakataga Reef.

After experience had been gained in recovering gold the rockers were abandoned and an enlarged and improved long tom or sluice box adopted. Copper plates and amalgamation were also discontinued, it being found that when sharp sands were washed not only the amalgam was scoured off and lost but the silver plating also was eroded from the copper plates. Canvas was first substituted for plates and then strips of blanket were substituted for canvas. Later tucks or plaits were sewed across the blankets. The saving of fine gold thus effected with blankets has proved far superior to that by the use of copper plates. The most convenient size for the blanket concentration boxes for hand shoveling is about 16 inches wide and 10 or 12 feet long.

About 300 men were in Yakataga district in 1904, which was the maximum in any one year. Since that time the number has dwindled greatly. In 1913 only about a dozen men engaged in beach mining resided in the district throughout the year.

Placer gold was found in the White River valley in 1902, and a little mining was done in the same year. About 1908 a small hydraulic plant was installed, and this has been operated when there was sufficient water. As will be shown below, this property is now being developed on a large scale.

PRODUCTION.

There are no records of the gold production, and estimates of the output by men who have engaged in mining differ greatly. The estimate of the value of the total gold output ranges from about $150,000 to over $350,000. It is impossible to harmonize the conflicting testimony on gold output. The writer is inclined to accept the lower figures as being nearly correct, and estimates based on these figures are presented in the following table. This table includes the silver production computed on the purity of the gold.

Estimates of gold and silver production from Yakataga district, 1899 to 1913.

	Gold.		Silver.	
	Fine ounces.	Value.	Fine ounces.	Value.
1899	96.75	$2,000	10	$6
1900	145.12+	3,000	16	10
1901	145.13−	3,000	16	10
1902	145.13+	3,000	16	8
1903	725.62−	15,000	80	43
1904	2,418.74	50,000	266	144
1905	1,451.25	30,000	160	98
1906	967.50	20,000	106	72
1907	725.63+	15,000	80	53
1908	967.50	20,000	106	56
1909	483.75	10,000	53	28
1910	483.75	10,000	53	29
1911	387.00	8,000	42	22
1912	435.38−	9,000	48	29
1913	193.50	4,000	21	13
	9,771.74	202,000	1,073	631

BEACH PLACERS.

The gold beach placers were originally distributed along the coast from about a mile west of Yakataga Reef to about a quarter of a mile east of Umbrella Reef, a distance of about 18 miles. Along this stretch the beach sands are still auriferous, though much of the richest placer ground has been mined out. The beach is steep and ranges from 200 to 300 feet in width at low tide. Its upper limit is marked by a scarp from 5 to 30 feet high that is cut into the outer margin of the coastal plain by storm-wave action. The base of this scarp is about 10 to 15 feet above mean high tide. The coastal plain has a width of about half a mile, except in its central part near White River, where it is fully a mile broad. It has the general configuration of a gently graded alluvial fan which extends up the White River valley. A mile from the beach this wide part of the coastal plain is fully 100 feet above sea level. To the east and west, where it is narrower, its inland border stands at an elevation of about 50 feet above sea level.

The surface action of the waves in cutting the margin of this coastal plain and the accompanying concentration of the heavier constituents in its sediments effected thereby, have produced the present beach placers. The gold-bearing beach sands are distributed with a variable degree of concentration along the present shore for a distance of about 8 miles to either side of the mouth of White River. On the east appreciable amounts of gold have been found only a short distance beyond Umbrella Reef, and on the west the beach sands yield nothing of value beyond the mouth of Yakataga River (Pl. IV). The richest concentrations of beach gold were found west of the mouth of White River. Before the beach was disturbed by mining the most continuous layers of gold-bearing sand were found along that part of the coast that extends 4 or 5 miles east of Yakataga Reef. The obstruction offered by this rocky reef to the general westward movement of the sand no doubt has had much to do with retarding a considerable portion of the heavier beach materials to the east of it. It is a significant fact that the gold which occurs in the beach just west of Yakataga Reef is considerably finer than that east of the reef. It is reported that the largest and heaviest beach gold is found within a mile or so of the mouth of White River, and that it becomes finer east and west from that locality. The beach adjacent to the mouth of White River is not favorable for mining, because that stream delivers considerable sand and silt to the ocean. This material is thrown up by the waves in such quantities as to cover the gold-bearing layers. The material itself is not sorted, and hence its gold content can not be profitably recovered. The covering of the beach gold with quantities of lighter top sands in which the fine gold is not concentrated to an appreciable degree is at times more or less characteristic of the whole length of the productive beach and is always present in some parts of the beach.

The gold placers that have been mined occur chiefly near the base of this escarpment but extend down the beach for different distances. As the gold is very fine it is carried farther down the beach in some places and concentrated at favorable spots. The auriferous sand occurs in irregular patches, many of them now mined being only a few square yards in extent and a few inches in thickness. When the district was first developed much larger areas of gold-bearing sand were found. The overburden in the present mining operations is in few places more than a foot in thickness, and much of the concentration is directly at the surface. There seems to be a little fine gold in all the beach sand. Some profitable mining is done by ground-sluicing the upper layer of sand at the margin of the beach near the scarp to a depth of 2 or 3 feet, thus concentrating the gold. The concentrates are then shoveled into the sluice box.

In the early days of mining there were probably well-defined layers of gold-bearing sand. Now the beach has been so torn up and so much of the gold taken out that it is difficult to determine the original character of the deposits.

The beach as a whole is thus undergoing a rather continuous process of natural concentration by the surf. Although this process of washing may be reducing certain parts of the beach sands to such a degree of concentration that fine gold is present in profitable quantities, other parts are receiving such quantities of unconcentrated material from the caving of the coastal plain scarp or from the surf sweepings of contiguous areas that the average tenor of a given number of cubic yards may be reduced far below the limit of profitable handling.

The periods and duration of violent storms in conjunction with the various stages of high and low tides, the difference in height of which ranges from about 4 to 14 feet, are the chief factors of beach concentration along the Yakataga coast. The best concentrations take place during the winter season, but often such concentrations are made along a certain part of the beach only to be dissipated before the gold can be recovered by the miners.

Bedrock is not exposed on the beach except at Yakataga and Umbrella reefs. It is reported by miners that the beach sands have been penetrated to depths of 17 feet and have been found to carry a little gold throughout that thickness. As the beach has a steep slope and it is not known where this hole was sunk, no measure of thickness is revealed by this information. Some holes put down 10 to 15 feet near the upper margin of the beach reached a layer of fine gravel, locally termed "bedrock" by the miners.

Most of the beach gold is bright colored, flakey, and very fine. A flake as large as the head of a pin is exceptionally large. The largest flakes have a value of about 4 cents. There is an unverified report that a gold nugget worth $43 was found on Umbrella Reef. Prospectors report that the gold mined west of Yakataga Reef is not flakey but granular, and that here the percentage of magnetite is greater than to the east.

The most common mineral in the heavy sand is garnet. This forms the so-called ruby sand of the miner, and, together with a small percentage of black magnetite, furnishes a guide in determining the profitable parts of the beach to work. A few small nuggets of native copper are reported to have been found near White River, but no trace of platinum is known to occur in the beach sands, although some heavy zircon sands have been supposed, mistakenly, to contain that metal.

The average fineness of the beach gold is about 0.880, and it contains about 11 per cent of silver. The commercial value of the native gold is about $18.50 an ounce.

The immediate source of the beach gold, as already shown, is in the gravels of the coastal plain. In these gravels the gold appears to be disseminated to such an extent that it can not be mined by methods now in use. The possibility of older beach lines existing in this gravel plain is not excluded, but the reports of the finding of such by prospectors are unverified.

The evidence in hand indicates that the coastal-plain sediments are largely fluvioglacial deposits of White River and possibly of some of the smaller streams. White River has changed its course in recent time, its mouth formerly being much farther west than it is now. The deposition of these coastal-plain sediments took place when the volume of White River and other streams was much greater than now and the waters were more heavily charged with sediments. A coastal plain was thus built, which extended far beyond the present beach line, but how far is not known. There is some evidence that the surf has eaten away 100 or 200 yards of the beach since mining first began in 1899. By this successive inland transgression of the sea, and hence of the strand line, new sections of the coastal-plain gravels have become exposed and their gold content concentrated in the beach to form placers. Such action had long been in progress when mining first began, and hence the first comers reaped the result of this surf concentration of a considerable period of time. The present miners, on the other hand, are dependent for the most part on the concentration now being effected by heavy storms.

It remains to consider the probability of gold placers being present in the coastal-plain sediments. In the absence of the results of actual tests of these sediments, such as may be obtained only by means of a carefully conducted and comprehensive series of drill holes or shafts, no definite statements are possible. There may be old beach lines of concentration similar to the present beach, but it is not thought to be probable, as there is no evidence of a scarp caused by the coastal plain having been eroded back by wave cutting previous to the present one. It is not impossible, however, that some shore-line concentration by transient advance took place along the margin of the coastal plain as it was built out and that these old beaches have been successively buried beneath the advancing sediments of which the coastal plain is constructed. It is not thought that such concentrations were as thorough and consequently as rich as the present beach. It is by no means certain that the entire coastal plain is made of the same material as that on the beach. There may have been an outer bar of sand and gravel back of which fine silts accumulated in lagoons deposited by streams too sluggish to carry gold.

The glaciofluvial nature of the coastal-plain sediments as a whole, and especially in the vicinity of White River, may be used as an argument that all the deposits contain some fine gold more or less uniformly scattered throughout the mass. If prospecting should determine this to be so and that the average gold content of the sediments is sufficient to be profitable, the mining of this deposit on a large scale may prove successful. Such an enterprise should not be entered upon, however, until the ground has been tested. If gold placers are found, they will probably only be such as can be exploited by dredges. The conditions for hydraulic mining in the coastal plain are unfavorable, for the water supply is scant unless long ditches are built. So far as known there is no bedrock to work to, and the sediments are so located as to offer no dump for tailings without elevating sluice boxes. If dredging ground is discovered, the operation is also confronted with difficulties, the most serious being the presence of a large quantity of driftwood in the coastal-plain sediments, including sticks of timber a hundred feet in length. The lack of information regarding depth to bedrock is another deterring factor for a dredging enterprise. On the other hand, the bedrock, if present, will probably be soft. The presence of large glacial bowlders is also not excluded, though such have not been observed. The unfavorable conditions of transportation will be considered below. The favorable conditions for dredging are that operations can be continuous probably throughout the year—certainly for eight or nine months—and that there is excellent timber at hand both for building and for fuel. In addition to the wood, oil is also available for fuel.

STREAM PLACERS.

The known stream-placer gold is confined, so far as known, to White River valley. This river drains a large glacial ice tongue of the same name and discharges into the sea about 7 miles east of Yakataga Reef.

The bedrock formations that now outcrop about the White River basin indicate that it was incised in the marine bowlder-bearing Pleistocene formation and the succeeding fluviatile deposits. Considerable remnants of the fluviatile sediments are still present in the bedrock of the basin in intimate association with the older marine

Pleistocene that here contains an abundance of marine shells. The exposures of these Pleistocene fluviatile terranes indicate a thickness of 400 or 500 feet, much of the material being erratic.

The Recent gravels of the White River basin comprise those of the present stream and those occurring as a bench deposit about the present water level. Both deposits carry alluvial gold, but only the bench placers have been mined. The concentration of the placer gold is probably greater in the narrow bed of the present stream than it is in the benches. To recover this gold would, however, necessitate the turning of the entire river from its present bed.

In the lower part of the White River valley there are only a few remnants of older valley floors, and this material is barren. Some fairly wide benches are developed in the upper valley, especially in that part of its course which lies within a mile of the glacier. The rock-cut benches are best developed along the right side of the valley. Here the channel of the river has dissected the old valley floor to a depth of about 15 feet above average stream level at the upper end of the bench, and to about 35 or 40 feet at the downstream end. This indicates that the present grade of the river is steeper, by 20 or 25 feet in a distance of about 1½ miles, than it was before it dissected its present channel below the grade of the benches, the remnants of an older valley floor. The following notes are largely based on memoranda furnished by Mr. V. Blodgett, who has charge of the mining operations at this locality.

The most extensive of these benches now lies in three somewhat detached strips. In upstream order these strips may be conveniently designated Nos. 1, 2, and 3 for the purpose of separate descriptions, although they were all planated by the same stage of erosion and had their unconsolidated covering of gold-bearing gravels deposited on them by the same stage of stream concentration. Benches Nos. 2 and 3 are virtually coextensive, being separated only by Willow Creek, a tributary stream. This stream has cut away about 1,000 feet of the bench and thus removed a considerable quantity of the gold-bearing gravels. The upper end of bench No. 1 is separated from the downstream end of bench No. 2 for a distance of about a quarter of a mile by a bedrock channel which the river is now making at the base of a projecting spur of the valley slope.

Bench No. 1 has an exposed face of gravel from 15 to 18 feet thick that extends along the river about 900 feet. These gravels rest on top of a rock-cut bench whose surface is 35 to 40 feet above the present grade of the stream. The width of the bench back from the river bank ranges from 300 to 500 feet and even more, but the bedrock slope of the valley rises steeply. Most likely the gravel covering of this bench becomes considerably thinner toward the valley wall. The whole surface of the bench is heavily overgrown with timber and brush.

The gravels in this bench are much smaller in average size, more typically stream assorted, and contain fewer cobbles and bowlders than those in the benches farther upstream. Their higher position above the level of the river affords a better dump for tailings. If ample water is available they should be much more easily hydraulicked than the upstream benches. Their successful exploitation will depend chiefly on whether their gold content is uniformly distributed throughout the deposit, unless parts of the deposit are much richer than is supposed. In view of their glaciofluvial origin it is probable that their gold content is not all concentrated on bedrock, as generally occurs with less vigorously deposited stream alluvium.

Bench No. 2 is a little more than a quarter of a mile long and extends back from the river in some places more than 500 feet. The bedrock surface on which the gravels rest has an average elevation above the river of about 25 feet and thus a fair dump for tailings is afforded. The thickness of the gravels ranges from about 5 to 15 feet, somewhat over half of the gravel deposit being about 15 feet thick. It contains a much larger quantity of coarser material and a great many more large bowlders than the bench described above.

Bench No. 3 is narrower than the two downstream benches previously described. It extends from the mouth of Willow Creek upstream for about one-third of a mile to a point where the narrow stream-eroded part of White River valley opens out into a broad basin near the glacier. This bench, 100 to 200 feet wide, swings around the southeast flank of a rounded knoll of bedrock a couple of hundred feet in altitude that now stands isolated in the valley floor. The knoll appears to be the end of a spur that has been cut off from the mountain slope which bounds the basin on the southeast. The rim of bedrock which marks the surface of the former bedrock floor of this part of the valley stands about 15 feet above the present river level, hence there is not so much dumping room for tailings along this bench as there is for the downstream benches. The unconsolidated bench materials of bowlder, cobbles, and gravel have an average thickness of about 10 feet. Much of the material of these deposits has been already sluiced off. At least 40 and possibly 50 per cent of this deposit is made up of very large cobbles and big bowlders which weigh from a few hundred pounds up to many tons. Small Pelton wheel derricks have been employed to move these bowlders out of the working cuts in the mining operations that have been conducted on this bench in the past, but these do not seem adequate for rapid work, such as is contemplated. Blasting and aerial cables operated by steam hoists probably will have to be used in removing some of these heavy bowlders.

The gravel benches described above are roughly estimated by Mr. Blodgett to contain a total of about 500,000 cubic yards of material that can be hydraulicked. The gold tenor of the deposit as a whole has not been determined by systematic prospecting. Some mining done by hand methods six to eight years ago and some hydraulicking done on the central part of the upstream bench with a small plant have demonstrated the gold-bearing character of this deposit though no high values have been found. The operations so far conducted have been of a somewhat experimental nature. Under efficient hydraulicking, with proper appliances for saving all the gold, the recovery probably would have been improved.

The gold is rather fine, light, and flaky. A few small nuggets are said to have been found. It is estimated that one nugget had a value of about $3. The larger pieces show distinctly the effects of having been rolled out thin, as would be expected by the turbulent stream washing, of which there is abundant evidence. The commercial value of the gold is said to be $18 an ounce.

A small hydraulic plant was installed by the White River Mining Co. on the middle bench in 1908, and this has since been operated as the water supply permitted.

In the spring of 1913 a comprehensive plan for the hydraulic working of the bench ground along upper White River was commenced. This project included the bringing of water for ground-sluicing across the lower end of the glacial basin by means of a flume about 9,000 feet long. The flume is 40 inches wide and 20 inches high. Its intake from the river is tunneled 50 feet through a rocky point to assure a secure connection with the glacial stream, whose violent fluctuations in volume must be reckoned with. The flume line consists of about 7,000 feet of trestle work and about 2,000 feet of grading. Construction work was continued throughout the summer and the hope was entertained of completing it early enough in the fall to make a trial run to test the ground on the lower part of No. 3 bench. It is not known whether this was accomplished, but no doubt actual mining will be conducted during the summer of 1914.

If the operations prove the gold-bearing value of the bench deposits and the practicability of mining them with profit is then demonstrated, the deposits in the depression now occupied by Willow Creek should not be overlooked. This depression has every appearance of having been a former channel of White River when the knoll was the nose of a mountain spur from the eastern slopes of the valley which now rise steeply opposite bench No. 3. The present channel of White River appears to have been cut across this spur and thus formed the knoll. During a stage of this cutting the bedrock platform on which the No. 3 bench deposits now rest was eroded. Since then the river has cut its channel about 15 feet below the surface of the former valley floor at this place, leaving the narrow strip of bench along the border of the knoll on the right side of the river.

SOURCE OF THE PLACER GOLD.

It has been shown that the beach placers are formed by the concentration of gold disseminated in the sand and gravels of the coastal plain and that these, in turn, are probably glaciofluviatile deposits of White River. It is possible that other streams played a part in this formation of coastal-plain deposits, but if so they did not contribute any gold, for none of their gravels are known to be auriferous. There is no direct evidence of the bedrock source of the gold. No mineralization has been found in any of the Tertiary sediments that have been examined, and if any of these carry gold it is probably derived from other sources and deposited as alluvium. On the other hand, the main St. Elias Range is made up of metamorphic and igneous rocks, and the evidence from other parts of the chain indicates that these are locally mineralized. Therefore it is probable that the glacer gold was derived from quartz veins or other forms of bedrock mineralization occurring in the unsurveyed high ranges north of the Yakataga district.

It remains to consider how this gold reached its present position. The source of the beach gold having been traced to the stream placers, it is only necessary to consider these. The White River valley does not reach the metamorphic rocks believed to be the source of the gold but is separated from them by a broad belt of Tertiary terranes. The same is probably true of most of the streams draining the Yakataga district. It is evident, therefore, that the alluvial gold could not have reached its position in the river gravel by action of the present watercourses. If this placer gold has been transported by water, it must have been by an older drainage system, whch reached back into the metamorphic highlands. The Tertiary and Pleistocene sediments of the region are in part probably of fluviatile origin, and there is no inherent reason why some of them may not have carried placer gold. There is, however, no direct evidence that any of the conglomerates and sandstones are auriferous, and in fact the distribution of the present placers indicates that most of them do not contain alluvial gold.

One of these formations may, however, be an exception to this rule, and that is the fluviatile beds of conglomerate and the sandstones that overlie the bowlder-bearing sediments carrying Pleistocene fossils. It has been shown that this formation is abundant in the White River valley, and this is believed to be the immediate source of the placer gold. These rocks have not, however, been tested for gold, so that the proof of its auriferous character is by no means positive. Even if it carries gold, the chances of finding workable deposits are not great. If these ancient placers were rich, their dissection and the re-sorting of their gold contents would be expected to have yielded placers of a far higher gold tenor than those that have been developed in the White River valley.

An alternate hypothesis for the origin of the placers is not to be neglected. This assumes that the gold reached the White River valley by glacial transportation. The erosion of the rocks of the St. Elias Range by glaciers must carry with it the removal of any gold deposits that they contained. In this connection it becomes important to consider the source of the bowlders in the fluvial deposits of the White River valley. These consist chiefly of greenstone, granite, gneiss, and crystalline limestone. None of these rocks occur in the entirely unmetamorphosed sediments of the Robinson Mountains, except as detrital material. They are believed to occur in the St. Elias Range, 30 or more miles inland from the present coast line. These bowlders may have reached their present position by ice transportation. The White River glacier probably has its source in a névé field connected with the St. Elias Range. If this be so, the gold may have been transported by the same agency.

On the other hand, these igneous and metamorphosed rocks do occur abundantly as bowlders and cobbles in the Pleistocene terrane already referred to. The writer is of the opinion that the immediate source of these bowlders and also of the gold is in this Pleistocene terrane—a view which has already been presented. It should be said, however, for the glacial argument of the source of the gold, that some of the Pacific coast placers are known to have been formed by the reworking of ice-borne material. Such deposits at Yakutat Bay have been described by Tarr and Butler[1] and at Kodiak Island by Martin.[2] The distant transportation of gold by glacial ice is also suggested by the occurrence of beach placers apparently derived from glacial débris on Middleton Island.[3] This island is located in the Gulf of Alaska, about 50 miles from the mainland.

PETROLEUM.

All the best-known petroleum seepages of the Yakataga district are located near the base of the seaward slopes of the coastal ridge of Robinson Mountains. (See Pl. IV, p. 130.) These seepages are distributed along a line extending from a point near Yakataga Reef to Johnston Creek, a distance of about 18 miles. They are located from half a mile to 2 miles from the beach. There are about a dozen seepages distributed at irregular intervals along this line, but the extreme easternmost, on Johnston Creek about 1½ miles above its mouth, is the only one of considerable volume. Most of these seepages are

[1] Tarr, R. S., and Butler, B. S., The Yakutat Bay region, Alaska: U. S. Geol. Survey Prof. Paper 64, pp. 165-168, 1909.

[2] Martin, G. C., Mineral deposits of Kodiak and the neighboring islands: U. S. Geol. Survey Bull. 542, pp. 134-136, 1913.

[3] Brooks, A. H., The mining industry in 1912: U. S. Geol. Survey Bull. 542, p. 43, 1913.

little more than meager indications of oil in the form of sulphurous coatings or exudations along joint cracks of the rocks, also as iridescent films over moist rock surfaces and on any small pools of water that may be collected near by. Thick oily residue has accumulated in notable quantity only at the seepage on Johnston Creek. Here the discharge of rather fresh petroleum is free enough to furnish considerable quantities to the swift-flowing, turbulent stream so that appreciable quantities of oil are carried down its course to the ocean. A scum of oily residue also occurs on the cobble bars of Johnston Creek from its mouth up to the seepage. It is probable that a barrel or more of petroleum a day escapes from this seepage. The odor of petroleum was also noted at the mouths of Munday, Poule, Lawrence, and Crooked creeks, small streams that flow across the narrow coastal plain westward from Johnston Creek. (See Pl. IV.) The seepages on these streams are from 1 to 2 miles above their mouths and are not so indicative of the free escape of oil as the one on Johnston Creek.

Prospectors report the occurrence of petroleum seepages in the second ridge of the Robinson Mountains from the coast. Jack Dalton reports that he saw a strong petroleum seepage east of Icy Bay and not far from Yahtsee River. This locality may mark an eastern extension of the Yakataga oil field.

The westernmost of the main line of seepages lies near the base of the mountain slope where it joins the coastal plain, whereas those to the east lie in valleys separated by minor ridges from the seaboard. This line of seepages in part marks a series of east and west extending depressions occupied by the headwaters of streams flowing southward. The chain of depressions between the foothill belt and the main mountain front appears to lie along the axis of a symmetrical anticline, whose south limb is sharply flexed into a nearly vertical position and the dip of whose north limb is 15° to 45° N. All the seepages of petroleum reach the surface along the axial zone of this anticlinal flexure, which strikes about N. 70° W. The rocks, which are sandstones and shales, are provisionally assigned to the Oligocene.

The development of the depressions between the foothill belt of vertical strata and the main mountain front at right angles to the north and south trunk gorge valleys across that belt is primarily caused by the more rapid erosion and removal of material that has occurred along the zone of the anticlinal axis. Here the sharp flexuring of the strata has shattered the rocks, and thus exposed them to the more rapid disintegration and consequent removal by the streams.

The strata at the base of the exposed portion of the section in the vicinity of Johnston Creek seepage are chiefly made up of sandstones that are favorable for either storage or migration of petroleum. These sandstones are overlain by close-textured shales, which may have served as the retentive cover. The liberal escape of fresh oil at this locality might be used as an argument for considering this horizon—the lowest rocks exposed in the coastal mountain ridge—to be at or near the ultimate oil-bearing horizon. This can not, however, be demonstrated without drilling, and there are some strong arguments against this hypothesis which will not here be presented.

Several seepages occur at or near the base of the seaward slopes of the coastal mountain west of the lower White River valley nearly to Yakataga Reef. Here all the outcropping strata belong to the moderately northward-dipping limb of the anticlinal fold, the south limb being covered by the coastal-plain deposits or the ocean. The geologic structure of Yakataga Reef indicates distinctly the plunging nose of the anticline marked by the seepage.

The crest of this anticline appears to have a decided inclination to the west, but the dip is not so marked as that of its terminal nose at Yakataga Reef. This westward inclination amounts to a fall of at least 2,000 or 3,000 feet in the distance of about 18 miles along the seepage belt.

As the ultimate source of the petroleum at Johnston Creek seepage may be near if not at the outcrop from which the free flow of fresh oil comes (about 100 feet above sea level), it may be supposed that the oil-bearing bed becomes progressively deeper westward along the anticlinal axis. If this is so, it must be heavily covered by a greater thickness of strata in this direction. This may account for the more scanty escape of oil at the seepages in the western part of the belt. These views are based on the assumption that there is only one oil-bearing stratum developed along the anticline—the one marked by the free-flowing Johnston Creek seepage. All this is mere assumption, for there may be oil-bearing beds at several horizons in the section. There are in the exposed section several extensively developed porous sandstone and conglomerate members with impervious capping of fine-textured shale that should afford storage for petroleum. Some of these, where under deep cover toward the western part of the anticline, may contain oil. Only intelligently directed drilling will determine these matters.

The evidence in hand indicates that the search for oil should not be nearly so involved with structural complexities as in the Katalla oil field, in the Controller Bay district. In the Katalla field folding and faulting are so intricate that the drilling thus far done has not proved very satisfactory. The essential structural factors presented in the Yakataga seepage belt do not seem to be any more complex than those met in some of the productive fields of California. If anything, the structure governing the occurrence of petroleum in the Yakataga district is probably more simple than that of some of the well-known California fields. If this is true, possibly only a small amount of intelligent drilling will be necessary to prove the commercial value of the Yakataga belt. The inaccessibility of the field and the local difficulties of transportation will be strong deterrents to development. The discussion of transportation is reserved for a later section of this report.

There are no complete tests of the petroleum from the Yakataga district, and, in the absence of any drilling, such as have been made are necessarily of samples taken from seepages in which there has been a loss of the volatile compounds. There is every reason to believe that the Yakataga petroleum is of the same high grade as that of the Katalla field. The Katalla petroleum is a refining oil of the same general nature as the Pennsylvania petroleum. Like that oil, it has a high percentage of volatile compounds, a paraffin base, and almost no sulphur. The following table, taken from Martin's report,[1] summarizes the available information about the composition of the oil from the two fields:

Summary of analyses and tests of Katalla and Yakataga petroleum.

Locality.	Color.	Specific gravity.	Gravity.	Flashing point.	Benzine.	Kerosene.	Lubricating oil.	Residue: Coke and loss.
KATALLA FIELD.			*°Baumé.*	*° F.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Katalla, well, 10[a]	....	0.8280	39.1	....	21.0	51.0	28.0	....
Do.[b]	....	.7958	45.9	....	38.5	31.0	21.5	9.0
Do.[c]	Light green	.7957	45.9	70-80	38.5	31.0	21.5	9.0
Do.[c]	....	.800	....	....	34.2	34.4	16.5	14.5
Do.[d]	Dark red	.802	....	—60	....	....	....	....
Do.[d]	do	.790	....	—60	....	....	....	....
(?)[d]	....	.869	....	....	....	19.0	78.6	1.7
(?)[d]	....	.914	....	....	....	9.0	87.6	2.7
(?)[d]	....	.800	....	....	24.8	53.9	16.7	1.2
Katalla Meadow[d]	Dark brown.	.929	....	240	....	....	....	....
Do.[d]	....	.901	....	156	....	....	....	....
Do.[d]	....	.874	....	156	....	....	....	....
Do.[d]	....	.869	....	152	....	....	....	....
Do.[d]	....	.961	....	266	....	....	....	....
Burls Creek[d]	Dark red-brown.	.942	....	234	....	....	....	....
YAKATAGA FIELD.								
Johnston Creek[d, e]	Dark brown.	.964	....	200	....	....	....	....
Do.[d, e]	do	.879	....	178	....	....	....	....
Poule Creek[d, e]	do	.970	....	250	....	....	....	....
Do.[d, e]	do	.881	....	67	....	....	....	....
Do.[d, e]	do	.914	....	156	....	....	....	....
Crooked Creek[d, e]	do	.921	....	172	....	....	....	....
Oil Creek[d, e]	do	.855	....	108	....	....	....	....
Yakogelty[d, e]	do	.937	....	246	....	....	....	....
Morrison Creek[d, e]	do	.991	....	270	....	....	....	....
Argyll Creek, Icy Bay[d, e]	do	.962	....	310	....	....	....	....

[a] Sample collected by G. C. Martin, test by Penniman and Browne. U. S. Geol. Survey Bull. 335, p. 121, 1908.

[b] Oliphant, F. H., The production of petroleum in 1902: U. S. Geol. Survey Mineral Resources, 1902, p. 583, 1903.

[c] Stoess, P. C., The Kayak coal and oil fields of Alaska: Min. and Sci. Press, vol. 87, p. 65, 1903.

[d] Redwood, Boverton, Petroleum, vol. 1, 2d ed., p. 198, 1906.

[e] The exact localities of seepages where these samples were taken are not known, but they are believed to be in the Yakataga field.

In 1897, soon after the occurrence of petroleum in Yakataga became known, a continuous tract of land about 1½ miles wide and 20 miles long was located and surveyed along the belt of seepages.

[1] Martin, G. C., Geology and mineral resources of the Controller Bay region, Alaska: U. S. Geol. Survey Bull. 335, p. 123, 1908.

This tract included all the known seepages in the coastal ridge of Robinson Mountains and covered the anticlinal axis from Johnston Creek on the east to its westward-plunging nose at Yakataga Reef. The original locations aggregated some 50 square miles or about 32,000 acres. Since then, however, the locators have relinquished much of this land in order to concentrate their assessment work on claims covering chiefly the actual seepages.

COAL.

Relatively few geologic observations were made in what is believed to be the coal-bearing area of the district. The coal field lies chiefly in the higher part of the Robinson Mountains and the surveys reached only its southern margin except along the valley of Duktoth River. Here the mountains were penetrated for a distance of more than 25 miles, and thus a part of the coal field was traversed, but unfortunately not many outcrops were seen, and detailed information regarding the structure of the field and thickness of beds are lacking. So far as known no coal claims have been staked or coal beds prospected in this field.

Though only a few exposures of coal were actually seen in place, the river gravels and glacial débris afforded evidence of a considerable coal field to the north. The gravels of Duktoth River and of the streams draining the Bering Glacier to the west include much coal. What is believed to be the approximate southern boundary of the coal field is indicated on the map; its northern boundary is unknown. Information furnished by prospectors indicates that there is an approximately east and west trending coal belt at least 10 miles wide. This is cut off on the west from the Bering River coal field by the Bering Glacier. Its easterly extension is not known. Coal has, however, been found on the southwestern flank of Mount St. Elias. Broke [1] mentions the occurrence in this area of coal beds 6 and 8 feet thick. Some of this coal he burned in the camp fire. All this evidence goes to show the probability of a considerable development of coal measures in the northern part of the Yakataga district.

As already mentioned on page 130, the rocks of the coal measures are chiefly arkoses, sandstones, and shales and are believed to be of the same age (Eocene) as the coal measures of the Bering River field. It is also believed that the southern boundary is marked by a thrust fault which has brought the coal-bearing rocks on top of the younger Pliocene sediments. The structure of the field is unknown, but in the absence of information to the contrary it is fair to assume that the coal measures are folded and faulted similar to those of the Bering River field.

[1] Broke, George, With sack and stock in Alaska, pp. 86-91, London, 1890.

As only two outcrops of coal were actually examined there are few data concerning the thickness of beds. One of these outcrops occurs in a bluff on Duktoth River about 22 miles from the mouth. The thickness measures 5 feet 6 inches, and the floor and roof are composed of shale. The middle of the bed shows a shale parting about 16 inches thick. Its strike is about N. 80° E., and the dip is 30° N. The second outcrop is located on the slope of Duktoth Valley, 200 feet above the floor and about 25 miles from the mouth of the river. This bed strikes about N. 80° E. and dips 35° N. It includes 4 feet of clean coal and has a shale roof and floor. A sample taken from the outcrop of this bed was analyzed by A. C. Fieldner, of the Bureau of Mines, with the following results:

Analysis of coal from Duktoth Valley, Yakataga district.

	Air dried.	Moisture free.
Moisture	1.05	....
Volatile matter	11.45	11.57
Fixed carbon	64.05	64.74
Ash	22.45	23.69
	100.00	100.00
Sulphur	.66	....

The large percentage of ash in this coal may in part be due to impurities caused by surface weathering, but otherwise this particular coal, though of a bituminous grade, has no commercial value.

Whether there are better coals in the district can only be determined by further prospecting. The chances are that a careful search would be rewarded by the discovery of better coals. On the other hand, the Yakataga coals are so much more inaccessible than those of the Bering River field that even if found to be of the same grade they could not now be exploited for exportation in competition with those of the Bering River field. In view of the abundance of timber and of the petroleum in the Yakataga district it is not likely that any coals found in these high ranges would be utilized, even as a local source of fuel. Therefore the coal of the Yakataga district can not be considered an available asset until the more accessible fuel approaches exhaustion.

HARBORS AND TRANSPORTATION.

The Pacific coast between Controller and Yakutat bays, a distance of about 175 miles, is open to the full sweep of the ocean, with no shelter for even a light-draft launch. The only possible exception is the recently opened indentation at the western margin of Malaspina Glacier, known as Icy Bay. (See description, pp. 150–151.) There are no permanent Indian settlements along this stretch of coast.

In their journeys by boat between settlements at Yakutat and Controller bays the natives occasionally made landings at Yakataga. This is indicated by the name Yakataga, of Tlingit derivation, which means "canoe landing place." The natives evidently so named this rocky reef because they considered it the most favorable place along this part of the coast to land their large dugout canoes.

The white population of the Yakataga district has fluctuated greatly since the first settlement was made, in 1898. Now there are about a score of permanent residents, whereas in 1903 to 1905 there were probably 200 or 300. As Yakataga Reef is the only place along this part of the coast where supplies may be landed with any facility, it has always been, by force of natural conditions, the principal point of settlement. This settlement comprises a straggling collection of log cabins and storehouses which may have numbered 30 or 40 at the time of greatest population. Only about half a dozen of these are in use. Many are dilapidated, and others have been burned for firewood.

During the summer of 1903, when beach mining was at its height, coastwise steamers called at Yakataga Reef, weather permitting, about once a month. This service was discontinued as soon as the early excitement caused by the mining of the richest beach placers had subsided. Since 1903 coastwise steamers have seldom called at Yakataga Reef, for it is not a good roadstead and the condition of the surf is rarely favorable for landing. Moreover, the trade inducements now amount to little.

The great glacier barriers that bound the district on the east, north, and west make it almost inaccessible by land. There is only one overland route of approach and this presents serious difficulties. It follows the shore for about 50 miles from Cape Suckling, at the eastern side of Controller Bay and about 30 miles from Katalla. For 30 miles east of Cape Suckling this route passes along the near-by front of Bering Glacier, and half a dozen swift glacial rivers issuing from beneath the ice must be crossed. All of these streams are more or less dangerous to ford because of quicksands in their constantly shifting channels. Several are so large that they may be crossed by rafts or boats. The others may be forded at times of low water, but this is always a hazardous undertaking even under the most favorable conditions. There are also two swift glacial rivers between the eastern margin of Bering Glacier and Yakataga Reef that must be crossed by boats or rafts. As there are no habitations along this route, it is necessary to carry all supplies for the journey on one's back, and it is also best to transport a canoe. This route is seldom traveled and then only under guidance of those familiar with its dangers. Several men have lost their lives in attempting this trip.

All landings on this part of the coast must be effected through the surf in small open boats. The only favorable place for accomplishing this with even approximate safety is at Yakataga Reef, a low rocky point that juts into the ocean about half a mile. This affords a slight protection from the breaking swell when it is not stormy. Even here it is only possible to make a safe landing at times of very moderate or calm weather. Southeast winds throw breakers against the east side of the reef, southwest winds against its west side, and only at low tide are the rocks not more or less awash if there be any ocean surge.

The supplies needed by the present small population of miners are for the most part brought in launches from Katalla, 85 miles to the west by steamer route and the nearest regular port of call. These launches are navigated by men who closely observe the weather changes and by experience are generally able to foretell the conditions for landing at Yakataga Reef a day or so in advance. At such opportune times quick trips are made with launches along the coast, generally at night so as to arrive at Yakataga Reef in the morning and begin to land the freight through the surf by daylight. This is usually accomplished within a few hours or a day at the most and the return made to the shelter of Controller Bay without delay. By this means the district is served with supplies and mail in an irregular manner at such times as the weather permits and its needs demand. It is not unusual for a month to pass during which no favorable opportunity for landing at Yakataga Reef occurs.

Until recently what is now Icy Bay was occupied by Guyot Glacier. Since 1904, however, there has been a marked change going on along the southwestern margin of the terminal lobe of this glacier. The ice has retreated and a considerable embayment formed. This is known as Icy Bay, which might be used as a harbor for Yakataga district if it were free from drifting icebergs, and if its western shore should prove to be deep enough for anchoring lighters near the land or to afford favorable conditions for the construction of a pier.

The writer's survey of Icy Bay, the results of which are indicated on the accompanying map, was very hasty and accomplished without the use of a boat. Hence no soundings were made and the character of the sea bottom could not be determined.

To determine the possible commercial value of this embayment it will be desirable to review briefly the history of the glacial movements in the vicinity as recorded by several observers during the past 120 years. This matter will be considered in greater detail in the final report. Vancouver[1] was the first to map this part of the coast, which he did in 1794. At this time the bay had approxi-

[1] Vancouver, George, A voyage of discovery to the northern Pacific and around the world, 1790-1795, new edition, vol. 5, pp. 348-409, London, 1801.

mately its present outline. Later the Guyot Glacier, now occupying the head of the bay, moved forward and not only filled the entire indentation but jutted out to sea beyond its confines and thus Icy Bay became Icy Cape and as such has long been known. There have been several fluctuations in the ice front during the past century, but these need not be considered here. It will suffice to state that during the past 10 years the front of Guyot Glacier has retreated about 10 miles, leaving the bay much as Vancouver saw it. The ice cliff of Guyot Glacier, from 200 to 250 feet high and about 5 miles long, now bounds the entire head of Icy Bay and discharges its bergs into it.

The bay, though it presents a 7-mile opening to the south, affords considerable shelter (Pl. IV, p. 130). The ocean surf is broken by a bar which lies off Icy Cape at the southwestern entrance of the bay. Conditions adverse to commercial utilization are (1) the drift ice from Guyot Glacier and (2) the known shoals of the west side of the bay.

The large amount of drift ice in the bay, at least during the summer, would present a great hindrance to boats landing cargoes on its west shore where they would be available to the Yakataga district. Though this is not known to be the condition on the east side of the bay, nothing would be gained by landing supplies there because that area is completely surrounded by impassable barriers of glacial ice.

The west side of Icy Bay, though not sounded, appears to be rather shallow for a distance of at least half a mile from shore. This is shown by the stranding of comparatively small icebergs. In addition to this, smaller masses of ice are generally so closely packed along this shore for a width of a quarter of a mile that even small boats would find it difficult to effect a landing, especially as the ice grinds together when moved by the ocean swell which enters the bay.

There is a question whether piers could be built out from the west shore to deep water that would withstand the damage of this drifting ice. Even if such piers should resist the impacts and pressure of the ice they would certainly furnish obstruction to the free movements of the ice as it now drifts along the shore. As a result, large quantities of ice would accumulate and clog about such artificial obstacles and thus not only make it difficult for vessels to reach the piers but might also damage their hulls. A possible solution to such a problem would be to build two piers, so that all large masses of ice would be excluded from a certain area, thus creating a small inclosed basin in which to moor vessels.

Because of the conditions described Icy Bay is not now available as a landing place for the Yakataga district. It seems doubtful whether the commercial interests to be served will justify the expenditure for improvements necessary to make the harbor available.

A further recession of Guyot Glacier, which is likely to take place, would bring about favorable changes. The glacier might then no longer discharge its bergs into the bay, which would eliminate the drift ice. On the other hand, the advance of the glacier is not precluded, in which event the bay might again be entirely closed to navigation, and any harbor improvements destroyed.

If Icy Bay is ever utilized to serve the Yakataga district it will be necessary to build a wagon road, tramway, or light railroad from its western shore to the placer and petroleum deposits. Probably a tramway, for the construction of which there is an abundance of timber, would be cheaper than a wagon road. Aside from the bridging of several considerable glacial streams, whose channels are ever shifting, such an undertaking would not be difficult.

The transportation of supplies along the coast between Yakataga and Umbrella reefs presents some difficulties. A few horses have been brought to the district and used in a wagon with broad-tired wheels to haul supplies from Yakataga Reef to White River (8 miles) and thence by a wagon road that has been built up that stream for about 2 miles. Beyond the end of the wagon road there is a very rough foot trail to the White River glaciers, totally impassable for horses and even difficult and dangerous for the foot traveler who is burdened with a pack. At low water pack horses can be taken up the White River bars to the glacier. Most of the supplies have been taken up White River in a small dugout canoe, which, when loaded with about 600 pounds, can be dragged up the swift current by two men.

When hard freezing weather begins the discharge of White River and of other glacial streams becomes low and then for a few weeks glare ice forms along most of the river bed. At such times heavy loads may be drawn up the stream on sleds, but heavy falls of soft snow soon cover the ice deeply and make sledding more difficult. Nevertheless, in the absence of well-constructed roads this is probably the most effective method of transporting supplies into this part of the district.

As the beach miners can not afford to keep horses, they transport their supplies along the shore from Yakataga Reef to the places of operation by means of small two-wheeled carts. These they either draw themselves or with the aid of dogs in the same manner as winter sledding is done throughout much of Alaska. A team of dogs will haul 200 to 300 pounds on one of these carts. Times of low tide are chosen for this manner of travel, because the ocean strand then presents a more compact and even road below high-tide level. Even here, however, the wheels of the carts sink into the coarse sandy stretches in spite of their broad tires, and the work of conveying a load of several hundred pounds a few miles along the beach is no easy task. Only small portions of the beach are compact enough to afford firm footing, and considerable stretches of it are too thickly strewn with cobbles and bowlders to render the use of carts satisfactory. This is especially the condition east of Umbrella Reef to Icy Bay, a distance of about 25 miles. Two large glacial streams and several lesser ones debouch across this section of the coastal plain, and thus present obstacles to transportation.

West of Yakataga Reef the many swift glacial streams already mentioned present similar difficulties. Though beach carts may be used along the shore between the rivers, it is necessary to carry them across each stream at some risk, because they are awkward to handle, especially so in the canoes or small boats that are necessary to cross the larger rivers.

Some of the larger rivers may be ascended with light boats, but only at considerable risk. To reach other parts of the inland region it is necessary to carry all supplies on the backs of men, and even this mode of travel is greatly hindered by the heavy timber, much of which is windfallen. Further obstacles are found in the dense underbrush, covering much the larger part of the coastal plain and the valleys up to the glaciers, as well as the steepest mountain slopes up to an altitude of 3,000 feet. In addition to these difficulties the prevailingly rainy or misty atmospheric condition keeps the dense growth of vegetation dripping with moisture that soon thoroughly wets one who travels through it. But the most serious obstacles to satisfactory progress in almost any inland direction are the large glacial streams, which must be forded. The channels of these streams are continually changing in depth and shifting in position. All are so heavily laden with silt that little may be judged of the nature of their beds without actually wading into them. Often a place of safe crossing must be sought for several miles along their courses.

The high mountainous part of the Yakataga district has been traversed only in an exploratory way by parties especially equipped for glacial travel. The feasibility of this has been demonstrated by the indomitable pioneering of the Alaska prospectors, small parties of them having made several trips from Yakataga, across the great interior glaciers, to the upper valley of Chitina River and return. The shortest route by which this journey may be made is said to be over about 50 miles of glacial ice.