RI bureau of mines
report of investigations 5986

RECONNAISSANCE STUDIES OF ALASKAN BEACH SANDS, EASTERN GULF OF ALASKA

By Bruce I. Thomas and Robert V. Berryhill

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1962

RECONNAISSANCE STUDIES OF ALASKAN BEACH SANDS, EASTERN GULF OF ALASKA

By Bruce I. Thomas and Robert V. Berryhill

* * * * * * * * * * * report of investigations 5986

UNITED STATES DEPARTMENT OF THE INTERIOR
Stewart L. Udall, Secretary

BUREAU OF MINES
Marling J. Ankeny, Director

TABLES

RECONNAISSANCE STUDIES OF ALASKAN BEACH SANDS, EASTERN GULF OF ALASKA[1]

by

Bruce I. Thomas[2] and Robert V. Berryhill[2]

SUMMARY

Reconnaissance studies of beach sands along the eastern part of the Gulf of Alaska were conducted by the Bureau of Mines to determine if any of these coastal areas warranted investigations as possible sources of valuable minerals. Because of difficult access and limited transportation facilities only a minimum of sampling, surveying, and camping equipment was utilized to obtain spot samples from key areas as well as information indicating the location, size, and character of the deposits. Such data were obtained from beaches located along approximately 247 miles of the Gulf of Alaska coastline during parts of the 1957 and 1958 field seasons. A total of 201 3-inch-diameter auger holes, spaced roughly at 1 mile intervals, were bored by hand methods to depths ranging from 3 feet to 27 feet; also 33 shovel samples were collected from selected localities. Samples were reduced to a rough concentrate in the field by panning; the rough concentrates were shipped to the Bureau of Mines laboratory at Juneau for further concentration and for petrographic and chemical analyses. Particular attention was given to the heavy-mineral content of the concentrates, although the types and relative amounts of rock-forming minerals were also determined.

The reconnaissance indicated that, generally, the valuable mineral content of the beach deposits was too low to be of further interest except in the vicinity of Yakutat and Lituya Bays where erratic but possibly significant concentrations of magnetite and/or ilmenite were found. At Yakutat, about 20 miles of beachline extending southeasterly from Ocean Cape, yielded samples containing from 1 pound to over 300 pounds of iron and from a trace to over 100 pounds of titanium dioxide (TiO_2) per cubic yard of beach material. However, the higher grade samples represented local concentrations of minor importance. The general tenor of the Yakutat beach, as indicated by the airthmetical average of 27 auger-hole samples, is about 35 pounds of iron and 20.5 pounds of titanium dioxide per cubic yard of beach material. Ilmenite is the predominant heavy mineral of the beach deposits in the vicinity of Lituya Bay, but it was found in concentrations only in limited areas near the

[1] Work on manuscript completed February 1960.

[2] Mine examination and exploration engineer, Alaska Office of Mineral Resources, Bureau of Mines, Juneau, Alaska.

mouth of Eagle Creek, between Lituya Bay and Steelhead Creek, and near the outlet of Crillon Lake. Auger-hole samples from these areas indicated a titanium dioxide content (as ilmenite) of 20 to 52 pounds per cubic yard. Because of equipment limitations, samples could not be obtained from deposits of coarse or unconsolidated gravel or from below the water table.

The principal heavy minerals occurring in most of the beach sand concentrates are magnetite, garnet, and ilmenite, with lesser to trace amounts of rutile, zircon, chromite, and gold. Traces of platinum have been reported from sands adjacent to Cape Yakataga and Lituya Bay, but none were detected during this study. All samples were tested for radioactivity; only trace amounts were detected.

INTRODUCTION

Black sands are known to occur in unconsolidated marine deposits at many localities along the 6,640 miles of Alaska's coastline. The easily accessible beaches have long been prospected for gold and in some localities, as at Nome on the Seward Peninsula, have been enormously productive. Prospecting for other minerals in these deposits has been either cursory or entirely neglected. If no indications of gold in paying quantities were found on preliminary examination, the beach deposit received little or no further attention. Some less accessible areas, such as those along the eastern coast of the Gulf of Alaska, have been recognized as containing potentially commercial black sand deposits. Some gold has been recovered from these deposits, notably in the vicinities of Cape Yakataga and Lituya Bay. However, few attempts have been made to evaluate the accessory heavy-mineral content.

During the summer of 1957 and May of 1958 the Bureau of Mines conducted preliminary studies to indicate the heavy-mineral content of the beach sands along the eastern shoreline of the Gulf of Alaska. The purpose of the study was to spot-sample key areas with a minimum amount of equipment to determine if detailed studies would be warranted. Physical and chemical studies were made in the laboratory on field samples.

The geological formations in the region behind the Gulf coast are considered favorable host rocks for mineral deposits. The extremely rugged topography, many live glaciers, turbulent streams, and severe storms make entry into this back region difficult and sometimes hazardous. These conditions, however, are favorable to rapid erosion of mineral deposits in the glaciated areas and for concentration of minerals along the comparatively narrow, low lying beaches. Reconnaissance studies of the heavy-mineral content of these beaches provides an indication of the character and of mineralization in the adjacent mountainous regions.

ACKNOWLEDGMENTS

Fieldwork along the Gulf coast was greatly aided by use of Federal Aviation Administration facilities at Yakataga and Yakutat. Federal Fish and Wildlife Service accommodations and transportation facilities at and near Yakutat contributed much to the field accomplishments.

Special acknowledgment is extended to Mr. George Nelson of Icy Bay for his kind and courteous assistance to the field crew while they were working in that area. The many services and courtesies, as well as helpful suggestions, given by the fishermen along the coast are greatly appreciated. Detail maps of the areas studied are modified from maps of the Geological Survey.

LOCATION AND ACCESSIBILITY

The area investigated is approximately 247 miles long and comprises a narrow strip of coastline along the Gulf of Alaska between the Kiklukh River (latitude 60° 01' N.; longitude 143° 50' W.) and Icy Point (latitude 58° 25' N.; longitude 137° 10' W.) (figs. 1 and 2). Icy, Yakutat, and Lituya Bays provide the only sheltered anchorages along this section of coast.

During favorable weather the area is readily accessible by airplane or by boat; experienced airplane pilots and boatmen travel the coast with relative ease. The area is subject to severe storms common to the Gulf of Alaska.

Yakutat, situated on a bay of the same name and about midway along the Gulf coast, is the largest settlement in the area. It has a permanent population of about 300, two general stores, a bulk fuel oil and gasoline dispensing depot, a post office, and a radio station. Yakutat also has the only protected harbor that can accommodate large ocean-going vessels. The harbor and port facilities are adequate for present needs of the community and surrounding area. A large airport, about 4 miles from town, can accommodate and service multimotored aircraft. This facility is operated and maintained by the Federal Aviation Administration. The U.S. Coast Guard operates an aid-to-navigation station near the entrance to Yakutat Bay. The Fish and Wildlife Service maintains a field station at Yakutat during the commercial fishing season.

Large ocean-going vessels will deliver freight to Yakutat from West Coast and Alaskan ports when consignments aggregate enough tonnage to justify stopping at the port. During the commercial fishing season, small boats frequently call at Yakutat. Small vessels seek the sanctuary of Yakutat's protected harbor during severe storms on the Gulf. Large, multimotored air transports, flying between Anchorage and Juneau, stop twice weekly to discharge mail, passengers, and freight. Several small aircraft are based at Yakutat to service the coastal area on a nonscheduled basis.

Most of the travel within the coastal region is done in small airplanes with wheel landing gear. Good landing areas are plentiful along the hard packed sand beaches. In addition to the beaches, there are small airstrips which have been constructed at selected locations along the coast (figs. 3, 4, 6, 7, and 8).

In the summer fishermen move along the coast in their small boats. This means of travel is slow and uncertain because of frequent storms. These fishermen are exceptionally skilled boatmen, and they are well acquainted with the coastal waters. They navigate the estuaries of the many large streams that discharge into the Gulf as well as the treacherous entrance to Lituya Bay and the dangerous ice floes of Icy Bay.

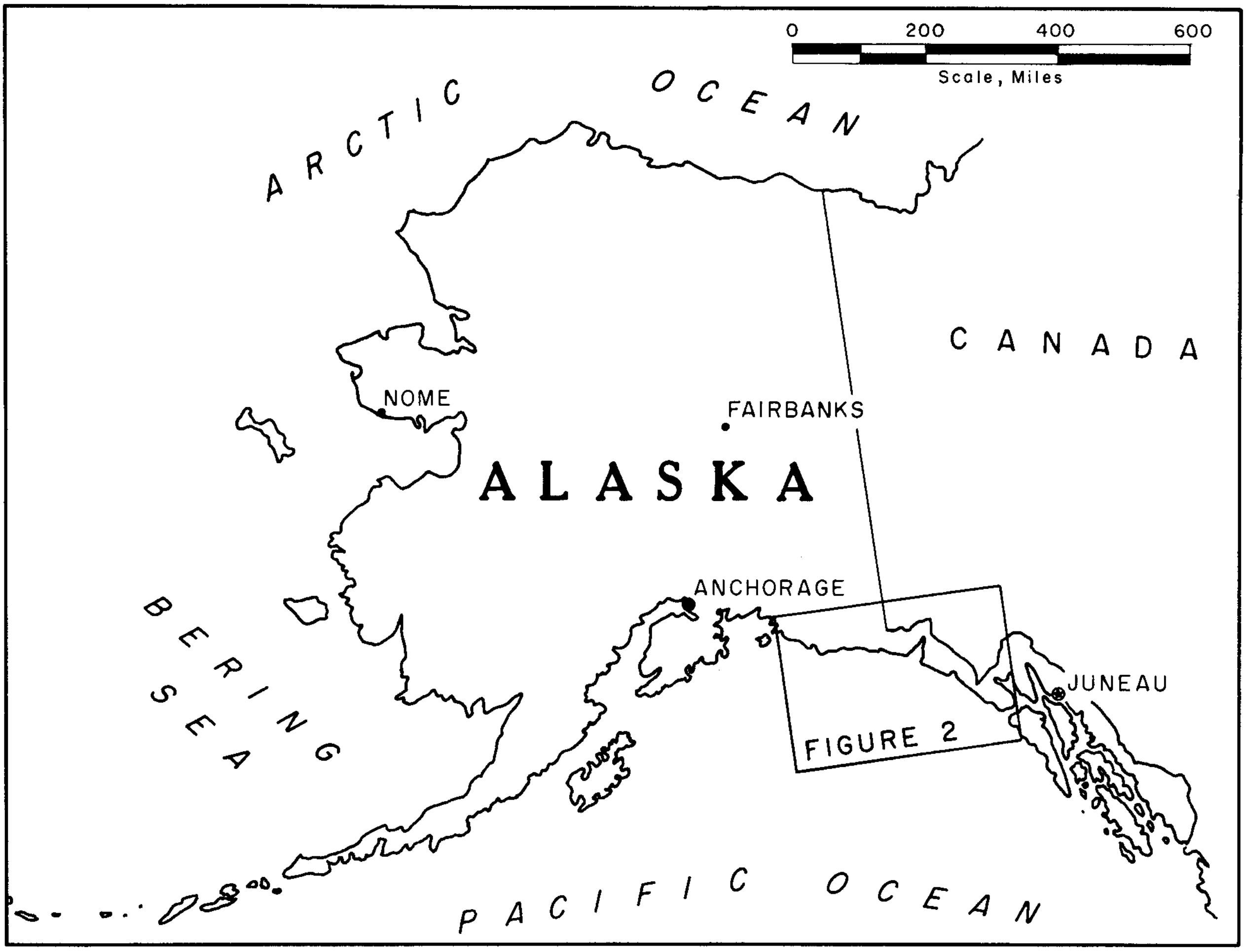


FIGURE 1. - Index Map of Alaska.

Yakataga, a small settlement near the Duktoth River (fig. 5), is the distribution center for the section of coast extending from Cape Suckling east to Icy Bay. The airport at Yakataga is maintained and operated by the Federal Aviation Administration and is large enough for air transport planes. Although Yakataga has about 30 permanent residents, there are no stores or facilities to serve the public. A weekly mail service is maintained by air carrier from Cordova, 150 miles to the west. Charter flights from Cordova can be arranged with scheduled and nonscheduled carriers at that city. During the field investigation a small aircraft with wheel landing gear was available at Yakataga for charter flights along the coast.

The coast in the vicinity of Yakataga is open to the full sweep of the ocean with no shelter for even a small boat. All landing on this part of the coast must be made through the surf, except near Cape Yakataga where there is some protection during calm weather. In the early days large vessels anchored in the Yakataga roadstead and lightered supplies ashore in the protection of the reef. Today most heavy freight is shuttled by barge from Cordova and is landed on the Yakataga beach during calm weather.

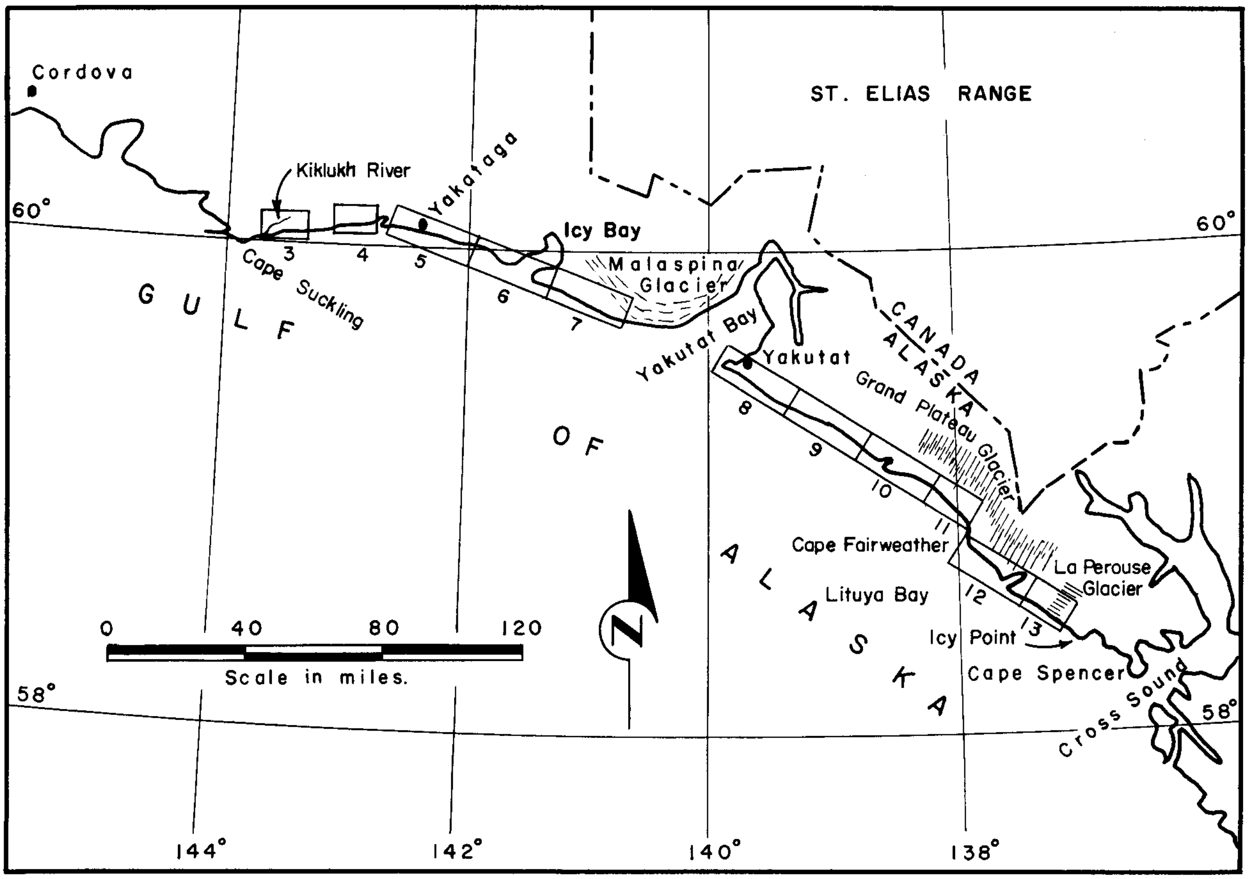


FIGURE 2. - Map of the Area Studied.

There are only a few miles of graveled roads along the eastern Gulf coast. Individual automotive operations are limited by the large streams entering the Gulf. Travel by car or truck is limited to those areas in and adjacent to Yakutat and Cape Yakataga, and to some areas between the larger streams and rivers.

PHYSICAL FEATURES AND CLIMATE

The St. Elias Range, with its many snow-covered peaks 8,000 to 18,008 feet in altitude, is the most prominent feature of the eastern Gulf of Alaska. Amid the peaks of the mountain range is a vast icefield which feeds the huge glaciers that extend almost to the coast. Along the coastal flank of the precipitous range are relatively steep fronted foothills from 3,000 to 4,000 feet high. The foothills are separated from the Gulf of Alaska by a coastal plain which varies in width from one-fourth mile to 15 miles.

The coastline is relatively uniform except where it is broken by Icy, Yakutat, and Lituya Bays. These bays cut back into the relatively steep fronted foothills where the lobes of glaciers reach the margins of the bays' inland waters.

Sandy beaches, which are constantly pounded by the surf, characterize most of the ocean-fronting tidal zone. The exceptions are short beach sections comprised of coarse glacial moraine, notably at Malaspina Glacier, the entrance to Yakutat Bay, Cape Fairweather, and the entrance to Lituya Bay. The coast is cut by many large glacial streams that issue from the icefields of the back country. These streams are swift, muddy, subject to large seasonal variations in flow, and have developed pronounced coastal flood plains. Many smaller clear-water streams flow from the foothill country and cut the coastline. Long sand spits have developed at the estuaries of these clear-water streams. The northwesterly trend of the spits indicates the direction of the onshore ocean currents and major storms.

The coastal plain and the lower slopes of the foothill range are covered with dense vegetation consisting of many varieties of berry and thorned bushes, willow, and alder. Much of the coastal plain is covered by moss, small lakes, and grass-covered bogs. Grass and strawberry plants grow profusely along the crests of the sand dunes that parallel the coastline. Timber is generally small and consists mainly of spruce and hemlock. Inland and to the south of Lituya Bay, spruce grows as large as 8 feet in diameter. Most animals common to Alaska live in the region.

The Gulf of Alaska is generally quite placid during the summer, but severe and often lengthy storms occur from early fall to late spring. The warm gulf stream has a marked affect on the climate of the low coastal foreland. The summers are warm, and the winters are relatively mild. At Yakutat the temperatures range from a summer high of 84° F. to a winter low of minus 15° F. The total annual precipitation varies from 112 inches at Yakataga to 135 inches at Yakutat. The wet month is usually October, and the dry month is usually June.

HISTORY AND PRODUCTION

Beach sand deposits along the Gulf of Alaska coast have been worked for their gold content at various times during the past 100 years. There is no record of these deposits ever being worked for other minerals. The discovery of ruby-tinted black sand containing gold created a minor gold rush at Yakutat Bay during the year 1887.[3] Auriferous sands were found on the western beach of Khantaak Island, on Logan Beach, and at many points along the shores of Yakutat Bay. The deposits at Black Sand Island were also mined for their gold content around the turn of the century. Gold production from the deposits in the vicinity of Yakutat Bay was carried on in a desultory manner for many years. Figures are not available, but production is believed to have been small.

The beaches along the Gulf of Alaska in the vicinity of Lituya Bay were mined sporadically for their gold content by the Russians until Alaska was purchased by the United States in 1867. The first work by Americans was done in 1894; 1896 was reported the best year for mining when 150 to 200 men were

[3] Tarr, R. S., and Butler, B. S., The Yakutat Bay Region, Alaska: Geol. Survey Prof. Paper 64, 1909, pp. 164-170.

at work along the beach. Gold-bearing sands occur from 2 to 16 miles northwest and 4 to 9 miles southeast of the entrance to Lituya Bay. An estimated $75,000 in gold was recovered by the year 1917, but there is no record of any substantial production since then.[4]

Gold was first discovered in the beach sands at Yakataga in 1897 or 1898. Auriferous sands extend for a distance of about 18 miles along the coast from a point 1 mile west to a point approximately one-quarter of a mile east of Yakataga Reef. An estimated $320,000 in gold had been produced through 1930. Mining has been carried on intermittently since 1930, but no production figures are available.[5] [6] During the summers of 1955 and 1956, considerable attention was directed toward the radioactive mineral potential of the beach deposits near Yakataga. Several prospectors as well as two private concerns conducted bore-hole sampling programs along the deposits fronting the tidal zone.

During the summer of 1957, a private concern was actively engaged in investigating the magnetite content of beach sands near Yakutat and Lituya Bays. Work consisted of churn-drill hole sampling of deposits near Black Sand Island and on a section of beach about 4 miles northwest of Lituya Bay.

PROPERTY AND OWNERSHIP

Beach deposits in the Yakataga, Yakutat, and Lituya Bay areas are only partially covered by placer claims; no attempt was made by the authors to accurately determine claim boundaries or ownership. No known patented placer-mining claims are held in any of these areas.

In the vicinity of Cape Yakataga, 73 placer claims, each covering about 20 acres, are held and maintained by several owners. The descriptions of these claims and the names of the claimants are on file in the recording office at Cordova.

Beach deposits in the Yakutat area are covered by 76 placer claims on Black Sand Island and along the estuary and lower stream course of the Ahrnklin River. In the Lituya Bay area, the beach deposits extending from the entrance of Lituya Bay westward to the Cape Fairweather lobe of Grand Plateau Glacier are covered by 160 standard placer claims. Beach deposits between the entrance to Lituya Bay and La Perouse Glacier are held with 14 placer claims. The descriptions of mining claims held in the Yakutat and Lituya Bay areas and the names of the claimants are on file in the recording office at Juneau.

---

[4] Mertie, J. B., Jr., Notes on the Geography and Geology of Lituya Bay, Alaska: Geol. Survey Bull. 836, 1933, pp. 117-135.

[5] Maddren, A. G., Mineral Deposits of the Yakataga District: Geol. Survey Bull. 592, 1913, pp. 119-153.

[6] Smith, P. S., Past Placer-Gold Production From Alaska: Geol. Survey Bull. 857, 1933, pp. 93-98.

GENERAL GEOLOGY AND DESCRIPTION OF DEPOSITS

The geology of the eastern Gulf of Alaska region has been described by Blackwelder,[7] Martin,[8] Mertie,[9] and others. The following brief discussion is based on a summary of the geological information contained in the various publications and on field observations by Bureau of Mines engineers.

The sands along the tidal zone are the products of marine erosion, transportation, and deposition. They are the result of abrasion of glaciofluvial material by wave action. The streams and rivers flowing from the icefields of the foothills and back country are building a plain of sand, gravel, and silt out into the Gulf. The strong ocean currents sweep the sand along the coast where it is deposited in bars and spits.

The coastal plain is glacial detritus that in places, notably between Yakataga and Icy Bay and near Lituya Bay, is being attacked directly by wave action. The broader expanse of the coastal plain northwest of Yakataga and between Yakutat Bay and Grand Plateau Glacier is composed of glaciofluvial material that at one time had been worked by the action of the sea. The remnants of old shorelines are evidence of the withdrawal of the sea because of a gradually rising coastline.

The foothills are composed of sedimentary and metamorphosed sedimentary rocks that have been subjected to intense folding and faulting. Some evidence of the oil potential in these rocks is shown by invertebrate fossil remains of marine origin and by many oil seeps found in the vicinity of Yakataga and Icy Bay.

Boulders and pebbles of igneous rocks are a common constituent of glacial detritus along the coastline. These rocks comprise various phases of both acidic and basic intrusives and are indicative of the rocks that will probably be found in the precipitous back country. The garnetiferous metamorphic equivalents of both sedimentary and igneous rocks, commonly found along the shore near Lituya Bay, indicate zones of contact metamorphism that are either obscured by moraine or occur beyond the investigated area.

The black sand minerals, notably magnetite, ilmenite, and rutile, are probably derived from the basic igneous rocks of the region. The abundant garnet is probably of contact metamorphic derivation.

The coastal region around the head of the Gulf of Alaska is one of the great seismic regions of the world. Uplifts of 47 feet have been recorded in the Yakutat Bay area.[10] Earthquakes originating in the vicinities of Yakutat

---

[7] Blackwelder, Eliot, Reconnaissance on the Pacific Coast From Yakutat to Alsek River: Geol. Survey Bull. 314, 1907, pp. 82-88.
[8] Martin, G. C., Preliminary Report on Petroleum in Alaska: Geol. Survey Bull. 719, 1921, pp. 34-42.
[9] Work cited in footnote 4.
[10] Tarr, R. S., and Martin, Lawrence, The Earthquakes at Yakutat Bay, Alaska, in September, 1899: Geol. Survey Prof. Paper 69, 1912, p. 21.

and Lituya Bays have caused physical changes in the glaciers and shorelines; the effects of waves, avalanches, and faulting are evident. Ground subsidence and waves caused by earthquakes have claimed lives in both Lituya and Yakutat Bays; a devastating earthquake in July 1958 took the lives of three people on Khantaak Island, Yakutat Bay, and two people in Lituya Bay.

WORK BY THE BUREAU OF MINES

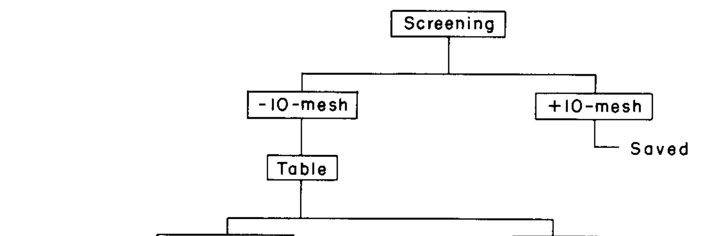
Field Investigations

The objectives of the Bureau of Mines work, along 247 miles of narrow coastline in the eastern Gulf of Alaska, were to determine the heavy-mineral constituents of the sandy beaches and to ascertain which areas have the heaviest concentrations of these minerals. The work consisted of spot sampling the beach sands with auger borings or shovel samples; the samples were pan-concentrated in the field, then analyzed physically and chemically in the laboratory.

The Bureau of Mines program began May 5, 1957, recessed from September 3, 1957, to May 6, 1958, and was completed on May 28, 1958. During the field investigations 201 auger holes were drilled by hand; total footage drilled was 1,732 feet. Test holes were spaced at intervals of 1 mile or less along the sand beaches; a total of 33 shovel samples were collected to supplement the auger test holes. Much of the travel between drill holes was on foot, requiring back-packing of sampling equipment and samples.

Laboratory Investigations

Beach-sand samples submitted to the laboratory for physical and chemical analyses were treated as shown on the following flowsheet.



NOTE: eU= Radiometric uranium equivalent.

The samples were weighed upon receipt at the laboratory. The screen, table, and magnetic separation products were weighed; iron, TiO_2, and eU (radiometric uranium equivalent) analyses were completed, and the results were recorded in percent. The weights of metals in the sample products were computed from these data. Petrographic examinations were made of the nonmagnetic fraction of approximately every fifth sample to determine its mineral constituents. Several samples were too small for table treatment, and others contained insufficient light material to justify table concentration.

Mineral-dressing tests were conducted on samples taken in the Yakutat area. Representative cuts of the original samples were screen-sized. Magnetite was removed from each sized fraction with a hand magnet; the nonmagnetic portions were subjected to radiometric and chemical analyses.

Sampling Methods and Equipment

Frequent moves along 247 miles of coast required the selection of light and easily portable sampling equipment that would extract fairly representative samples from semicompacted beach sands. At most localities it was necessary to back-pack equipment between boring sites, but moves from area to area were usually made by small airplane.

Before the investigation along the Gulf of Alaska, preliminary tests were made along readily accessible beaches of the Kenai Peninsula, Alaska, with various types of hand-operated soil-testing equipment; an Iwan auger was selected as best suited for the spot-sampling program. Holes to 27 feet in depth were attained with a 3-inch Iwan auger in semicompacted beach sands. With caution, a fairly uniform open hole (without casing) could be bored and sampled to this depth in 1½ hours. The Iwan auger is not satisfactory for use in dry, loose, or water-saturated sands or gravel, but outside these limitations, samples usually can be obtained that will be roughly representative of the beach area. A light, compact, and readily portable bore sampling kit, consisting of the items listed in table 1, was used during the field investigation.

TABLE 1. - Bore sampling equipment

Quantity	Size	Description
1	3-inch	Iwan auger.
6	1-inch x 5-foot	Aluminum pipe with coupling.
5	1-inch	Pipe coupling.
2	14-inch	Pipe wrench.
1	1-inch	Pipe die nut.
1	-	Tee-handle for auger.
3	16-inch	Gold pan.
1	No. 2	Wash tub, galvanized.

Bore-hole records show the location, depth of hole, and material penetrated. Most of the holes were bottomed in water-saturated sands or loose gravel. The boring or bulk sample from each hole was measured loose in a gold pan, then reduced to a rough concentrate by panning. The rough concentrate was shipped to the Bureau of Mines laboratory at Juneau for additional concentration and analyses.

A few shovel samples were taken from natural concentrations of black sands. They were not concentrated in the field but were shipped as bulk samples to the laboratory.

The percentage of heavy mineral recovered in the pan concentrate was determined by panning efficiency and by judgment in selecting the satisfactory panning end point; the desired end point was 100-percent heavy-mineral recovery. Laboratory results and field observations indicated that the percentage of heavy-mineral recovery decreased as total heavy-mineral content increased. Field checks indicated almost 100 percent recovery in samples containing few heavy minerals.

Calculation of Sampling Results

The auger holes were not of uniform diameter because of sloughing from the walls. Therefore, without refined methods of core control, a volume computed by using the diameter of the auger and depth of hole was considered unsatisfactory. The measured volume loose (pan count times volume per pan) of the boring from each hole was used instead to determine the approximate in-place volume. Field measurements indicated that beach sand had a swell factor of about 1.48; the in-place volume was computed using this swell factor. Contained metals were calculated in pounds per in-place cubic yard.

Areas Investigated

Bering Glacier

Access to the beach deposits between Cape Suckling and the Duktoth River is gained by use of a small bush plane; landings are made along the beach. The rivers dissecting the area, notably the Seal, the Tsiu (not shown), and the Kaliakh, are glacial, deep, and have tidal estuaries. Traveling this section of coast on foot would necessitate fording these rivers, which would be hazardous during the summer and impossible during most of the remainder of the year.

Twenty-nine auger-hole samples and three shovel samples were taken from the beaches between the Kiklukh and Seal Rivers and between the Tsivat and Kaliakh Rivers in the Bering Glacier area (figs. 3 and 4). The lack of heavy minerals in these sands indicated detailed physical and chemical analysis of all samples would not be justified; three representative bulk samples (total hole recovery) were treated according to the flowsheet previously shown. A summary of the bulk sample results is shown in table 2. The pan concentrates of 26 holes and 3 shovel samples were analyzed for acid soluble iron, tested for eU, and examined petrographically. A summary of petrographic examinations of nonmagnetic fractions is shown in table 3; auger-hole and shovel sampling results are shown in table 4.

TABLE 2. - Bulk sampling results, Bering Glacier

	Sample number		
	218	232	233
Total depth in feet...........	20.8	11.1	22.6
Material at bottom of hole....	Water	Sand	Water
Adjusted measured volume loose, cubic yard............	0.050	0.026	0.053
Table concentrate:			
Magnetic fraction:			
Pounds iron per cubic yard	1.1	0.4	1.7
Pounds TiO_2 per cubic yard	0.3	0.1	0.4
Petrographic analysis.....	Fine grained titaniferous magnetite in quartz and shale.	Fine grained titaniferous magnetite in gangue.	Fine grained titaniferous magnetite in gangue.
Nonmagnetic fraction:			
Pounds eU per cubic yard..	None	0.007	None
Petrographic analysis.....	Chiefly quartz, altered plagioclase feldspar, epidote, and hornblende. Small amounts of garnet and orthoclase; traces of zircon, olivine, chlorite, apatite, chromite, and ilmenite. No tin minerals or scheelite.	Chiefly epidote crystals, with less chlorite, quartz, hornblende, and garnet. Traces of altered feldspar. No tin minerals, chromite, ilmenite, zircon, or scheelite.	Aggregates of fine minerals including chlorite, epidote, quartz, hornblende, and garnet. No tin minerals or scheelite.
Table reject:[1] Petrographic analysis.	Quartz, chlorite, altered plagioclase and epidote, with less hornblende and shale fragments.	Quartz, altered feldspar, dark shale fragments, some chlorite and epidote.	Quartz and quartz aggregates and dark shale fragments.

[1]No eU in all samples.

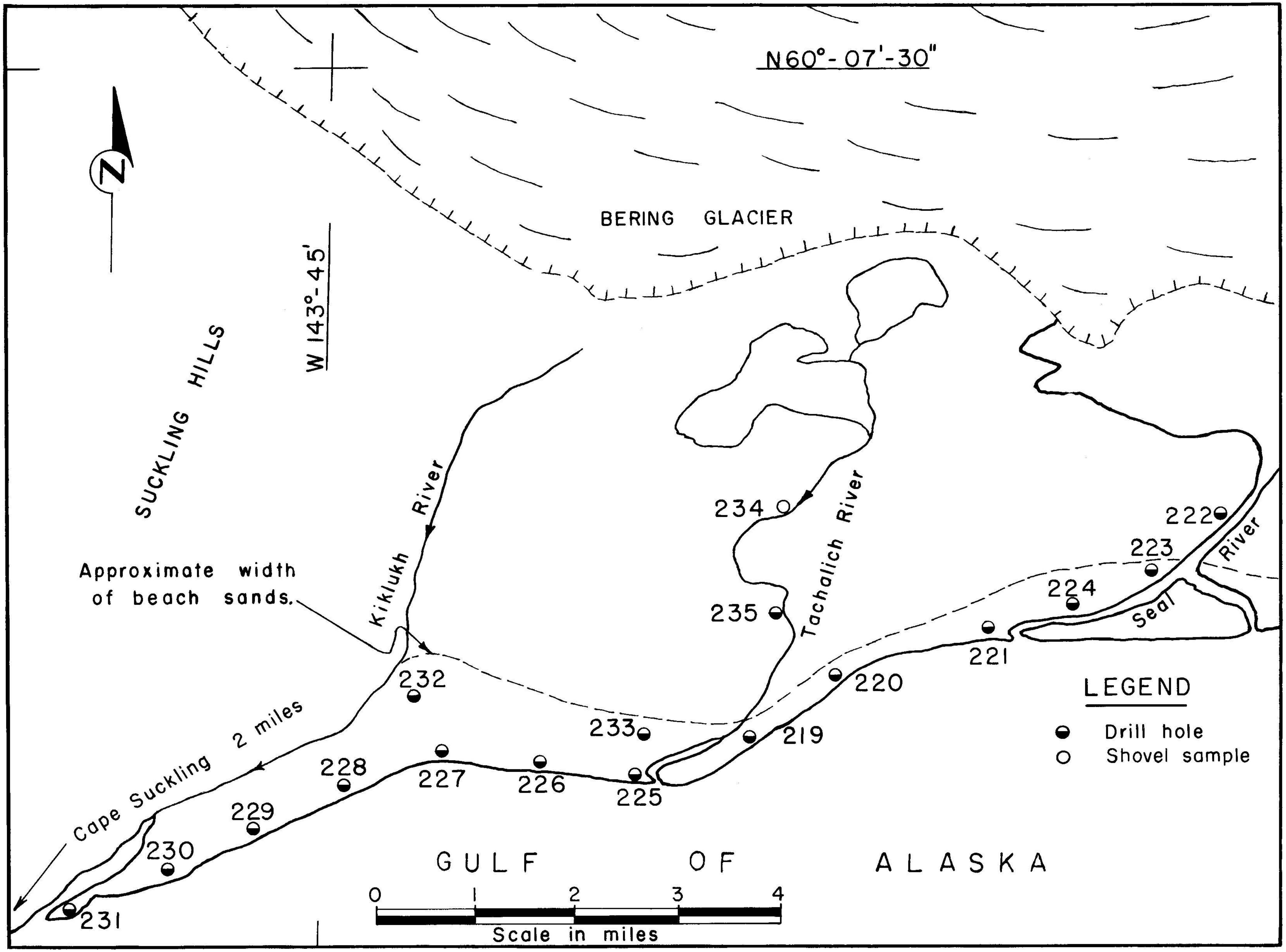


FIGURE 3. - Bering Glacier Area Between Kiklukh and Seal Rivers.

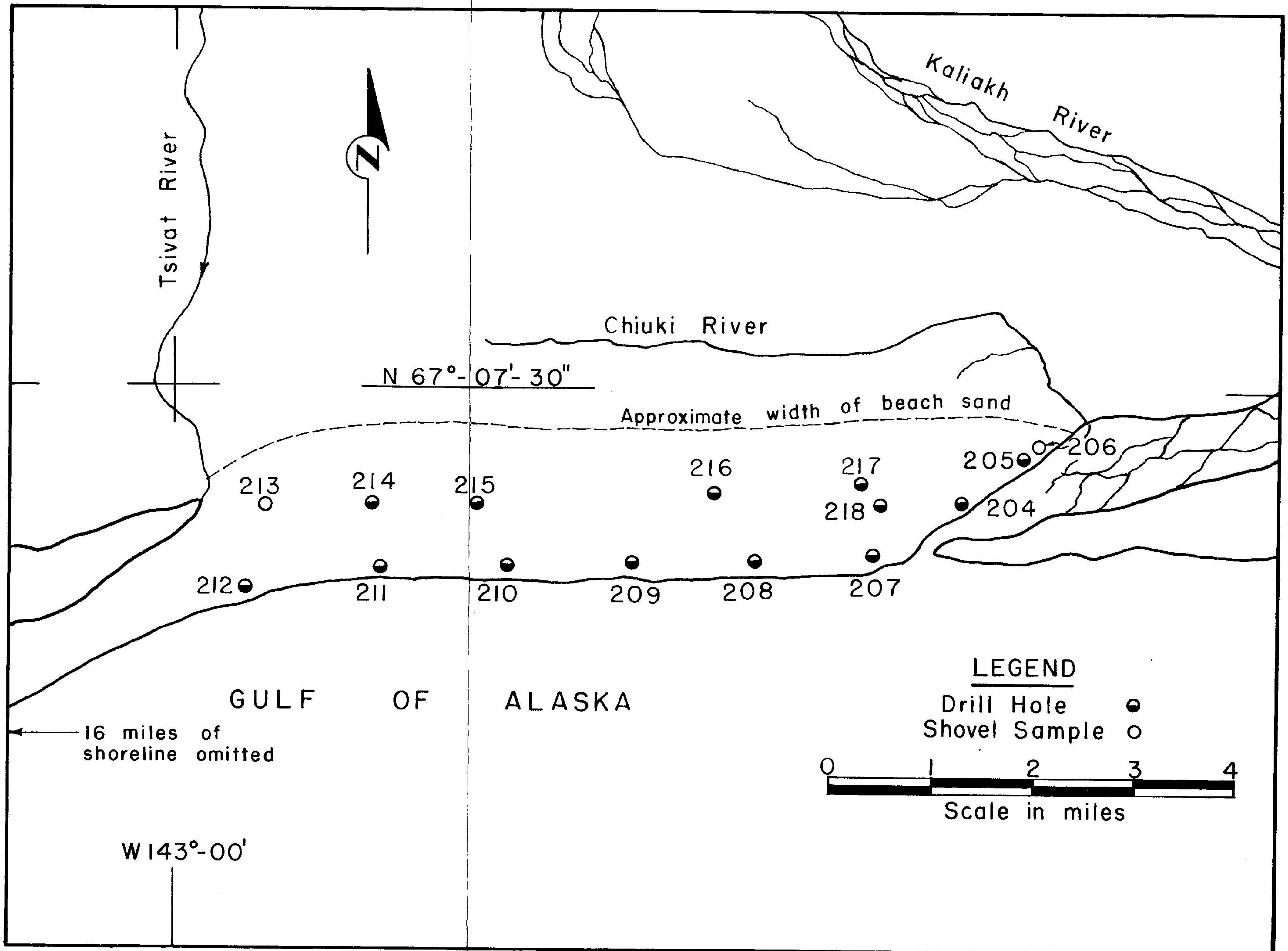


FIGURE 4. - Bering Glacier Area Between Tsivat and Kaliakh Rivers.

TABLE 3. - Petrographic examination of nonmagnetic fractions, Bering Glacier

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number														
	204	205	[1]206	207	208	209	210	211	212	[1]213	214	215	216	217	219
Magnetite......	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Hematite.......	3	-	-	-	3	-	-	3	3	3	3	-	3	3	3
Zircon.........	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Rutile.........	-	-	3	3	-	3	3	-	-	-	-	-	-	-	-
Garnet.........	2	2	2	2	3	2	2	2	2	2	3	2	2	2	2
Staurolite.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Augite.........	3	-	3	3	-	3	-	-	-	3	3	-	3	-	3
Sphene.........	-	3	3	3	-	3	-	-	-	3	-	-	-	-	-
Epidote........	1	1	1	1	1	1	2	1	1	1	3	3	2	2	2
Hornblende.....	1	1	1	1	3	1	2	1	2	1	2	2	2	2	3
Olivine........	-	3	-	-	-	-	3	-	-	-	-	-	-	-	-
Apatite........	3	-	3	-	-	3	-	-	-	-	3	-	-	-	-
Biotite........	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorite.......	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
Feldspar.......	2	2	3	3	1	1	-	1	1	3	3	3	2	2	2
Quartz.........	1	1	1	3	1	1	2	3	2	1	1	1	1	1	1
Greenstone fragments.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Shale fragments	2	2	2	-	2	2	2	2	2	2	3	2	2	2	1
Sandstone fragments.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Mineral constituent	Sample number													
	220	221	222	223	224	225	226	227	228	229	230	231	[1]234	235
Magnetite......	3	3	3	3	3	3	2	2	2	2	2	2	3	2
Hematite.......	3	3	3	3	3	3	3	3	3	2	3	3	3	3
Zircon.........	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Rutile.........	3	3	-	3	3	3	3	3	-	3	-	3	-	3
Garnet.........	2	2	2	2	2	2	2	2	2	2	2	1	2	2
Staurolite.....	-	-	3	-	-	-	-	-	-	-	3	3	-	-
Augite.........	3	3	3	3	3	-	3	3	3	3	2	3	3	3
Sphene.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Epidote........	2	2	2	2	2	2	2	1	1	2	2	1	2	2
Hornblende.....	2	2	2	2	2	2	2	2	2	3	2	2	2	2
Olivine........	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apatite........	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Biotite........	-	-	3	3	-	-	-	-	-	-	3	-	-	-
Chlorite.......	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Feldspar.......	2	2	-	2	2	2	-	-	-	-	-	-	-	-
Quartz.........	3	2	1	1	-	1	2	2	2	2	2	2	1	1
Greenstone fragments.....	1	1	1	1	1	1	1	1	1	1	1	1	2	1
Shale fragments	1	1	1	1	1	1	1	1	1	1	1	2	1	1
Sandstone fragments.....	-	-	-	-	-	-	-	-	-	-	1	-	1	1

[1] Shovel sample.

TABLE 4. - Auger-hole and shovel sampling results, Bering Glacier

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pan concentrate[1] [2]		Pounds iron per cu. yd. in place
				Total weight, grams	Percent iron	
204	18.2	Sand and water	0.044	200	4.8	0.5
205	18.2	do.	.047	211	2.9	.3
[3] 206	-	-	.014	127	3.1	.6
207	20.3	Sand and water	.053	147	5.1	.3
208	11.0	do.	.025	148	2.9	.4
209	9.4	do.	.026	150	4.0	.5
210	13.2	do.	.035	159	4.5	.4
211	18.3	do.	.041	167	4.8	.4
212	7.3	do.	.017	163	5.1	1.1
[3] 213	-	-	.014	122	3.6	.6
214	20.6	Sand	.049	487	2.8	.6
215	18.3	Sand and water	.019	175	2.5	.5
216	20.1	do.	.050	464	2.6	.5
217	16.9	do.	.035	268	2.7	.5
219	8.3	Gravel	.024	315	4.2	1.2
220	20.5	Sand and water	.048	464	4.9	1.0
221	32.3	do.	.081	989	4.7	1.3
222	4.2	Gravel	.014	205	4.0	1.3
223	5.9	Sand and water	.014	242	4.1	1.5
224	11.0	do.	.024	255	4.2	1.0
225	12.4	do.	.032	201	4.4	.6
226	13.9	Gravel	.035	290	4.6	.8
227	16.4	Sand and water	.045	292	4.2	.6
228	9.8	do.	.026	192	4.3	.7
229	5.0	Log	.012	138	4.5	1.1
230	9.0	Sand and water	.022	192	3.7	.7
231	7.9	Log	.020	200	3.8	.8
[3] 234	-	-	.014	115	3.3	.6
235	3.7	Mud	.005	81	3.1	1.1

[1] eU percent <0.001 in all samples.
[2] No Au noted in any pan concentrate.
[3] Shovel sample.

Yakataga

The area shown in figure 5 may be traversed in a specially equipped, four-wheel-drive, balloon-tired truck, but during the investigation a truck was not available, and the area was traveled on foot. The beaches shown east of Cape Yakataga are generally composed of loose sand and gravel that is not suitable for bush plane landings. During periods of high water the glacially fed White River is impassible, and access to that part of the coast east of the White River must be on foot or by truck, from Icy Bay (fig. 6).

Twenty-nine auger samples were taken between the Duktoth River and Munday Creek in the Yakataga area. The shore zone was sampled by 24 auger holes, and the old Yakataga dune, by 5 holes. Shovel samples were collected from the west bank of the White River and from the old Yakataga dune. The results of petrographic examination made of the nonmagnetic fractions from select samples are shown in table 5. Auger-hole and shovel sampling results are shown in table 6.

Auger-hole sample No. 193, taken at the mouth of the White River, intercepted a 1-3/4-inch black sand layer at 3.7 foot depth. The sands recovered from the stringer panned well for gold, but a series of additional auger holes fanned on a 50 foot radius from No. 193 failed to intercept any extension of the layer.

TABLE 5. - Petrographic examination of nonmagnetic fractions, Yakataga

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number									
	137	140	181	184	189	193	197	200	201	202
Ilmenite	-	3	-	-	-	3	3	2	2	3
Chromite	-	-	3	3	-	2	2	-	-	3
Zircon	3	2	3	3	-	2	2	3	3	-
Rutile	-	-	3	-	-	3	3	-	3	3
Garnet	3	1	3	1	2	1	1	1	1	1
Limonite	-	-	-	-	-	-	-	3	-	-
Staurolite	-	-	3	3	3	3	3	-	3	3
Augite	-	-	3	3	-	3	3	-	-	3
Sphene	-	3	3	3	3	-	-	-	3	-
Epidote	-	2	3	3	3	3	-	-	3	2
Hypersthene	-	-	3	3	-	-	-	3	3	3
Hornblende	3	2	2	3	2	-	3	3	3	3
Olivine	-	3	3	-	-	-	-	-	-	-
Chlorite	2	-	-	2	-	3	3	3	3	2
Feldspar	2	-	3	2	2	-	3	1	2	3
Quartz	2	-	1	2	3	3	3	2	3	3
Shale fragments	1	-	1	2	1	2	2	3	-	-

TABLE 6. - Auger-hole and shovel sampling results, Yakataga

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place			Gold, troy oz. per cu. yd.
				Magnetic fraction		Nonmagnetic fraction	
				Iron	TiO_2	TiO_2	
133	6.8	Gravel	0.019	0.5	0.2	0.3	0.0027
134	4.2	Silt	.008	.3	.1	.6	([1])
135	9.9	Gravel	.024	.3	.1	[2].4	([1])
136	9.0	do.	.019	.1	([1])	[2].1	([1])
137	4.2	Coarse gravel	.010	.2	([1])	.6	([1])
138	2.8	do.	.007	.2	([1])	.7	([1])
139	2.0	Sand and water	.005	.8	.2	1.7	([1])
140	6.0	do.	.018	1.0	.2	[2]2.0	([1])
141	3.0	Coarse gravel	.007	3.3	.7	4.8	([1])
181	4.2	Gravel	.014	.3	([1])	.7	([1])
182	3.3	do.	.014	.3	([1])	[2].5	([1])
183	2.9	do.	.010	1.2	.3	[2] [3]1.5	.0040
184	11.4	Coarse gravel	.026	2.6	.9	[2]2.6	([1])
185	10.9	Clay	.030	.8	.3	1.0	.0040
186	7.3	Coarse gravel	.019	.5	.2	.4	([1])
187	9.7	Silt	.024	.6	.2	[2].6	.0031
188	3.8	Gravel	.010	1.3	.3	[2]1.0	([1])
189	8.9	Sand and water	.020	.2	([1])	.4	([1])
[4]190	-	-	.014	.2	([1])	1.3	([1])
191	6.2	Sand and water	.014	.2	([1])	.5	.0021
192	7.3	Silt	.017	([1])	([1])	.1	([1])
193	9.9	Gravel and water	.032	1.0	.3	[2].7	.0596
[4]194	-	-	.010	([1])	([1])	[2].1	([1])
195	5.3	Gravel	.014	.2	([1])	[2] [3].2	.0031
196	7.0	Silt	.017	.3	.1	[2].5	.0013
197	11.3	Gravel and water	.029	1.7	.4	[2]1.7	.0036
198	6.0	Coarse gravel	.014	6.1	1.8	7.3	.0174
199	7.1	Rock	.018	2.0	.6	2.3	.0056
200	1.5	Silt	.025	1.4	.4	1.4	.0039
201	11.0	Gravel and water	.029	2.2	.7	[2]2.5	([1])
202	10.4	do.	.024	6.2	1.8	[2]5.6	([1])

[1] Trace.
[2] Trace eU in table concentrate.
[3] Trace eU in table tailing.
[4] Shovel sample.

Icy Bay

Several exploratory oil wells have been drilled in the area west of Icy Bay (fig. 6). During these activities three airstrips and several access roads were constructed; two of the airstrips are suitable for DC-3 or equivalent airplanes. However, the oil exploration project had been terminated before August 1957, and the roads and airstrips were deteriorated through lack of maintenance.

The coastline shown in figure 6 is generally composed of hard packed beaches that are suitable for small bush plane operations. Landing barges have been used successfully along the shores of Icy Bay, however, caution should be exercised when entering the Bay by small vessel because dangerous ice floes are always present. Only the most experienced boatman should attempt entering the tidal estuary of the Yahtse River.

A total of 31 samples, consisting of 22 auger-hole and 9 shovel samples, was taken along the exposed beaches between Johnston Creek and Icy Cape and between Point Riou and the mouth of Yahtse River. Samples were also collected from a part of the inner shoreline of Icy Bay. Petrographic examination (table 7) of the nonmagnetic fraction from select samples shows the mineral constituents of sands in the Icy Bay area to be similar to that of the sands in the Yakataga area. A summary of auger-hole and shovel sample results is shown in table 8.

TABLE 7. - Petrographic examination of nonmagnetic fractions, Icy Bay

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number					
	143	149	158	158A	159	162
Magnetite	3	3	-	-	-	-
Pyrite	-	-	-	3	-	3
Ilmenite	2	2	1	3	1	2
Chromite	2	2	-	-	-	-
Zircon	3	3	2	3	2	3
Xenotime	-	3	-	-	-	-
Rutile	3	3	2	-	2	-
Garnet	1	1	1	2	1	2
Limonite	-	-	-	3	-	-
Pyroxene	1	1	1	3	1	2
Sphene	-	3	-	-	-	-
Epidote	3	3	2	-	3	3
Hornblende	1	1	1	1	1	1
Zoisite	-	-	-	3	3	-
Olivine	3	3	-	3	1	-
Chlorite	-	-	-	-	1	-
Quartz	-	-	-	1	3	1

TABLE 8. - Auger-hole and shovel sampling results, Icy Bay

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place		
				Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
128	2.2	Coarse gravel	0.007	0.5	0.1	0.6
129	4.0	do.	.010	.9	.2	1.1
130	3.1	do.	.010	.4	.1	.3
131	6.2	Gravel	.019	.4	.1	.6
132	3.7	Coarse gravel	.010	.2	([1])	.3
142	3.6	Sand and water	.007	.2	([1])	.4
143	6.4	Coarse gravel	.014	5.4	1.0	[2]6.4
144	7.3	do.	.022	.1	([1])	[2].8
145	2.4	do.	.007	1.5	.4	[2] [3].4
146	2.2	Loose sand	.011	2.1	.3	[3].9
147	10.9	Sand and water	.029	.6	.2	[2].5
148	7.4	Coarse gravel	.019	.3	([1])	.4
149	5.6	do.	.014	.4	.1	[2] [3].5
150	3.1	Sand and water	.005	.8	.2	[2]1.8
[4]151	-	-	.019	1.8	.4	[3]1.8
[4]152	-	-	.014	.2	([1])	[2] [3].4
153	3.2	Gravel	.007	.1	([1])	[2].2
154	2.3	Shale	.005	.8	.1	[3]5.2
155	2.4	do.	.005	1.4	.2	[2]1.5
[4]156	-	-	.024	3.9	.4	[2]2.6
[4]157	-	-	.024	6.0	.6	[2] [5]4.8
[4]158	-	-	.024	4.6	.5	[2]4.7
[4]158A	-	-	.010	1.7	.3	1.8
[4]159	-	-	.029	5.7	.5	[2] [5]4.1
[4]159A	-	-	.010	3.0	.4	3.0
160	-	-	.024	6.2	.7	[2]5.1
161	5.9	Loose sand	.014	1.0	.1	1.3
162	8.3	Sand and water	.024	.5	([1])	[2].5
163	6.3	Shale	.017	2.4	.2	2.1
164	8.2	Gravel and water	.022	.9	.1	[2].1
171	4.6	Coarse gravel	.014	.2	([1])	.3

[1] Trace.
[2] Trace eU in table concentrate.
[3] Trace Au.
[4] Shovel sample.
[5] Trace eU in table tailing.

Malaspina

Access to the coastline along the Malaspina foreland (fig. 7) is by small bush plane landing on the hard packed beaches. Even during the calm summer weather, heavy swells and pounding surfs generally prohibit any onshore landings. There are no inhabitants in the area.

The sandy beaches along the Malaspina foreland were sampled by 13 auger holes and 2 shovel samples. Petrographic examinations (table 9) show the sands to be similar to the sands along beaches to the west. The heavy-mineral content of the sand is small as shown by the summary of sampling results (table 10). Uranium and gold were detected only in a few samples as shown by footnote references.

TABLE 9. - Petrographic examination of nonmagnetic fractions, Malaspina

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number					
	165	168	172	174	176	178
Pyrite	3	3	3	3	3	3
Ilmenite	3	3	3	3	3	3
Zircon	3	-	3	3	3	3
Rutile	3	3	3	3	3	3
Garnet	2	3	2	2	2	1
Limonite	3	3	3	3	3	3
Augite	3	3	-	-	-	-
Sphene	3	3	-	-	-	-
Epidote	-	2	3	3	3	3
Hypersthene	2	2	3	3	3	3
Hornblende	1	1	1	2	2	1
Zoisite	-	-	-	3	3	-
Olivine	-	-	3	-	-	3
Feldspar	1	1	1	2	2	2
Calcite	3	3	3	3	3	-
Quartz	1	1	1	1	1	2
Shale fragments	-	-	-	1	1	2

TABLE 10. - Auger-hole and shovel sampling results, Malaspina

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place		
				Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
165	14.3	Sand and water	0.043	0.2	(1)	0.5
166	2.3	Coarse gravel	.007	.2	(1)	.3
167	10.3	Loose sand	.026	5.0	0.7	[2]4.7
168	4.4	Gravel	.014	.6	.1	[2]1.2
169	9.1	Coarse gravel	.024	.3	(1)	.4
[3]170	-	-	.014	.7	.2	.6
[3]172	-	-	.014	.6	.1	1.3
173	4.2	Gravel	.012	.3	.1	.4
174	10.2	do.	.034	.5	.1	[4].8
175	9.9	Coarse gravel	.029	.5	(1)	.8
176	5.2	Gravel	.012	1.3	.2	[2]2.0
177	8.2	Coarse gravel	.022	1.9	.3	[4]2.3
178	10.6	do.	.026	2.7	.4	[5]2.5
179	3.6	Gravel	.007	.5	(1)	[2].8
180	4.2	Coarse gravel	.014	.4	(1)	.5

[1] Trace.
[2] Trace Au.
[3] Shovel sample.
[4] Trace eU in table concentrate.
[5] 0.0034 troy oz. of Au per cubic yard.

Yakutat

The beach deposits in the vicinity of Yakutat (fig. 8) are readily accessible by auto, rail, and air transportation. About 11 miles of graveled roads serve the requirements of the community, but additional roads are being built to provide access for oil exploration. An unimproved road along the beach provides ready access to the deposits between Ocean Cape and Lost Creek. Those deposits between the Ahrnklin River and the Dangerous River are accessible by small aircraft landing on the beach or on a small aircraft strip, or by rail to the Situk River and then by small boat up the tidal estuary of the Ahrnklin River. The railroad, built years ago, is still used to haul fish to Yakutat.

Investigations in the Yakutat area consisted of 29 auger-hole samples and 1 shovel sample (fig. 8). Sandy beaches on Khantaak Island and at Logan Bluff (not shown, about 12 miles north of Khantaak Island) were examined; four shovel samples, two from each locality (samples 19 to 22 inclusive), were collected from these beaches. The minerals in the nonmagnetic fractions from select samples are listed in table 11. Auger-hole and shovel sampling results are summarized in table 12.

TABLE 11. - Petrographic examination of nonmagnetic fractions, Yakutat

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number				
	8	12	15	25	30
Scheelite	3	-	3	-	-
Pyrite	-	3	-	-	-
Ilmenite	2	1	2	2	2
Zircon	3	3	3	3	3
Rutile	3	3	3	3	3
Garnet	1	2	1	1	1
Pyroxene	1	1	1	2	2
Topaz	3	3	3	3	3
Sphene	2	3	2	3	3
Epidote	2	2	2	1	1
Hornblende	1	1	1	1	1
Apatite	3	-	3	-	-
Chlorite	3	-	3	-	-
Feldspar	3	3	3	-	-
Calcite	3	3	3	-	-
Quartz	3	3	3	3	3

TABLE 12. - Auger-hole and shovel sampling results, Yakutat

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place: Magnetic fraction, Iron	Pounds per cu. yd. in-place: Magnetic fraction, TiO_2	Pounds per cu. yd. in-place: Nonmagnetic fraction, TiO_2	Gold, troy oz. per cu. yd.
1	6.4	Gravel	[1]0.017	50.5	3.4	[2]23.2	([3])
2	10.1	Sand and water	[1].026	8.7	.6	[2]5.7	([3])
3	9.9	do.	[1].026	25.9	1.7	[2]13.8	([3])
4	20.1	do.	.053	33.6	2.1	[4]16.1	([3])
5	16.5	Gravel and water	.053	27.9	1.7	[2]18.5	([3])
6	19.7	do.	.065	15.5	.8	[2]6.4	([3])
7	20.0	Sand and water	.057	30.5	1.6	[2]12.6	([3])
8	19.3	do.	.067	19.7	1.1	[2] [4]9.1	([3])
9	9.5	do.	.026	100.9	7.0	[2] [4]55.9	([3])
10	4.0	do.	.010	69.2	8.7	[2] [4]72.2	([3])
11	16.8	do.	.067	27.4	1.9	[2] [4]13.9	([3])
[5]12	-	-	.010	306.0	16.1	[4]98.2	([3])
13	10.3	Sand and water	.032	28.9	2.0	[2]16.8	([3])
14	19.2	do.	.059	49.0	2.9	[2] [4]21.4	([3])
15	22.6	do.	.084	14.0	.8	[2]6.4	([3])
16	2.2	do.	.007	104.9	7.0	[2] [4]39.5	([3])
[6]17	-	-	-	11.7	1.8	11.9	([3])
18	12.4	Sand and water	.038	.5	([7])	.3	0.00052
[5]19	-	-	.014	.3	([7])	.2	.00052
[5]20	-	-	.014	.1	([7])	[2].2	([7])
[5]21	-	-	.014	.1	([7])	.2	([3])
[5]22	-	-	.010	1.2	.2	1.1	([3])
23	9.3	Sand and water	.024	6.0	.5	3.5	([3])
24	11.9	do.	.036	18.1	1.7	11.6	([3])
25	8.5	do.	.019	150.3	6.5	[2] [4]47.4	([3])
26	6.8	do.	.019	25.8	1.1	[2]10.6	.00012
27	4.0	do.	.014	.9	.1	.9	([3])
28	7.6	do.	.017	8.4	.5	4.7	([3])
29	4.9	do.	.012	8.1	.4	4.4	([3])
30	6.5	do.	.014	32.9	1.4	[2]13.3	([3])
31	16.8	do.	.043	22.6	1.2	[2]11.5	([3])
32	6.8	do.	.014	53.0	2.6	[4]33.2	([3])
33	8.5	do.	.019	11.7	.8	6.8	([3])
34	2.0	Silt	.005	.8	.4	([7])	([3])
35	1.0	Sand and water	.003	1.0	([7])	[2]1.3	([3])

[1] Theoretical volume computed by using 0.3-foot diameter of auger hole.
[2] Trace eU in table concentrate.
[3] None.
[4] Trace eU in table tailing.
[5] Shovel sample.
[6] Pan tailings from sample 16.
[7] Trace.

Samples 16 and 17 are respectively the pan concentrate and pan tails of the same auger hole borings. Laboratory analysis indicated the pan concentration recovered about 90 percent of the total acid-soluble iron and about 77 percent of the total TiO_2. Screen analysis of samples 12 and 16 (table 13) indicated a marked concentration of titanium mineral in the finer sizes, the mineral being a finely interlocked magnetite-ilmenite. Sample 12 is representative of a 0.1-foot aeolian concentration along the crest of the ocean-fronting dune. Localized black sand veneers from 0.1 to 0.2 foot thick are typical along the coast shown. Sample 25 is representative of sands that have been river concentrated in a small area at the mouth of the Situk River.

TABLE 13. - Screen analysis, Yakutat

Product (mesh)	Weight		Magnetic separation				
			Magnetic, weight percent	Nonmagnetic			
	Grams	Percent		Weight percent	Assay, percent		
					eU	TiO_2	ZrO_2
	Sample 12[1]						
+35	0.0	-	-	-	-	-	-
-35, +48	3.4	0.30	17.65	82.35	0.001	8.5	0.08
-48, +65	76.9	6.87	5.20	94.80			
-65, +100	751.1	67.11	33.82	66.18	0	18.5	.8
-100, +200	287.5	25.69	80.90	19.10	.001	29.5	3.2
-200	.3	.03	50.00	50.00			
	Sample 16 (panned concentrate)						
+35	2.1	0.49	33.33	66.67	0.002	1.9	0.06
-35, +48	16.0	3.71	9.37	90.63			
-48, +65	110.0	25.50	6.18	93.82	.0003	3.9	.02
-65, +100	210.5	48.81	20.90	79.10	.003	12.5	.08
-100, +200	92.4	21.42	70.78	29.22	.012	25.5	2.2
-200	.3	.07	16.67	83.33			
	Sample 17 (panned tail)						
+35	39.0	3.73	-	100.00	0	0.7	0
-35, +48	369.3	35.30	0.08	99.92	0.003	.8	0
-48, +65	467.5	44.68	.34	99.66	.002	1.5	0
-65, +100	158.7	15.17	2.58	97.42	.002	3.7	([2])
-100, +200	11.1	1.06	33.33	66.67	.004	12.0	([2])
-200	.6	.06					

[1] Head assay 12.5 percent TiO_2, 0.04 percent ZrO_2, no eU.
[2] Trace.

Preliminary mineral dressing studies were made of an unweighted composite of table concentrates from 17 samples taken between Ocean Cape and Lost Creek (samples 1 through 17). The composite represented a bulk heavy-mineral concentrate such as might be obtained from a dredge or stationary washing plant. The material tested consisted principally of ilmenite, titaniferous magnetite, and spessartite. Some ferromagnesian minerals were present as well as small amounts of calcite, quartz, tourmaline, apatite, and altered feldspar. The head sample assayed 36.8 percent acid-soluble, Fe, 11.3 percent TiO_2, 0.51 percent ZrO_2, and less than 0.02 ounces of Au or Ag per ton. The sand was screen-sized with standard Tyler sieves, and the component fractions were analyzed for titania content. The results are shown in table 14.

TABLE 14. - Composite sample screen analysis, Yakutat

Product (mesh)	Weight, percent	Assay, percent TiO_2	Distribution, percent TiO_2
+65	7.10	7.3	4.6
-65, +100	57.28	11.3	58.0
-100, +200	35.26	11.8	37.2
-200	.36	6.0	.2
Calculated head..	100.00	11.2	100.0

A sample was treated on a high intensity magnetic separator to produce a magnetite concentrate, ilmenite concentrate, garnet concentrate, and nonmagnetic product. The latter was tabled to concentrate the heavy minerals. Results are shown in table 15.

TABLE 15. - Composite sample magnetic and gravity concentration, Yakutat

Product	Weight, percent	Assay, percent			Distribution, percent	
		Fe	TiO_2	ZrO_2	Fe	TiO_2
Magnetite	28.70	67.7	3.5	0.05	53.2	9.2
Ilmenite	16.25	36.5	37.0	-	16.3	55.2
Garnet	30.50	26.8	8.8	.06	22.4	24.5
Nonmagnetic concentrate	7.25	16.8	8.5	6.6	3.4	5.6
Nonmagnetic tail	17.30	10.0	3.5	-	4.7	5.5
Calculated head	100.00	36.5	11.0	.51	100.0	100.0
Combined magnetite and ilmenite	44.95	56.5	15.7	-	69.5	64.4

The iron concentrate was composed chiefly of magnetite with some extremely intimate intergrowths of ilmenite; hornblende and garnet were estimated to make up less than one-half percent impurities. The ilmenite fraction was estimated to be 99 percent ilmenite intergrown with magnetite plus about 0.5 percent each of hornblende and garnet. Because the test was run to produce a high-grade ilmenite concentrate, considerable titania was lost in the garnet fraction. Microscopic examination indicated that the garnet fraction contained an estimated 60 percent spessartite, 25 percent ilmenite, 15 percent hornblende and hypersthene, plus a trace of zircon.

The nonmagnetic fraction of the sand was tabled to further concentrate the heavy minerals. The concentrate from this process was composed of an estimated 30 percent hornblende and augite, 20 percent garnet, 10 percent zircon, 14 percent ilmenite, 10 percent epidote, 8 percent quartz, calcite, and apatite, 4 percent hypersthene, and 4 percent sphene and rutile. Radiometric analysis showed a uranium equivalent content of 0.016 percent, which was probably due to the radioactivity of zircon. Approximately 90 percent of the total zircon was recovered in this product.

The nonmagnetic table tailing consisted chiefly of hornblende, augite, and hypersthene, with lesser amounts of garnet and epidote, approximately 4 percent tourmaline, 2 percent zircon, and 4 percent combined sphene, quartz, calcite, apatite, and altered feldspar. A trace of radioactivity was noted. Chromium was detected spectroscopically in this and in the nonmagnetic concentrate, but no chromium mineral was identified.

Akwe

The Akwe River area (fig. 9) is accessible by small aircraft. The beaches are sandy, are usually hard packed, and may be used as bush plane fields; two small auxiliary airstrips have been constructed in the area. During the summer, four-wheel-drive trucks are used to haul salmon from the tidal estuary of the Akwe River to the mouth of the Alsek River. An unimproved road follows the grassy crest of the ocean-front dune eastward to the Alsek River (fig. 10).

A total of 22 auger-hole samples was taken between the Italio and Akwe Rivers and along the Akwe spit. The mineral constituents of the nonmagnetic fractions from four representative samples are shown in table 16. A summary of sampling results is shown in table 17.

TABLE 16. - Petrographic examination of nonmagnetic fractions, Akwe

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number			
	54	59	70	74
Ilmenite	1	1	1	1
Chromite	-	-	3	3
Zircon	3	2	2	2
Rutile	3	-	-	-
Garnet	2	1	1	1
Pyroxene	1	1	1	1
Sphene	3	-	-	2
Epidote	1	2	-	2
Amphibole	1	1	1	1
Tourmaline	-	-	-	3
Feldspar	2	-	1	-
Calcite	3	-	2	-
Quartz	2	-	1	-

TABLE 17. - Auger-hole and shovel sampling results, Akwe

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place		
				Magnetic fraction		Nonmagnetic fraction[1]
				Iron	TiO_2	TiO_2
52	8.2	Sand and water	0.019	1.3	([2])	[3]0.6
53	9.9	do.	.024	1.4	([2])	[3].7
54	20.2	Compact sand	.062	3.4	0.1	[3]1.2
55	16.1	Sand and water	.043	2.4	1.0	[3].9
56	14.4	do.	.043	1.8	1.0	[3 4].7
57	9.9	do.	.026	1.8	.1	[3 4].7
58	11.5	do.	.031	2.3	.1	[3]1.0
59	8.5	Driftwood	.022	5.6	.3	[3]2.1
64	5.0	Sand and water	.012	10.5	.8	[3]4.5
65	3.4	do.	.007	6.2	.4	3.2
66	7.3	do.	.017	5.1	.3	[3]1.7
67	12.0	do.	.031	5.0	.3	[3 4]2.0
68	13.8	do.	.034	6.0	.3	[3]2.0
69	15.4	do.	.038	3.5	.2	[4]1.1
70	6.1	do.	.014	3.5	.2	1.3
71	6.5	do.	.012	2.5	.1	1.2
72	6.1	do.	.014	7.8	.3	[3]3.2
73	6.1	do.	.014	4.9	.2	[3].2
74	7.5	do.	.019	8.4	.4	[3]3.2
75	10.0	do.	.024	6.7	.4	[4]2.7
76	6.2	do.	.014	1.3	([2])	[3].6
77	16.3	Compact sand	.036	.6	([2])	.3

[1]No Au in all samples.
[2]Trace.
[3]Trace eU in table concentrate.
[4]Trace eU in table tailing.

Dry Bay--Sea Otter

Access to the Dry Bay--Sea Otter area (figs. 10 and 11) is by small airplane. With the exception of coarse terminal moraine material below the Grand Plateau Glacier and at Cape Fairweather, the beaches are sandy and generally suitable for small plane landings. Several small airstrips have been constructed in the area. Four-wheel-drive trucks traverse unimproved roads which provide a means for hauling salmon caught in the Akwe (fig. 9), East, and Dohn Rivers to the mouth of the Alsek. On the Alsek the salmon are transferred to fish packers that anchor in the protection of the river estuary.

A total of 31 samples were recovered from auger holes located in the area shown (figs. 10 and 11). Four shovel samples were also collected. Petrographic examinations of nonmagnetic fractions of select samples are shown in table 18. Table 19 is a summary of the auger-hole and shovel sampling results.

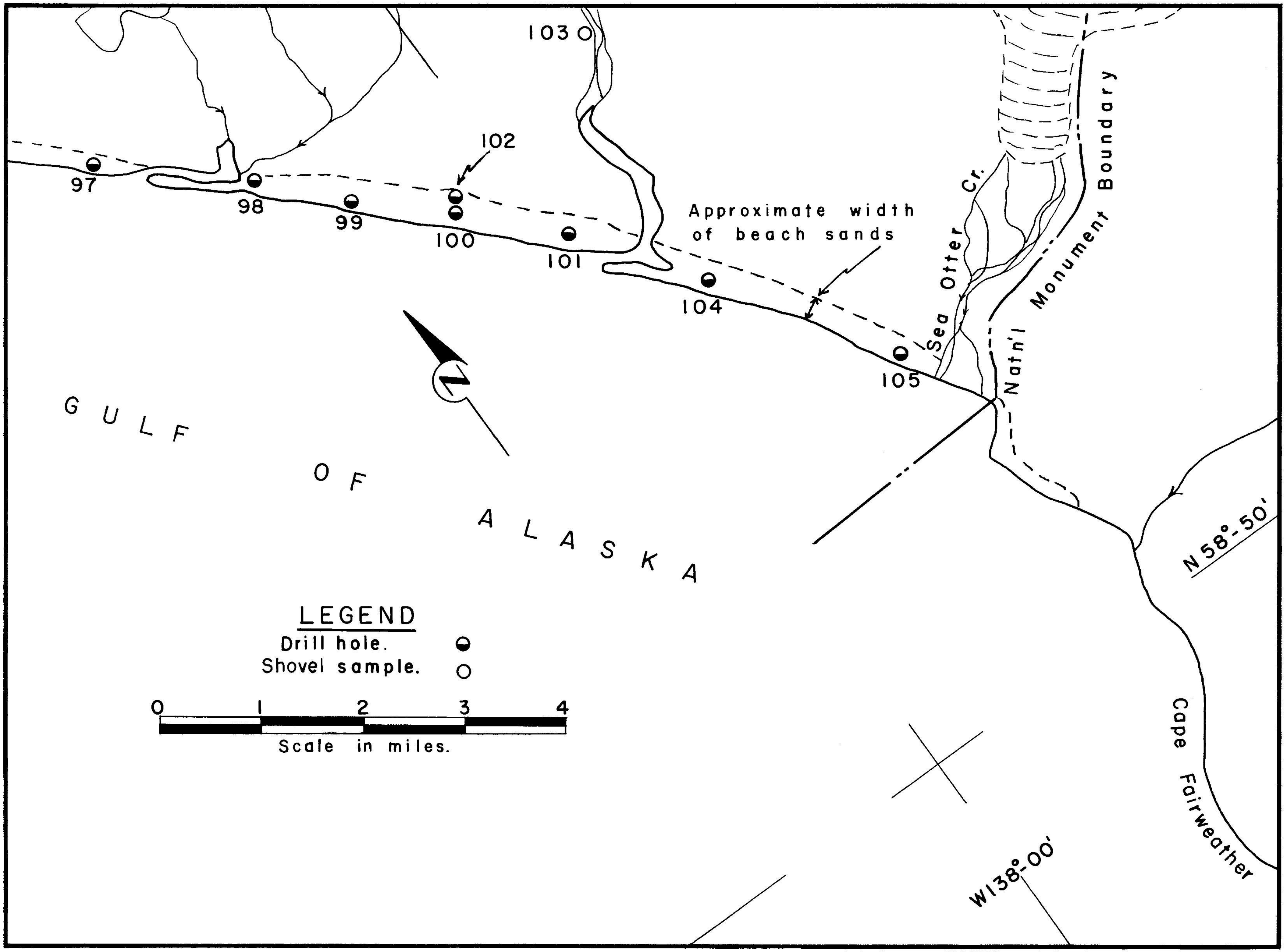


FIGURE 11. - Sea Otter.

Sample No. 102 was not pan-concentrated in the field; instead, the bulk sample (total auger-hole borings) was shipped for laboratory treatment and analysis. Field observations indicated sample No. 102 was representative of the best heavy-mineral concentration in the Sea Otter area.

TABLE 18. - Petrographic examination of nonmagnetic fractions, Dry Bay--Sea Otter

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number							
	40A	41	45	51B	61	95	102	105
Ilmenite	1	-	1	-	1	3	2	2
Zircon	3	-	3	-	3	-	-	-
Rutile	3	-	3	-	-	-	-	-
Garnet	2	3	2	3	1	1	1	1
Staurolite	-	-	-	-	-	3	3	-
Pyroxene	1	-	1	-	1	1	1	1
Topaz	3	-	-	-	-	-	-	-
Sphene	3	-	3	-	-	-	-	-
Epidote	2	2	1	2	-	3	-	3
Ampibole	1	1	1	1	1	1	1	1
Olivine	-	-	-	-	-	1	1	1
Apatite	3	-	-	-	-	-	-	-
Tourmaline	-	-	-	-	3	-	-	-
Chlorite	-	3	-	3	-	-	-	-
Feldspar	2	3	2	3	1	1	1	1
Calcite	3	3	3	3	-	-	-	-
Quartz	3	3	2	3	3	2	-	-

TABLE 19. - Auger-hole and shovel sampling results, Dry Bay--Sea Otter

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place		
				Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
36	7.7	Gravel and water	0.029	0.4	([1])	[2]0.3
37	12.0	do.	.038	.4	([1])	.3
38	7.7	Loose sand	.024	.7	.1	.6
39	8.8	Fine gravel	.024	.4	([1])	[2].3
40	11.4	Sand and water	.041	.3	([1])	[2].2
[3]40A	-	-	.010	8.0	.7	[2]1.5
41	7.7	Sand and water	.029	.4	([1])	[2].6
42	2.0	Gravel	.010	6.2	.5	[4]3.2
[3]42A	-	-	.014	59.2	4.3	[5]26.9
43	11.5	Sand and water	.029	5.6	.3	2.7
44	8.3	Gravel and water	.019	2.4	.2	[2]1.5
45	16.3	Sand and water	.038	7.4	.7	[6]4.4
46	16.0	do.	.050	3.4	.2	[2 6 7]1.6
47	5.6	do.	.012	1.0	.1	2.1
47A	3.2	do.	.007	6.0	.7	15.9
48	6.9	do.	.011	.3	([1])	.6
49	10.2	do.	.012	1.8	.2	2.4
50	9.0	do.	.023	.3	([1])	[2].5
51	6.7	Gravel	.018	1.6	([1])	[2].5
[3]51A	-	-	.005	2.7	.1	[2]2.0
60	2.2	Sand and water	.005	7.7	.6	[2]4.4
61	7.2	do.	.022	5.8	.5	[6]2.8
62	13.5	do.	.036	16.2	1.4	[6]7.8
63	8.6	do.	.022	9.9	.8	[2 6]4.9
95	4.7	Gravel	.014	5.6	.6	6.5
96	9.9	do.	.031	2.2	.2	3.3
97	6.3	do.	.017	.5	([1])	.8
98	7.3	do.	.019	.5	([1])	.8
99	8.4	do.	.024	4.9	.6	7.2
100	5.4	do.	.014	3.7	.4	5.0
101	7.8	do.	.014	6.8	.8	11.2
102	12.7	do.	.048	12.2	1.8	20.0
[3]103	-	-	.005	2.0	([1])	1.6
104	7.3	Gravel	.018	1.9	.3	3.0
105	9.2	do.	.024	9.4	1.6	16.5

[1] Trace.
[2] Trace eU in table concentrate.
[3] Shovel sample.
[4] Trace Au.
[5] 0.0065 troy oz. Au per cubic yard.
[6] Trace eU in table tailing.
[7] 0.0034 troy oz. Au per cubic yard.

Lituya Bay--La Perouse

The beaches between Grand Plateau and La Perouse Glaciers are accessible by small plane from Yakutat or Juneau. These beaches may also be reached in a small boat by entering Lituya Bay during calm weather at slack tide. The sheltered deep water of Lituya Bay is also suitable for landing with amphibious-type or pontoon-equipped aircraft. From Lituya Bay the beaches may be reached by traveling the coast on foot.

The beach area shown (figs. 12 and 13) was sampled with 26 auger holes and 11 shovel samples. The shovel samples collected at the head of Lituya Bay were composed of sand from glacier moraines. The mineral constituents of nonmagnetic fractions from select samples are shown in table 20. The results of auger-hole and shovel sampling are summarized in table 21.

A suite of specimens was collected from the moraine on La Perouse Glacier. Samples 106 and 111 were identified as quartz diorite, altered gabbro, schist, and altered diorite; a trace of chromium was present in the altered diorite. Samples 125 and 127 were specimens collected from the moraines of Lituya and Crillon Glaciers; both were diorite.

TABLE 20. - Petrographic examination of nonmagnetic fractions, Lituya Bay--La Perouse

[Code: 1 = major constituent, 2 = small amount, 3 = trace, and - = not detected]

Mineral constituent	Sample number						
	81	83	86	89	94	108	110
Ilmenite	2	-	-	-	-	2	3
Zircon	-	3	-	-	-	-	-
Garnet	1	2	1	1	3	3	3
Staurolite	-	-	2	3	-	-	-
Augite	1	2	2	2	-	1	1
Epidote	2	3	2	3	-	-	-
Hypersthene	1	1	1	1	2	1	1
Hornblende	1	2	2	2	1	1	1
Olivine	3	2	1	3	3	2	2
Chlorite	-	-	-	-	1	-	-
Feldspar	-	-	2	-	1	-	3
Quartz	-	-	2	-	2	-	3

TABLE 21. - Auger-hole and shovel sampling results, Lituya Bay--La Perouse

Sample number	Total depth, feet	Material at bottom of hole	Adjusted measured vol. loose, cu. yd.	Pounds per cu. yd. in-place		
				Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
80	8.1	Gravel	0.017	4.6	0.4	33.4
81	7.0	do.	.017	4.3	.4	[1]20.4
82	12.0	Fine gravel	.038	.6	([2])	[3]3.3
83	13.5	Loose sand	.040	.9	.1	[3]6.0
84	8.0	Gravel	.027	1.1	([2])	[3]1.0
[4]85	-	-	.014	5.3	.4	6.7
86	4.0	Gravel	.010	16.5	1.9	18.2
87	9.4	do.	.024	5.4	.9	[3,5]9.6
88	8.3	do.	.029	1.7	.1	6.1
89	9.2	do.	.026	.8	([2])	4.3
90	6.3	do.	.019	1.0	([2])	5.1
91	6.1	do.	.014	9.6	.6	[6]51.6
92	3.1	do.	.008	.3	([2])	2.6
[4]93	-	-	.014	.2	([2])	[6,7]1.0
[4]94	-	-	.014	.4	([2])	3.1
107	12.0	Gravel	.031	1.8	([2])	7.9
108	8.2	do.	.019	5.4	.2	19.7
109	6.4	do.	.016	.6	([2])	4.0
110	5.2	Boulders	.014	.6	([2])	7.5
[4]112	-	-	.014	.2	([2])	[3]1.4
113	14.0	Sand	.034	6.5	.4	38.1
114	5.7	Coarse gravel	.012	6.0	.4	[3,6]33.4
115	6.6	do.	.014	.9	([2])	7.2
116	2.9	do.	.007	.2	([2])	[6].7
117	.6	Bedrock	.002	.1	([2])	.5
118	4.6	Boulders	.010	.1	([2])	[6].3
119	3.5	Gravel	.008	4.3	([2])	[3]43.7
120	3.4	do.	.008	1.1	([2])	1.3
121	6.0	do.	.014	.2	([2])	.8
122	2.6	do.	.007	2.6	.4	35.6
[4]123	-	-	.005	4.6	.6	89.5
[4]124	-	-	.010	.3	([2])	3.3
[4]126	-	-	.010	([2])	([8])	.7

[1] Trace Au.
[2] Trace.
[3] Trace eU in table tailing.
[4] Shovel sample.
[5] 0.0103 troy oz. Au per cubic yard.
[6] Trace eU in table concentrate.
[7] 0.00078 troy oz. Au per cubic yard.
[8] None.