RI bureau of mines report of investigations 6214

RECONNAISSANCE OF BEACH SANDS, BRISTOL BAY, ALASKA

By Robert V. Berryhill

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

1963

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UNITED STATES DEPARTMENT OF THE INTERIOR
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RECONNAISSANCE OF BEACH SANDS, BRISTOL BAY, ALASKA

by

Robert V. Berryhill[1]

ABSTRACT

Reconnaissance studies of beach deposits along approximately 220 miles of the shoreline of Bristol Bay, Alaska, were made to determine if more detailed investigations were warranted. In addition to preliminary mapping of the deposits, samples were obtained from auger borings spaced at 1-mile intervals in key areas; shovel samples were collected to supplement the borings. Most samples were roughly concentrated in the field; magnetic separation tests, petrographic analyses, and determinations for radiometric equivalent uranium, gold, platinum, iron, and titanium were made in the Bureau of Mines laboratory at Juneau, Alaska.

Spot samples from some beaches along the shores of the Alaska Peninsula indicate small deposits containing up to 10 percent recoverable titaniferous magnetite; some larger deposits were indicated to contain from 1 to 2 percent total heavy metal, principally as titaniferous magnetite. Significant amounts of other commercial minerals were not detected.

INTRODUCTION

Although the more accessible beaches along the 6,640-mile coastline of Alaska were thoroughly prospected for gold by early day miners, little attention was given to less valuable minerals found as heavy sand in the concentrate of beach deposits. The abundance of such heavy sand was sometimes noted in reports of beach-placer operations and was reflected in place names such as Black Sand Island (near Yakutat). Only a few attempts were made, however, to determine more exactly the character and abundance of the heavy minerals. Because of the steadily increasing interest in placer deposits as possible commercial or strategic sources of monazite, ilmenite, rutile, magnetite, and other industrial minerals, the Bureau of Mines, in 1957, initiated a program of spot sampling of key beach areas to determine if more detailed studies of beach deposits were warranted. During parts of the 1957 and 1958 field

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

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seasons, spot samples were taken from beach deposits along approximately 247 miles of the Gulf of Alaska shoreline; sampling results have been published.[2]

This report describes the methods and results of the program as conducted in the Bristol Bay region during parts of the 1958 and 1959 field seasons.

ACKNOWLEDGMENTS

Fieldwork in the Bristol Bay region was aided by use of Federal Aviation Administration facilities at Cold Bay. The many services and courtesies extended by fishermen along the coast were greatly appreciated.

Special acknowledgment is made to the bush-plane pilots who serviced the field crew working in the region. Through their efforts, exacting schedules were maintained, often under extremely adverse weather conditions.

LOCATION AND ACCESSIBILITY

Bristol Bay is in southwestern Alaska about 250 miles southwest of Anchorage, Alaska (fig. 1). This region is between the Aleutian Range on the south and the Ahklun and Kilbuck Mountains on the northwest. The area investigated comprises approximately 625 miles of coast along Bristol Bay, extending from Goodnews Bay (latitide 59° 05' N and longitude 161° 55' W) on Kuskokwim Bay to Moffet Point (latitude 55° 27' N and longitude 162° 35' W) on the Alaska Peninsula (fig. 2).

Virtually all travel to and from the region is by air. The air traffic center, the King Salmon Air Base, is 16 miles inland from the fishing community of Naknek at the head of Bristol Bay. Multimotored passenger and cargo planes from Anchorage usually refuel at King Salmon and continue either west to Dillingham and Platinum or south down the Alaska Peninsula and Aleutian chain.

Platinum, 180 airline miles west of King Salmon on the shore of Kuskokwim Bay, is the westernmost community in the area investigated. It has an airstrip on which DC-3 or equivalent-size airplanes can land. A roadhouse, general store, and post office adjacent to the airstrip provide facilities for the traveler; fuel oil in bulk is available, and a U.S. Weather Bureau Station is maintained. The town derives its name from the platinum-placer mining in the area. A few native families live at Platinum, but the major native community is 12 miles northeast at Goodnews where school facilities are available. The community of Platinum is west of the Bristol Bay region; the western limit is Cape Newenham.

Dillingham, at the head of Nushagak Bay 65 miles west of Naknek-King Salmon, is the largest town in the region; it has a permanent population of about 500. During the peak of the fishing season, lasting from late June to mid-July, as many as 1,500 people inhabit the Nushagak fishing district. The

[2] Thomas, Bruce I., and Robert V. Berryhill. Reconnaissance Studies of Alaskan Beach Sands, Eastern Gulf of Alaska. BuMines Rept. of Inv. 5986, 1962, 40 pp.

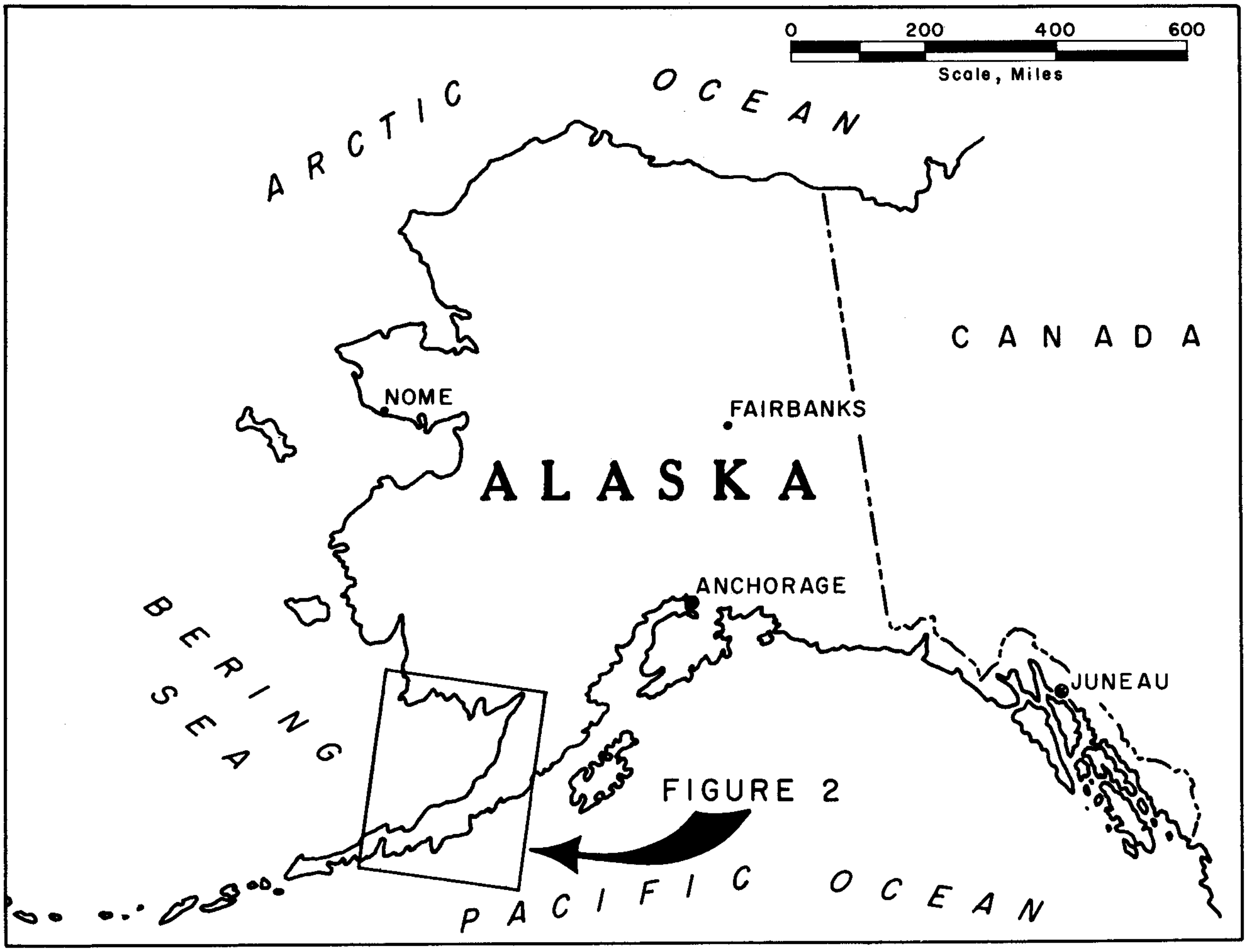

FIGURE 1. Index Map of Alaska.

town has two hotels, four general stores, a cafe, a theater, a post office, and a modern school system. An airstrip, about 3 miles west of town, will accommodate a DC-3 or equivalent aircraft. A small airstrip on the edge of town is used by the local bush pilots and private aircraft owners. Fresh-food supplies are flown in directly from Anchorage or via King Salmon. An Alaska Native Service hospital at Kanakanak, 4 miles south of Dillingham, provides medical care for the native population in the Bristol Bay region.

Naknek, one of the major fishing communities in the area, is situated at the head of Bristol Bay on Kvichak Bay at the mouth of the Naknek River. Naknek is connected with the King Salmon Air Base by a well-maintained gravel road. Naknek has a population of about 225, two general stores, a post office, an other services necessary for an active fishing community of its size. King Salmon has a post office, a general store, a cafe, and two hotels to serve the needs of the traveler.

The Bristol Bay region is bounded on the east and south by the Alaska Peninsula. Port Heiden is the first major embayment on the peninsula south of

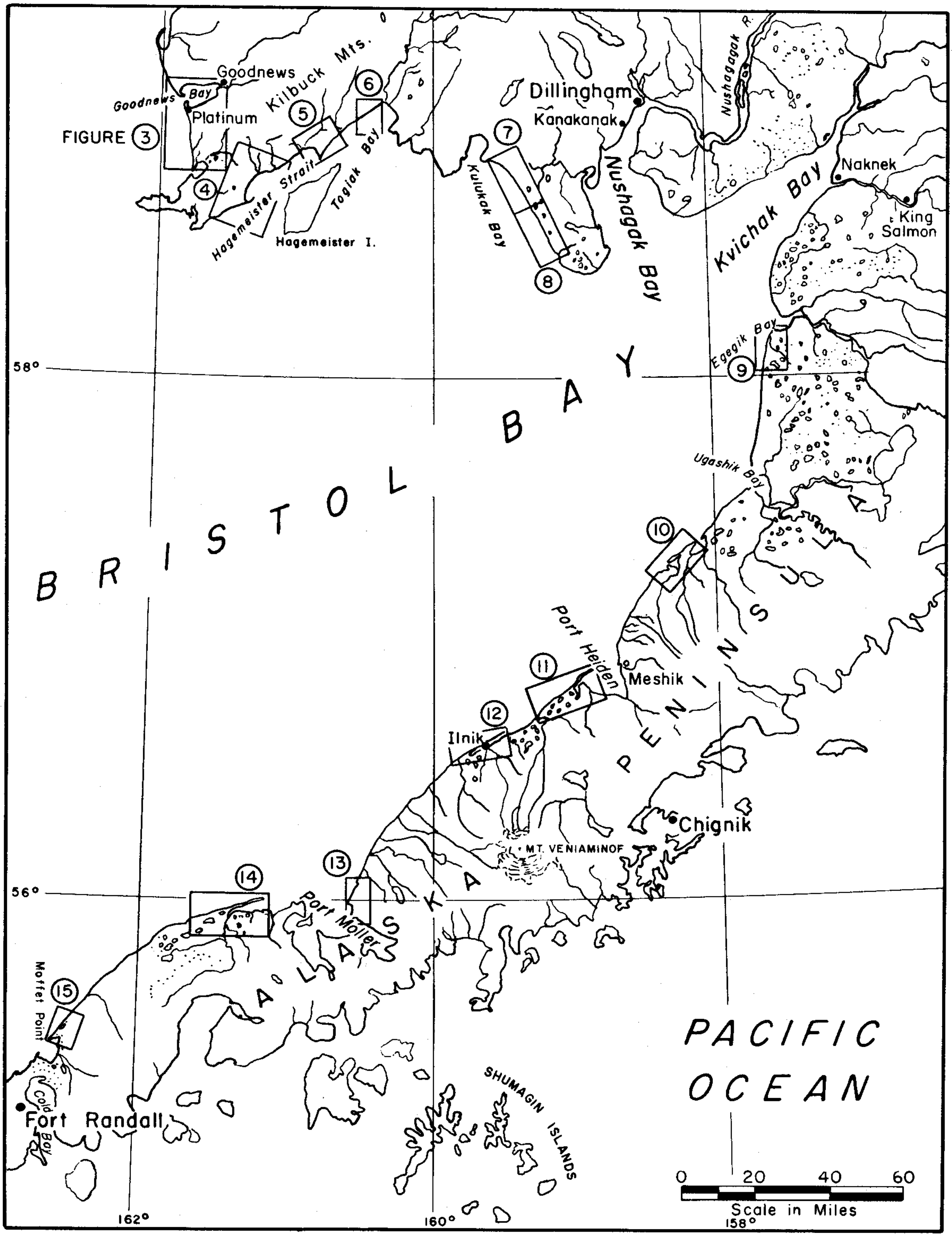

FIGURE 2. - Index to Location of Figures. Adapted from Geological Survey map.

King Salmon; here, an airfield is operated as an alternate refueling station by the Reeve Aleutian Airways for their Aleutian schedules. The village of Meshik (40 people) on the north shore of Port Heiden is 4 miles from the airfield and is the only community in the area; it has no stores or roadhouses.

Substantial fishing communities have developed on the tidal estuaries of the Egegik and Ugashik Rivers, which are intermediate between King Salmon and Port Heiden. Egegik and Ugashik (plus the downriver village of Pilot Point) do not have major airfields. Mail an other supplies are obtained through bush-aircraft service based at King Salmon. These villages were not used as a base of operations during this investigation, and the extent of facilities available to the traveler is unknown. During the fishing season, food and supplies can be obtained at the fish canneries.

South from Port Heiden the next community and multimotored aircraft landing field is at Port Moller. The indigenous population of the Port Moller area, approximately 30 people, is about equally divided between those living on the north side of the bay adjacent to the cannery and those living at Nelson Lagoon on the south side of the bay. There is no post office or store, but supplies may be purchased from the cannery, and temporary housing may be obtained.

Port Moller-Nelson Lagoon is the southernmost community on the north shore of the Alaska Peninsula. The next inhabited area to the southwest is Fort Randall on Cold Bay. There, an airbase constructed during World War II is being operated by the Federal Aviation Administration; the population is composed of people maintaining the various service facilities. Northwest Orient Airlines for several years has used the Cold Bay airfield as an alternate refueling stop on their Orient schedule; they maintain a hotel, store, and cafeteria on the field. Canadian Pacific Airlines and Reeve Aleutian Airlines use the field as a refueling stop. Reeve also maintains a small cafeteria and quarters for passengers between flights. The State Magistrate for the Unga recording district is stationed at Cold Bay; a post office is also maintained. Excepting jet and aviation fuels, there are no facilities available for fuel in bulk.

Oceangoing vessels carry freight between the Bristol Bay communities and west coast ports when consignments aggregate enough tonnage to justify delivery. The Alaska Steamship Co. schedules from three to five freighters a season to the region. There are no deep-water harbors in Bristol Bay, and the ships must anchor well offshore; all freight must be lightered from ship to shore, a distance of a few hundred yards at Dillingham and several miles at Naknek. At present, the major tonnage of freight comes into the bay region by ship; the remainder comes by air.

The region is entirely dependent upon air and water transportation; it has less than 150 miles of gravel roads. Except for the Naknek-King Salmon road, no roads exist between communities, and no highway system connects the region with central Alaska.

Most of the travel within the region is done in small airplanes with wheel landing gear. Good landing areas are plentiful along the hard-packed beaches, and every community has a small craft airstrip. The area probably has one of the highest aircraft per capita rates in the nation. Many of the pilot-owners have obtained commercial aviation licenses and are available for short-term charter flights; however, these pilots are usually not available during the height of the fishing season, particularly in July. Several regular bush pilots at both Dillingham and King Salmon service the coastal area on a nonscheduled basis. Western Alaska Airlines, with operations from Dillingham and King Salmon, maintain regular bush schedules to various villages. Aircraft necessary for access within the region are available for charter. Wheel planes are used along the coast, and float planes are generally used inland, landing on both rivers and lakes. During the investigation, small aircraft with wheel landing gear were available at Dillingham, King Salmon, and Cold Bay. In 1958, a three-place helicopter was available for charter at King Salmon.

During the summer months, fishing boats move along the coast. This means of travel is slow and uncertain because of the large tides, frequent storms, and continually shifting offshore bars and shoals; sometimes onshore landings may be made through the surf but often are difficult or impossible. It would be inadvisable to rely on boat services, as their movement is necessarily controlled by weather and fish, especially during the height of the fishing season. The fishermen are exceptionally skilled boatmen and are well acquainted with the coastal waters; they easily navigate the estuaries of the many large streams that discharge into the bay.

PHYSICAL FEATURES AND CLIMATE

Except for a small segment of beach lying at the southern extremity of the Kuskokwim River region near Goodnews Bay, all deposits examined during this investigation lie within the Alaska Peninsula and Bristol Bay regions as defined by the Bureau of Mines.[3]

The region comprises three well-defined geographic units: The first and most prominent is the Alaska Peninsula which includes the Aleutian Mountains, a southward continuation of the Alaska Range. The second unit is the comparatively low-lying but rugged Kilbuck Mountain system on the western border of the region. The Kilbuck Mountains on the west and the Aleutian Range on the east border the third unit consisting largely of wide lowlands fronting on the head of Bristol Bay. The lowlands are generally flat for some distance inland from the coast and rise gradually toward the base of the mountains enclosing the basin.

Extensive glaciation created many large lakes. Lake Iliamna, the largest in the State, covers an area of 2,000 square miles; it is the headwaters of the Kvichak River.

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[3]Ransome, A. L., and W. H. Kerns. Names and Definitions of Regions, Districts, and Subdistricts in Alaska (Used by the Bureau of Mines in Statistical and Economic Studies Covering the Mineral Industry of the Territory). BuMines Inf. Circ. 7679, 1954, 91 pp.

The coastline in the western part of the region lacks sandy beaches except for the large well-developed spits in the Hagemeister Strait and Goodnews Bay areas. The coastal waters are attacking bedrock and areas of glacial moraine; the glacial detritus is generally coarse, and some gigantic boulders are evident. The Togiak River is the major drainage in this western part of the region. The long spits developed in Hagemeister Strait and at Chagvan and Goodnews Bay are indicative of the strong ocean currents.

The coastline bordering Nushagak and Kvichak Bays is composed of dark gray silts which form broad tidal flats. At some places low morainal hills provide material for gravel beaches along the coast. Nushagak and Kvichak Bays are great shallow tidal embayments; shifting channels and shoals are evident in the middle of these bays and are continually being reworked by strong tidal currents. Tidal waters have a maximum rise of only 20 to 21 feet, but with low river gradients, the tidal pileup at the river's mouth will raise the water level for many miles upstream. The coastal foreland rises from a swampy, treeless lowland with a gradual slope inland over gently rolling benches of silt, sand, and gravel.

South of Kvichak Bay on the northwestern margin of the Alaska Peninsula, the land is low and the waters shallow. Sand and gravel beaches, sand reefs, and offshore bars characterize the coast. Pumice and volcanic ash are common constituents of many bars; Cinder River was probably named for the volcanic scoria it carries. Extensive sand dunes are indicative of the frequent strong winds. The lowlands between the sea and mountains consist of small knolls and shallows characteristic of glacial moraine. Water accumulated in the depressions has created many small lakes, swamps, and marshes.

The coastal plain and low foothills are generally void of timber. A few small spruce grow along the banks of rivers flowing from the north, but the region is essentially a tundra country. In wind-protected hollows and gullies, willows grow to several inches in diameter and up to 8 feet in height. Marsh grass is common, and a variety of wild hay grows along the crests of sand dunes paralleling the coast. Most types of animal life common to Alaska are abundant in the region.

All five species of Pacific salmon spawn in the Bristol Bay region, but the most important is the red salmon; more red salmon spawn here than anywhere else in the world. Almost the entire economic life of the region revolves about catching and processing the salmon as they migrate toward the spawning lakes.

The Bristol Bay area is not subject to severe annual fluctuations in temperature. Records show that January averages from 14° to 24° F and that July averages reach the mid-fifties. Snowfall is moderate, and the average annual precipitation is about 25 inches. The summers are cool and include many cloudy days. Sudden severe storms may occur at any time, and high winds are not uncommon. Drift ice begins forming in the bays by November and does not clear for navigation until June.

HISTORY AND PRODUCTION

The first white man to make a systematic survey of the region was Captain James Cook who entered the bay in 1778 and named it in honor of the Earl of Bristol. Before and after Cook's visit, the Russians, expanding eastward from Siberia, succeeded in establishing a fur trade in the bay area. After the United States purchased Alaska in 1867, the first real interest in the region by the Americans was in 1884 when an experimental cannery was established. By 1900, cannery operations were established on all the major rivers. During the early 1900's, gold was sought in the region, but few promising prospects were found. Placer gold has been mined from small operations in the Iliamna district at the head of Lake Iliamna. Several copper and a few lead prospects were also explored in the area.[4] Placer gold occurs in the Nushagak Hills,[5] but no production has been recorded. A cinnabar deposit on Marsh Mountain[6] near Aleknagik has been explored.

The only producing mining operation is at Platinum in the western extremity of the area examined. The history and geology of Platinum is well described in several Geological Survey bulletins.[7] The platinum placers were discovered in 1926, and production on a moderate scale has continued since dredging began in 1938.

The most promising recent mineral discovery in the Bristol Bay region was made in the Nushagak River valley where more than 800 20-acre lode claims were located on an iron deposit. The location of these claims, about 80 air miles north of Dillingham, renewed mining interest in the region. The deposit was indicated by an airborne magnetometer survey and proved by diamond drilling in an area of no outcrops.

The beaches in the region were probably prospected in the early days, but no substantial placer gold or platinum deposits were found. Gold was

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[4]Rutledge, F. A., and J. J. Mulligan. Investigation of the Millett Copper Deposit, Iliamna Lake, Southwestern Alaska. BuMines Rept. of Inv. 4890, 1952, 22 pp.
Smith, P. S. The Lake Clark-Central Kuskokwim Region, Alaska. Geol. Survey Bull. 655, 1917, 162 pp.
Warfield, R. S., and F. A. Rutledge. Investigation of Kasna Creek Copper Prospect, Lake Kontrashibuna, Lake Clark Region, Alaska. BuMines Rept. of Inv. 4828, 1951, 10 pp.

[5]Martin, G. C., and F. J. Katz. A Geologic Reconnaissance of the Iliamna Region, Alaska. Geol. Survey Bull. 485, 1912, p. 131.

[6]Webber, Burr S., Stuart C. Bjorklund, Franklin A. Rutledge, Bruce I. Thomas, and Wilfred S. Wright. Mercury Deposits in Southwestern Alaska. BuMines Rept. of Inv. 4065, 1947, pp. 54-57.

[7]Brooks, A. H., and Others. Mineral Resources of Alaska, Report on Progress of Investigations in 1919. Geol. Survey Bull. 714, 1921, pp. 207-228.
Mertie, J. B., Jr. Platinum Deposits of the Goodnews Bay District, Alaska. Geol. Survey Bull. 910-B, 1939, pp. 115-145.
Mertie, J. B., Jr. The Goodnews Platinum Deposits, Alaska. Geol. Survey Bull. 918, 1940, 97 pp.

discovered in beach sands of Togiak Bay in 1914,[8] but there is no record of production. Further interest in these deposits occurred in 1938, and a mild stampede developed,[9] but results were discouraging.

PROPERTY AND OWNERSHIP

Beach deposits in the Platinum and Hagemeister Strait areas have been covered by placer claims in the past, but there were no known active claims on beach deposits in the region in 1959. The descriptions of mining claims held in the region are on file in the Commissioner's offices at Bethel, Dillingham, Naknek, and Cold Bay.

GENERAL GEOLOGY AND DESCRIPTION OF THE DEPOSITS

The geology of the Bristol Bay region has been described by Spurr,[10] Knappen,[11] Mertie,[12] and others. The following discussion is a summary of the geological information contained in the cited publications supplemented by field observations by Bureau of Mines engineers.

The sands along the tidal zone in the western part of the region are limited in extent and occur primarily as deposits derived from the effects of classification by wave action on glaciofluvial material. Locally, strong ocean currents are abrading, transporting, and redepositing the sands along the coast as bars and spits. The sea washes alluvial cliffs and hard-rock bluffs in the Platinum, Togiak Bay, and Nushagak areas.

The Nushagak and Kvichak Bays geographically divide the region. Shorelines of the two bays were not examined because aerial reconnaissance indicated the strand line deposits here to be principally silt, mud, and clay bordered on the sea by extensive muddy tide flats. Bluffs of glaciofluvial material occur up to 200 feet in height along the shore of Nushagak Bay; eastward toward Kvichak Bay, the bluffs are lower and gradually disappear.

The eastern part of the region is a geographic and geologic unit. The lands are low lying and continue inland with very little relief to the mountains of the Aleutian Range. Evidence of glaciation is apparent intermittently along the entire north shore; between the head of Bristol Bay and Moffet Bay, low sea cliffs of glacial drift are being attacked by the sea. The north shore of the peninsula is broken by several large bays characterized by extensive sand and gravel spits, sand reefs, offshore bars, and small

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[8] Brooks, A. H., and others. Mineral Resources of Alaska, Report on Progress of Investigations in 1914. Geol. Survey Bull. 622, 1915, pp. 357-358.

[9] Smith, P. S. Mineral Industry of Alaska in 1938. Geol. Survey Bull. 917-A, 1939, p. 62.

[10] Spurr, J. E. A Reconnaissance of Southwestern Alaska in 1898. Geol. Survey 20th Ann. Rept., pt. 7, pp. 31-264.

[11] Knappen, R. S. Geology and Mineral Resources of the Aniakchak District. Geol. Survey Bull. 797, 1926, pp. 161-223.

[12] Mertie, J. B., Jr. The Nushagak District, Alaska. Geol. Survey Bull. 903, 1938, 91 pp.

islands. The waters of Bristol Bay are shallow, and the waves strike bottom long before reaching shore. Instead of doing much erosional work, the waves, undertow, and offshore currents are actively depositing and shifting the beach materials. Extensive sand dunes are also present along the entire coastline. The Recent beach and aeolian deposits were those sampled during the investigation.

WORK BY THE BUREAU OF MINES

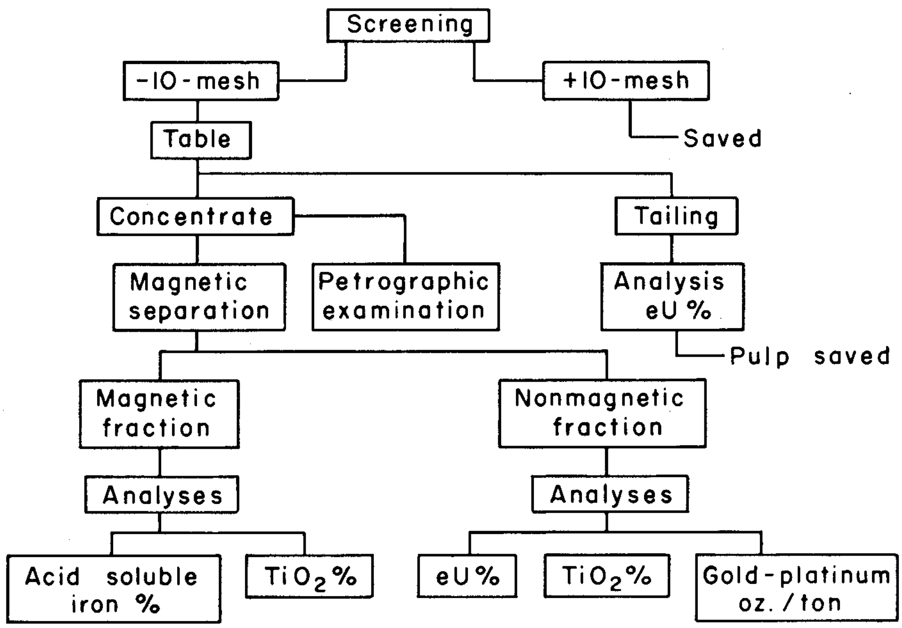
Field Investigations

The objective of the Bureau of Mines work was to do the minimum amount of sampling necessary to determine if heavy minerals were present in sufficient amount to justify more detailed investigation of selected areas. 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 program in the Bristol Bay region began June 5, 1958, recessed from August 28, 1958 to May 25, 1959, and was completed on July 20, 1959. During the field investigations, 220 auger holes were drilled by hand in key areas along approximately 220 miles of coastline. Test holes were spaced at intervals of 1 mile or less along the sand beaches; a total of 65 shovel samples was collected to supplement the auger test holes. All the travel between drill holes was on foot; sampling equipment and supplies were backpacked.

Laboratory Investigations

Samples containing appreciable amounts of heavy minerals were treated in the laboratory as shown by 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; acid soluble iron, equivalent TiO_2 and eU (radiometric uranium equivalent) analyses were completed. Petrographic examinations were made of the table concentrates to determine the mineral constituents.

Those samples that contained insufficient heavy mineral to justify table treatment were screened, and petrographic, acid soluble iron, and eU analyses were completed on the minus 10-mesh fraction. In most samples, petrographic analyses indicated too little titanium-bearing mineral to justify further analyses.

Gold and platinum analyses were made on samples in which more than traces of these metals had been observed during field concentration. Mineral constituents estimated to comprise more than 10 percent of the petrographic sample were recorded as major amounts. Minerals estimated to comprise between 1 and 10 percent were recorded as minor amounts, and those minerals comprising less than 1 percent were recorded as trace amounts. Screen oversize products (plus 10-mesh) were subjected to cursory petrographic analyses; no ore minerals were detected.

Sampling Methods and Equipment

Frequent moves along the coast required the selection of light and easily portable sampling equipment which would extract fairly representative samples from semicompacted beach sands. At all places it was necessary to backpack equipment between boring sites, but moves from area to area were made by small airplane.

During previous investigations by the Bureau of Mines[13] tests were conducted with various types of hand-operated soil-testing equipment; an Iwan (post-hole) auger was selected as best suited for the spot-sampling program. Hole depths of as much as 27 feet were obtained with a 3-inch Iwan auger in semicompacted beach sands. With caution, a fairly uniform open hole (without casing) can be bored and sampled to this depth within a period of 1-1/2 hours. The Iwan auger cannot be used to obtain accurate representative samples of coarse gravel, or from dry, loose or water-saturated sand, although roughly indicative samples of these materials may usually be obtained.

A water-volume-measurement method was developed to accurately measure the in-place volume of the sample taken. Field tests proved that 24-inch-circumference 0.002-gage polyethylene tubing inserted in the auger hole and water-filled provided an accurate measurement of the sample volume. The overall elapsed time to perform the measurement ranged from 10 to 30 minutes, depending on hole depth, availability of water, and other physical conditions. The method was developed because the 3-inch auger hole has an irregular cross section owing to sloughing which prohibits a calculation of the in-place volume. The wide range of particle size found in the different holes caused inaccuracies in applying a fixed-expansion factor to a measured volume loose. The

[13]Work cited in footnote 2.

24-inch-circumference tubing will work in 3-inch-diameter auger holes having a maximum depth of 20 feet and in which sloughing has occurred up to 2-1/2 times the diameter of the auger. The method consisted of tying a knot at one end of a precut length of the polyethylene plastic tubing, placing a cupful of water into the tube, and dropping the weighted tube to the bottom of the hole. The tube, acting as a containing element, was filled with a measured amount of water. The method was used only during the investigation of deposits at Port Heiden and southward along the Alaska Peninsula. Water measurements were made in selected auger holes within individual areas to determine an average expansion factor for the area, or when the quantity of contained heavy mineral, indicated by field concentration, justified the close check of the hole volume.

The percentage of heavy mineral recovered in the pan concentrate was determined by the panning efficiency of the sampler and by his judgment in selecting the correct panning end point; the desired end point was 100 percent recovery of all minerals having a specific gravity of 3.3 or more. During investigation of a beach deposit on the Gulf of Alaska, laboratory analyses of pan concentrates and pan tailings indicated that pan concentration recovered about 90 percent of the total acid soluble iron and about 77 percent of the total titania in samples containing about 180 pounds of these metals per cubic yard.

A light, compact, and readily portable bore-sampling kit consisting of the items listed in table 1 was used during the field investigations.

TABLE 1. - Bore-sampling equipment

Description	Quantity	Size
Iwan auger...................................	1	3 in
Aluminum pipe with coupling.................	6	1 in by 5 ft
Pipe coupling...............................	5	1 in
Pipe wrenches...............................	2	14 in
Pipe die nut................................	1	1 in
Tee handle for auger........................	1	
Gold pans...................................	3	16 in
Washtub, galvanized.........................	1	No. 2
Graduated water container...................	1	0.05 cu ft
Continuous roll 24-in circumference, 0.002-gage polyethylene tubing...........	2	300 ft

Bore-hole records show the location, depth of hole, and material at the bottom of the hole. Most of the holes penetrated sand and bottomed in water-saturated sand or loose gravel. The boring from each hole was measured loose in a gold pan and then was 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. Shovel samples were also substituted for auger holes where boulders or coarse gravel made auger sampling impractical.

Calculation of Sampling Results

The auger holes were not of uniform diameters because of sloughing from the walls; therefore, a volume computed by using the diameter of the auger and depth of hole is considered unsatisfactory. The measured volume loose (pan count times volume per pan) of the boring 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 of samples 1 through 179 (taken during the 1958 field season) was computed using this swell factor.

During the 1959 field season, the in-place volumes of several samples within individual areas were obtained by water-volume measurement. An average-expansion factor was then calculated for each area, and the in-place volumes for the remaining samples were computed; individual area swell factors varied from 1.30 to 1.39. Contained metals were calculated to pounds per in-place cubic yard.

Areas Investigated

Platinum

Except for sandy gravel spits on Goodnews and Chagvan Bays, beach deposits in the Platinum area are shallow and narrow, consisting essentially of a thin, sandy gravel veneer overlying coarser alluvial material. The sea is attacking bedrock at the base of Red Mountain. Here, for about 1-1/4 miles, the beach is strewn with large boulders embedded in loose sand and gravel. Access to the beach deposits south of Platinum (fig. 3) is obtained by using a four-wheel-drive vehicle and on foot. Those deposits north of Platinum are reached using an outboard-motor-driven boat.

Twenty-four auger-hole and twenty-three shovel samples were taken between the north spit of Goodnews Bay and Chagvan Bay. Select shovel samples (24 and 34) of thin-sand veneers representing only a few cubic yards of material were taken to indicate the maximum gold-platinum potential. The absence of yardage containing notable heavy minerals indicated detailed physical and chemical analysis of all samples would not be justified. Samples selected from natural surface concentrations, where found throughout the area, were composited and pan-concentrated; the concentration contained 33.8 percent acid soluble Fe, 12.1 percent Cr_2O_3, no eU, and less than 0.02 troy ounces per ton of Pt, Au, and Ag; petrographic analysis detected only those minerals found in the auger-hole and shovel samples. The mineral constituents of pan concentrates are shown in table 2. A summary of sampling results is shown in table 3.

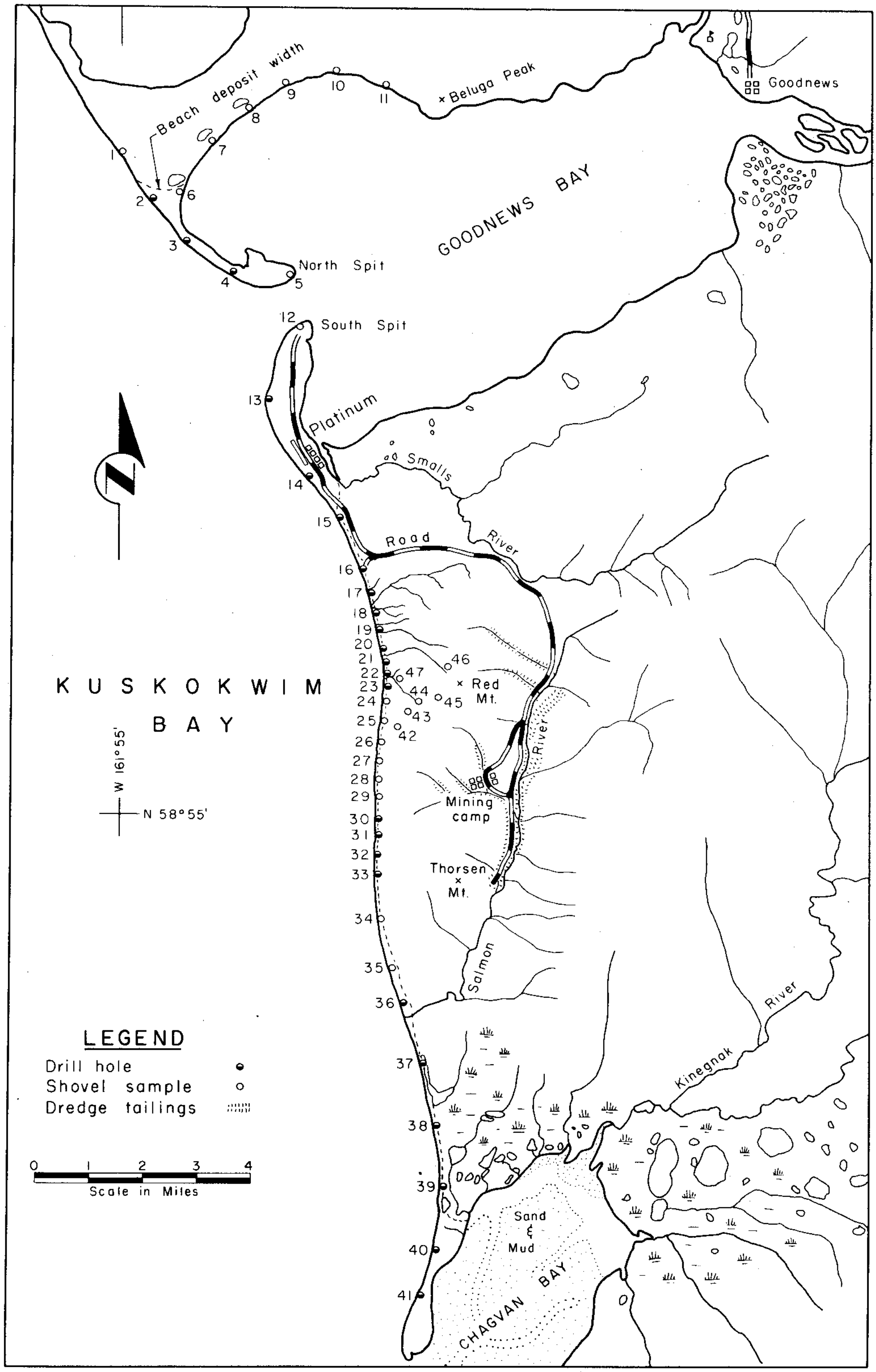


FIGURE 3. - Platinum. Adapted from Geological Survey map.

TABLE 2. - Petrographic analyses of pan concentrates from the Platinum area

Mineral constituent[1]	Sample 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Magnetite..........	1	1	1	2	3	3	3	3	3	3	-	2	1	1	1	1	1
Chromite...........	1	1	1	2	3	-	-	-	3	-	-	2	1	1	1	1	1
Zircon.............	2	3	2	3	-	-	-	-	-	3	-	3	3	-	3	3	3
Garnet.............	3	3	2	3	3	-	-	-	3	-	-	2	2	2	3	3	-
Limonite...........	3	3	-	-	-	-	-	-	-	-	-	-	2	2	2	2	2
Staurolite.........	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-
Augite.............	2	2	2	2	3	-	-	-	3	2	2	2	2	2	1	1	2
Epidote............	3	3	2	3	3	-	-	-	-	3	-	3	3	3	3	3	3
Hypersthene........	2	2	1	1	2	-	-	2	3	2	-	1	1	2	2	3	2
Hornblende.........	3	3	2	3	3	-	-	2	3	3	-	3	3	2	2	2	-
Olivine............	2	3	2	2	3	3	-	-	-	-	-	1	1	1	1	2	2
Chlorite...........	3	3	3	2	1	1	1	1	2	2	2	1	1	2	1	2	1
Feldspar...........	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
Quartz.............	2	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1

Mineral constituent[1]	Sample 18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Magnetite..........	1	1	1	1	1	1	1	2	1	1	2	2	1	1	1
Chromite...........	1	1	1	1	1	1	1	2	1	1	2	2	1	1	1
Zircon.............	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Garnet.............	3	3	-	3	3	-	3	3	3	-	-	3	3	3	3
Limonite...........	-	3	3	-	-	3	3	-	-	2	2	-	-	3	3
Staurolite.........	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-
Augite.............	1	1	2	2	2	3	1	1	1	2	1	1	1	2	1
Epidote............	2	-	-	3	-	3	3	3	-	-	-	3	3	3	1
Hypersthene........	2	2	2	1	2	2	2	2	2	3	3	2	2	2	2
Hornblende.........	2	2	2	2	3	2	2	2	3	3	2	2	2	3	3
Olivine............	1	1	1	1	1	1	1	1	1	2	2	1	1	2	3
Chlorite...........	2	2	1	1	1	1	2	2	2	1	2	2	2	3	3
Feldspar...........	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
Quartz.............	1	2	1	1	1	2	2	2	1	1	1	1	2	2	2

Mineral constituent[1]	Sample 33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Magnetite..........	1	1	1	1	1	1	1	1	1	-	-	-	-	-	2
Chromite...........	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2
Zircon.............	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3
Garnet.............	2	-	3	2	-	3	3	3	2	-	3	-	-	-	-
Limonite...........	-	-	3	3	-	-	-	3	3	2	3	3	3	3	3
Staurolite.........	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Augite.............	1	1	1	1	3	2	2	1	3	2	2	1	1	2	2
Epidote............	-	2	2	3	3	3	2	2	2	2	-	-	3	-	-
Hypersthene........	1	3	2	2	1	3	3	1	1	-	-	-	-	-	-
Hornblende.........	2	2	2	2	2	3	3	2	2	1	2	1	1	2	1
Olivine............	1	2	3	1	2	2	2	3	3	1	1	1	1	1	1
Chlorite...........	3	2	3	2	3	3	2	2	3	-	-	-	-	-	-
Feldspar...........	2	1	1	1	2	1	1	1	1	2	3	-	-	-	-
Quartz.............	2	2	1	2	2	1	2	2	1	2	2	3	-	-	3

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.

TABLE 3. - Auger-hole and shovel-sampling results from the Platinum area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Iron, pounds per cu yd in-place	Gold	Platinum
					Troy oz per cu yd	
1....	(1)	-	0.010	6.1	(2)	(4)
2....	4.4	Gravel..........	.014	1.5	(2)	(3)
3....	3.2	do.......	.014	5.5	(2)	(4)
4....	2.9	do.......	.014	1.3	(4)	(4)
5....	(1)	-	.010	3.2	(4)	(4)
6....	(1)	-	.005	(2)	(4)	(4)
7....	(1)	-	.005	(2)	(4)	(4)
8....	(1)	-	.005	(2)	(4)	(4)
9....	(1)	-	.005	(2)	(4)	(4)
10....	(1)	-	.005	(2)	(4)	(4)
11....	(1)	-	.005	(2)	(4)	(4)
12....	(1)	-	.010	2.2	(2)	(4)
13....	5.8	Gravel..........	.014	2.4	(2)	(4)
14....	4.0	do.......	.019	3.6	(2)	(3)
15....	2.7	do.......	.014	1.6	(2)	(4)
16....	3.7	do.......	.018	8.6	(2)	(4)
17....	2.3	Water and gravel	.007	4.2	(2)	0.0008
18....	1.9	Gravel..........	.007	23.0	(2)	(2)
19....	2.2	do.......	.005	13.3	(4)	(4)
20....	2.7	do.......	.008	10.2	(2)	(2)
21....	2.2	do.......	.009	8.0	(2)	(2)
22....	3.2	Water and gravel	.008	38.4	(2)	(2)
23....	2.2	Gravel..........	.006	5.6	(3)	(2)
24....	(1)	-	.010	21.3	(2)	.0178
25....	(1)	-	.010	8.4	(2)	(2)
26....	(1)	-	.010	12.8	(2)	(2)
27....	(1)	-	.010	8.3	(2)	(2)
28....	(1)	-	.010	3.5	(2)	(2)
29....	(1)	-	.010	3.4	(4)	(4)
30....	5.7	Mud.............	.013	6.4	(2)	(2)
31....	7.5	Gravel..........	.035	19.4	(2)	(2)
32....	2.3	do.......	.005	3.6	(2)	.0023
33....	2.7	do.......	.006	10.8	(2)	(2)
34....	(1)	-	.010	11.6	0.0736	.0573
35....	(1)	-	.010	22.2	(2)	(2)
36....	3.7	Gravel..........	.019	20.9	(2)	(2)
37....	6.8	Water and gravel	.019	8.5	(2)	(2)
38....	2.2	do.......	.010	13.2	(2)	(2)
39....	7.3	do.......	.027	4.2	(2)	(2)
40....	3.6	Gravel..........	.016	30.7	(2)	(2)
41....	2.7	do.......	.007	7.4	(2)	(2)
42....	(1)	-	.024	3.9	(2)	(2)
43....	(1)	-	.024	(2)	(2)	(2)
44....	(1)	-	.024	(2)	(2)	(2)
45....	(1)	-	.024	(2)	(2)	(2)
46....	(1)	-	.014	(2)	(2)	(2)
47....	(1)	-	.014	(2)	(2)	(2)

[1] Shovel sample. [2] Trace. [3] None. [4] No assay.

Hagemeister Strait

The beaches of the Hagemeister Strait area (fig. 4) are coarse gravel intermittently overlain by thin sand veneers; west of Asigyukpak Spit and east of Estus Point, the sea is attacking bedrock bluffs. The spit at the mouth of the Osviak River is the only extensive sand deposit in the area; black sands occurred in only trace amounts.

The area is accessible by means of small aircraft or boat. The beaches are generally unsuited for use as bush-plane fields; however, skilled pilots testing the beach in near-landing flight usually find a beach sufficiently packed for safe landing. There are no inhabitants in the area. Traveling this section of the coast on foot necessitates fording the tidal estuary at the mouth of the Osviak River. This estuary may be forded at low tide without too much difficulty.

A total of 13 auger-hole samples and 7 shovel samples was taken as shown. The mineral constituents of pan concentrates are shown in table 4. A summary of sampling results is shown in table 5. Trace quantities of flour gold were noted in most samples west of Asigyukpak Spit. Outcrops consisted of green schists, greenstone, and altered andesites, pyroxenites, and basalts.

TABLE 4. - Petrographic analyses of pan concentrates from the Hagemeister Strait area

Mineral constituent[1]	Sample																			
	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Magnetite........	3	1	3	2	2	2	2	1	3	3	3	2	2	2	3	2	2	3	2	3
Ilmenite.........	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	3	-
Chromite.........	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-	-
Zircon...........	-	3	3	3	3	3	3	3	3	3	3	-	3	3	-	3	-	-	3	-
Garnet...........	-	3	3	3	3	3	3	3	-	-	3	-	3	-	-	3	-	-	-	-
Limonite.........	-	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	2	-	-
Augite...........	1	2	2	2	1	2	3	2	2	2	2	2	3	2	3	3	3	3	3	-
Epidote..........	3	2	3	2	2	1	2	2	2	1	1	2	3	2	2	2	2	-	2	1
Hypersthene......	1	2	3	1	3	2	2	1	2	2	2	2	2	2	2	2	1	3	2	1
Hornblende.......	3	3	3	2	3	3	2	3	2	2	3	2	3	3	3	3	3	3	3	-
Olivine..........	3	3	3	2	2	2	3	2	2	3	3	2	3	2	3	3	2	-	2	-
Chlorite.........	1	1	2	2	2	2	2	2	2	3	1	2	3	3	2	2	3	2	2	1
Feldspar.........	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	1	2
Quartz...........	1	2	3	3	2	3	2	2	3	2	2	2	1	2	2	2	2	-	2	2

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.

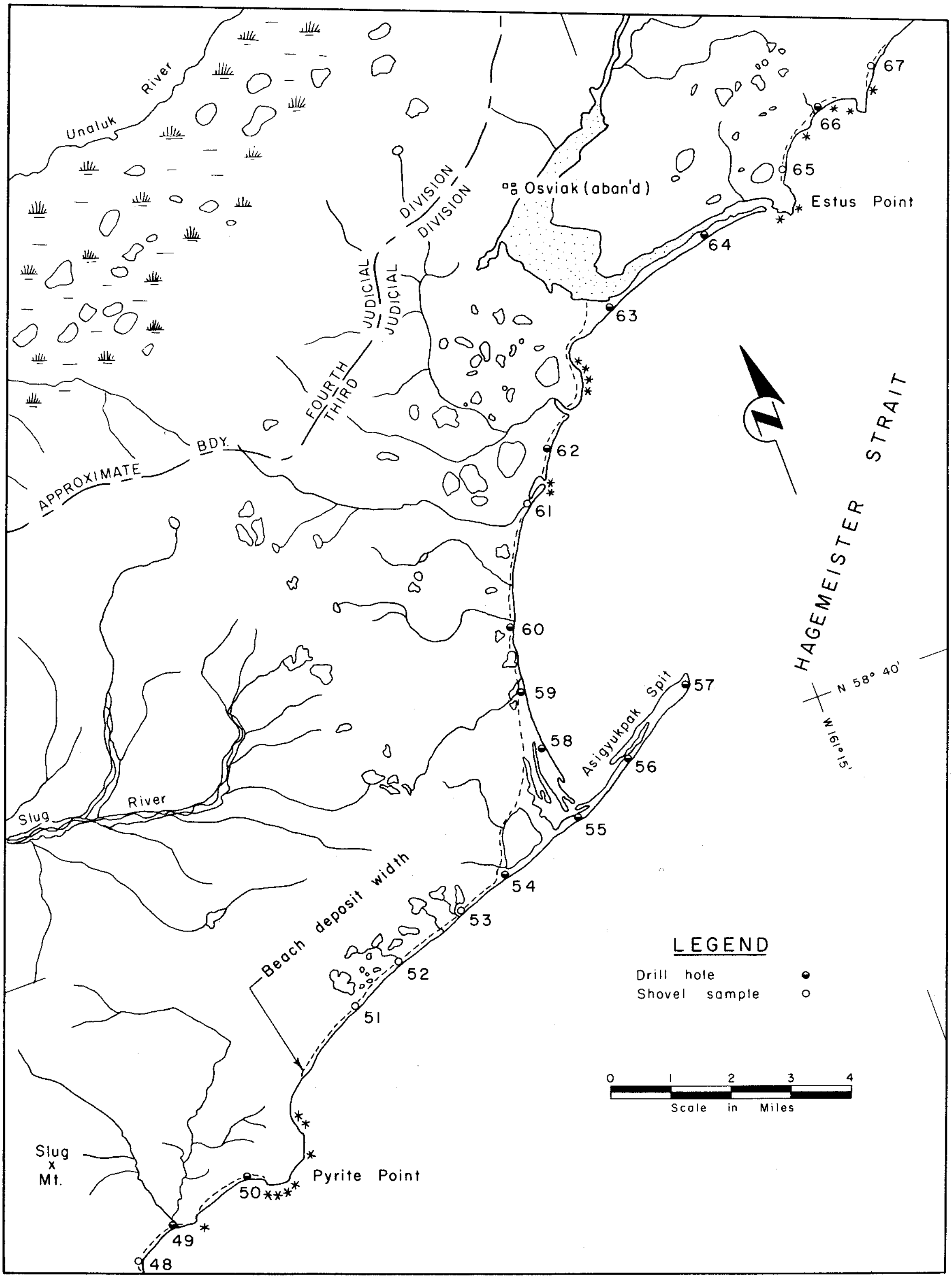


FIGURE 4. - Hagemeister Strait. Adapted from Geological Survey map.

TABLE 5. - Auger-hole and shovel-sampling results from the Hagemeister Strait area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Iron	eU	Gold, troy oz per cu yd
				Pounds per cu yd in-place		
48..............	([1])	-	0.010	1.8	([3])	([4])
49..............	7.9	Gravel..........	.018	6.1	([3])	([2])
50..............	6.0	Water and gravel	.015	.9	([3])	([2])
51..............	([1])	-	.010	3.8	([3])	([2])
52..............	([1])	-	.010	4.0	([3])	([2])
53..............	([1])	-	.010	7.3	([2])	([2])
54..............	2.9	Water and gravel	.008	2.7	([3])	([2])
55..............	5.8	Gravel..........	.014	2.5	([3])	([2])
56..............	4.4	do.......	.010	2.9	([3])	([4])
57..............	4.9	do.......	.014	.5	([3])	([4])
58..............	3.4	do.......	.014	.5	([3])	([2])
59..............	2.4	do.......	.011	.8	([2])	([4])
60..............	3.7	do.......	.008	3.0	([3])	([4])
61..............	([1])	-	.010	1.9	([3])	([4])
62..............	3.8	Water and gravel	.010	1.9	([3])	([4])
63..............	11.4	Water and sand..	.029	.9	([3])	([4])
64..............	13.6	Gravel..........	.032	1.0	([3])	([4])
65..............	([1])	-	.010	1.4	([3])	([4])
66..............	5.2	Water and gravel	.014	1.2	([3])	([4])
67..............	([1])	-	.010	.8	([3])	([4])

[1] Shovel sample. [2] Trace. [3] None. [4] No assay.

Hagemeister Strait-Togiak Bay

The beaches of the Hagemeister Strait-Togiak Bay area (figs. 5 and 6) are similar to those found in the southwestern Hagemeister Strait area (fig. 4). On Tongue Point coarse gravel is overlain by thin sand veneers. Elsewhere the sea is eroding bedrock and alluvial bluffs. In places beneath the bluffs, either no beach exists or it is composed of large boulders embedded in a sandy gravel matrix.

The Hagemeister Strait-Togiak Bay area (figs. 5 and 6) is accessible by small aircraft or boat. An airstrip at Togiak, the only one in the area, is suitable for use by small bush planes. The beaches near Tongue Point are suited for small-plane landings. The strand line cannot be traversed on foot because sheer shoreline bluffs occur, particularly adjacent to Aeolus Mountain.

Petrographic examination of bedrock outcrop specimens taken along the shoreline (figs. 5 and 6) indicated that the predominant rock types were andesite and altered basalt. Fifteen auger hole samples and eleven shovel samples were taken in the area. Petrographic analyses of the pan concentrates are given in table 6. A summary of sampling results is shown in table 7.

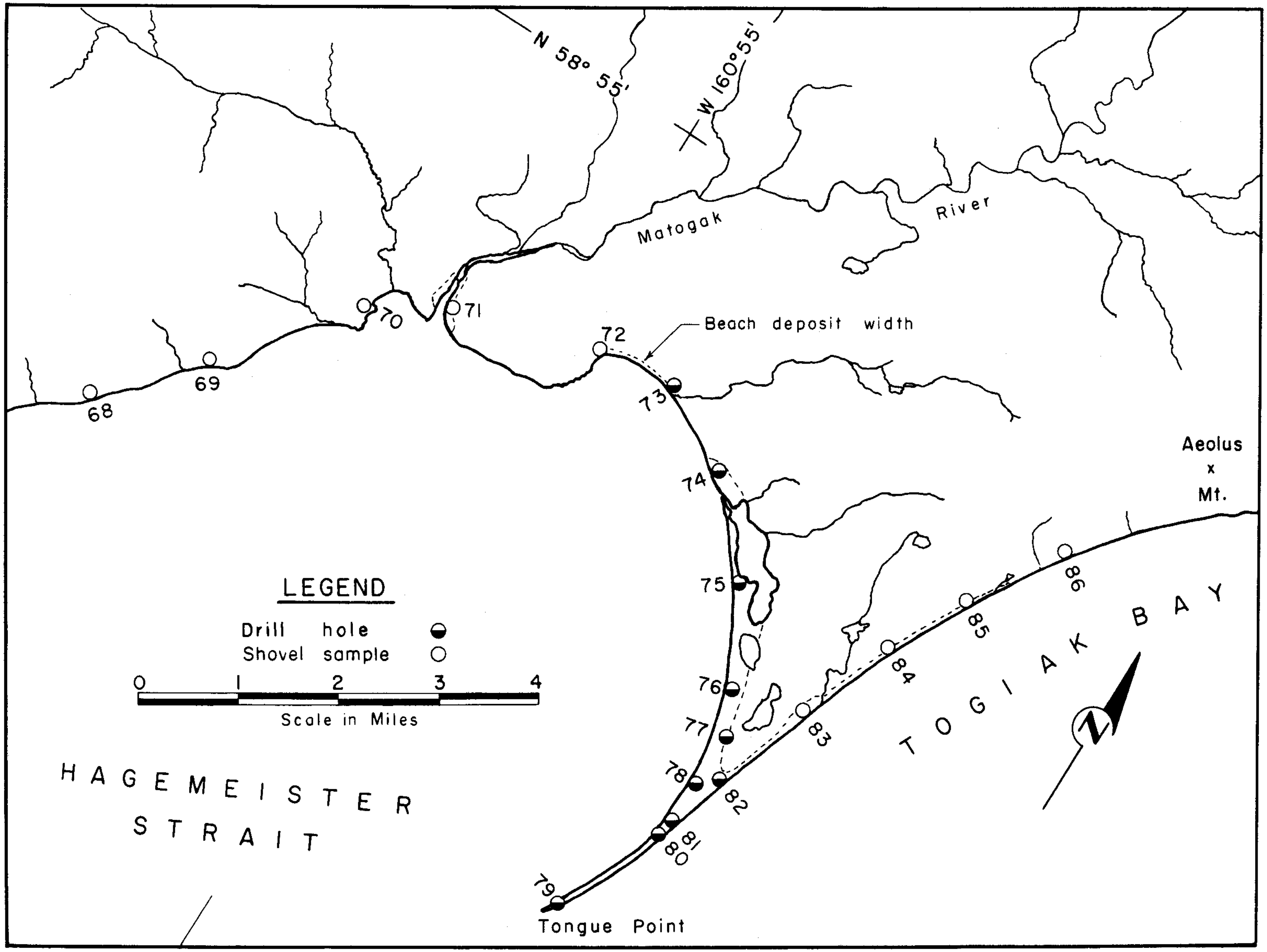


FIGURE 5. - Hagemeister Strait-Togiak Bay. Adapted from Geological Survey map.

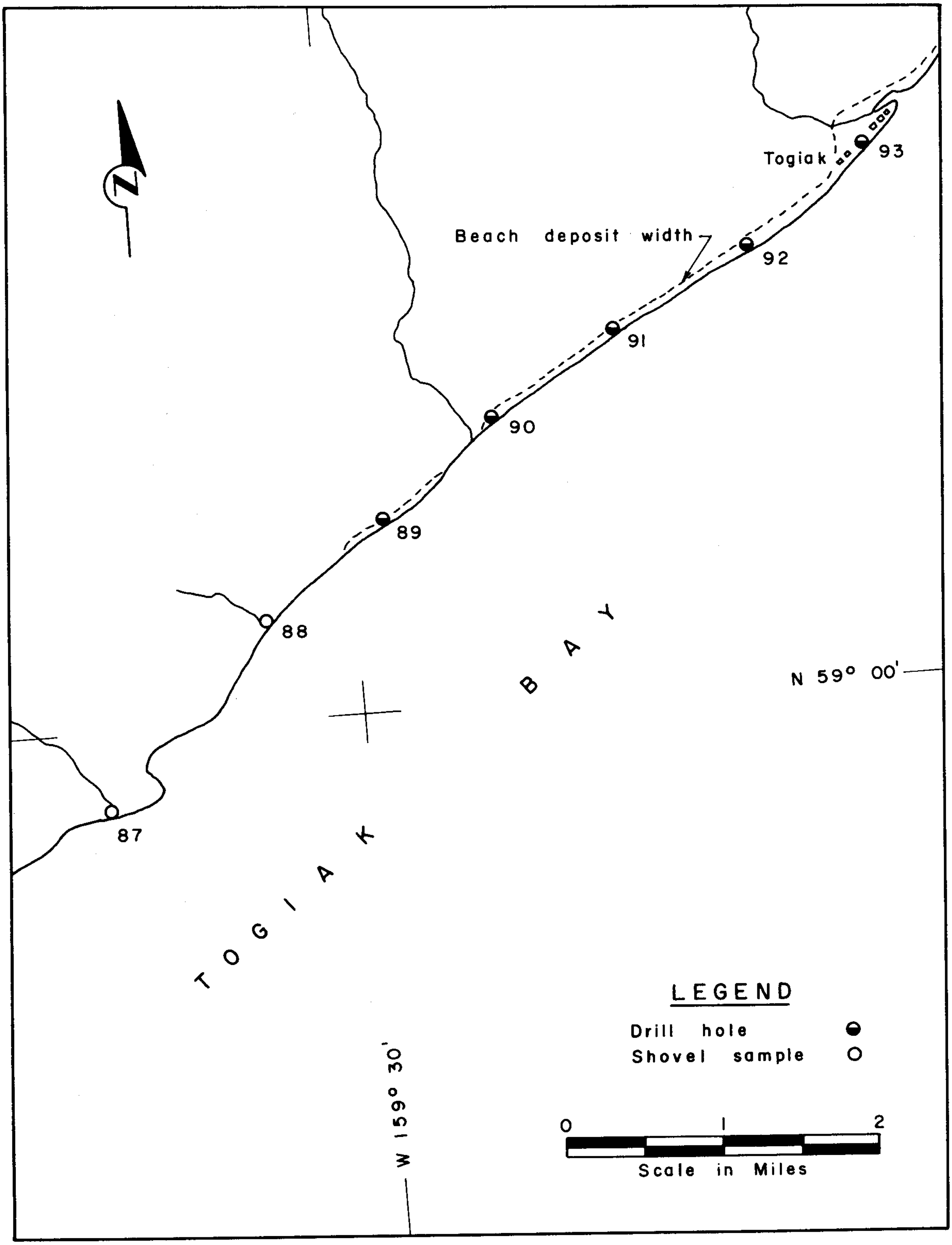


FIGURE 6. - Togiak Bay. Adapted from Geological Survey map.

Small quantities of flour gold were in the pan concentrates of samples 77, 81, and 86. Sample 86 represents a thin veneer of sands concentrated below a 40-foot bluff of glaciofluvial material that was the source of flour gold. Several old hand-dug surface trenches were noted on Tongue Point.

TABLE 6. - Petrographic analyses of pan concentrates from the Hagemeister Strait-Togiak Bay area

Mineral constituent[1]	Sample												
	68	69	70	71	72	73	74	75	76	77	78	79	80
Magnetite................	3	3	3	3	3	3	3	3	3	3	3	3	3
Titaniferous magnetite...	-	-	-	-	-	-	-	-	-	-	-	-	-
Zircon...................	-	-	-	3	-	3	3	3	-	-	-	-	-
Garnet...................	-	-	-	-	-	-	-	-	-	-	-	-	-
Limonite.................	3	-	-	3	3	3	3	3	3	3	3	-	-
Pyroxene.................	3	3	3	3	2	2	2	3	3	2	3	3	3
Epidote..................	2	3	2	3	-	3	-	-	-	3	3	3	-
Hornblende...............	-	3	-	3	3	3	3	-	-	3	3	-	3
Olivine..................	3	3	3	2	2	2	2	3	3	2	3	3	3
Biotite..................	-	-	-	-	-	-	-	-	-	3	-	-	-
Chlorite.................	2	2	2	3	3	3	3	3	3	3	3	-	3
Feldspar.................	1	1	1	2	2	3	2	2	3	2	2	3	2
Quartz...................	2	2	2	3	3	2	3	2	2	3	2	2	3
Rock fragments...........	1	1	1	1	1	1	1	1	1	1	1	1	1
	Sample												
	81	82	83	84	85	86	87	88	89	90	91	92	93
Magnetite................	-	-	-	-	-	-	-	3	3	-	3	3	3
Titaniferous magnetite...	2	2	2	2	2	2	2	-	-	2	-	-	-
Zircon...................	-	-	-	-	3	3	3	-	-	-	-	-	-
Garnet...................	-	-	-	-	3	-	-	-	-	3	-	-	-
Limonite.................	-	3	-	3	3	-	3	3	3	3	3	3	3
Pyroxene.................	2	2	2	3	2	2	2	3	3	3	3	3	3
Epidote..................	-	-	-	-	3	3	-	-	-	-	-	-	-
Hornblende...............	3	-	3	3	3	3	-	3	-	3	3	3	3
Olivine..................	2	2	2	2	2	2	2	2	2	2	2	3	3
Biotite..................	-	-	-	-	-	-	-	3	-	-	3	3	3
Chlorite.................	3	-	3	3	2	3	3	3	3	3	3	3	3
Feldspar.................	3	2	2	2	3	3	3	2	2	2	2	2	2
Quartz...................	3	3	3	3	3	3	3	3	3	3	3	3	3
Rock fragments...........	1	1	1	1	1	1	1	1	1	1	1	1	1

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.

TABLE 7. - Auger-hole and shovel-sampling results from the Hagemeister Strait-Togiak Bay area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Iron	eU
				Pounds per cu yd in-place	
68............	(1)	-	0.010	1.0	(2)
69............	(1)	-	.010	1.2	(2)
70............	(1)	-	.010	1.4	(2)
71............	(1)	-	.010	1.8	(3)
72............	(1)	-	.010	1.3	(3)
73............	2.4	Gravel..........	.007	2.9	(2)
74............	3.0	do.......	.008	2.6	(2)
75............	3.7	do.......	.010	2.1	(2)
76............	3.2	do.......	.010	2.0	0.001
77............	7.8	Water and gravel	.047	1.0	(2)
78............	3.0	Gravel..........	.010	1.8	(3)
79............	2.0	do.......	.005	3.0	.001
80............	1.9	do.......	.004	3.6	(2)
81............	5.7	do.......	.018	2.2	(2)
82............	4.2	do.......	.034	.3	(2)
83............	(1)	-	.014	1.8	.001
84............	(1)	-	.010	1.8	(2)
85............	(1)	-	.010	4.4	(2)
86............	(1)	-	.010	4.6	.001
87............	(1)	-	.014	1.3	(2)
88............	(1)	-	.014	1.9	(2)
89............	4.1	Gravel..........	.014	1.9	(2)
90............	5.9	do.......	.022	1.2	(3)
91............	5.5	do.......	.013	2.1	(2)
92............	4.4	do.......	.014	2.2	(3)
93............	1.9	do.......	.005	5.1	(2)

[1] Shovel sample. [2] None. [3] Trace.

Nushagak Peninsula

The Nushagak Peninsula (figs. 7 and 8) is a large low-lying mass of alluvial material extending south from the Wood River Mountain foothills into Bristol Bay. The southern limit of bedrock crops out near Tvativak Bay; no bedrock outcrops are known to occur on the peninsula. The sea is eroding the peninsula south of Kikertalik Lake; here, narrow sandy gravel beaches lie beneath 20- to 40-foot bluffs of mud and silt. North of Kikertalik Lake Recent sand and gravel beaches occur a mile in width.

The Nushagak Peninsula is a primitive uninhabited area accessible by air or boat from Dillingham. The beaches are suitable for bush-plane landings; those north of Kikertalik Lake could be used by DC-3 or equivalent planes.

The beach area shown was sampled with 41 auger holes and 3 shovel samples. Samples 104 through 108 and 112 through 118 were made to determine the heavy mineral content of older beaches running parallel to the present strand line. Petrographic examinations of pan concentrates are shown in table 8. A summary of sampling results is shown in table 9. Analyses of eU in percentage were negative in all samples.

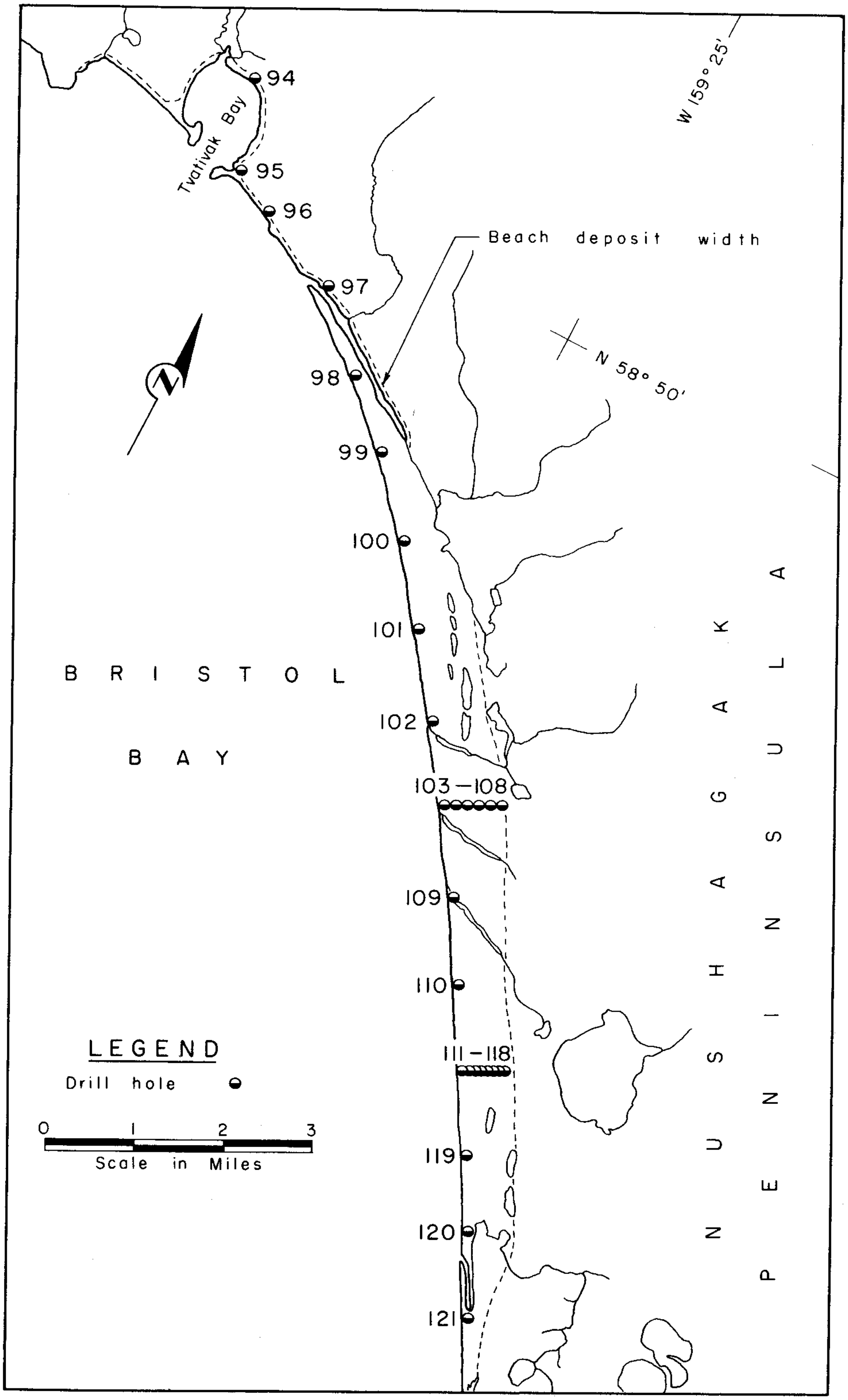


FIGURE 7. - Nushagak Peninsula (Samples 94-121). Adapted from Geological Survey map.

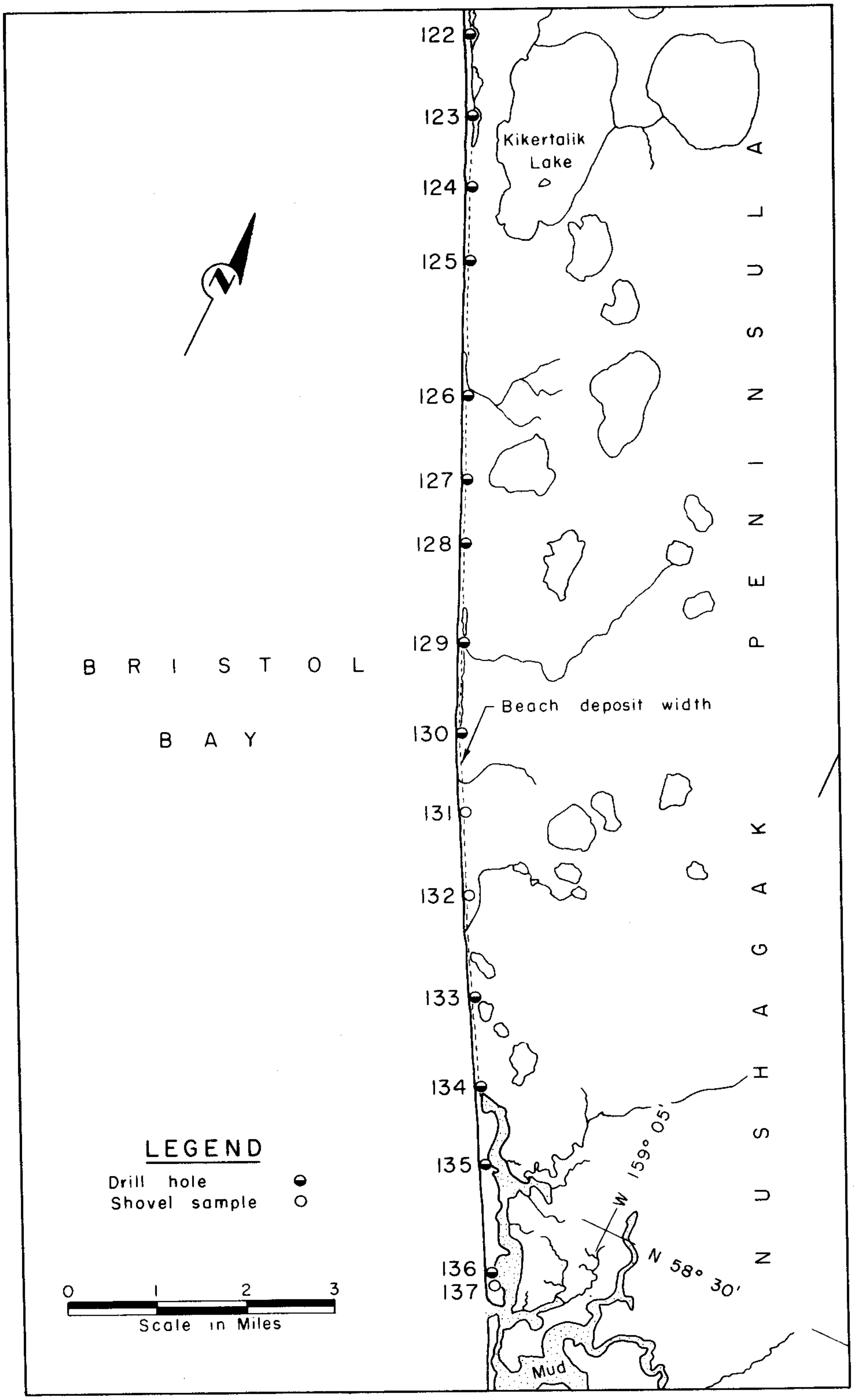


FIGURE 8. - Nushagak Peninsula (Samples 122-137). Adapted from Geological Survey map.

TABLE 8. - Petrographic analyses of pan concentrates from the Nushagak Peninsula area

Mineral constituent[1]	Sample												
	94	95	96	97	98	99	100	101	102	103	104	105	106
Magnetite.........	-	3	3	3	2	-	-	-	-	-	-	-	-
Titaniferous magnetite.......	3	-	-	-	-	2	2	3	3	2	3	3	3
Franklinite.......	-	3	-	-	-	-	-	-	-	-	-	-	-
Ilmenite..........	-	-	-	-	3	3	3	3	3	3	3	3	3
Zircon............	3	3	-	-	3	3	3	3	3	3	3	3	3
Garnet............	-	3	-	3	3	3	-	3	3	3	3	3	-
Pyroxene..........	2	3	3	2	2	2	2	2	2	2	2	2	2
Sphene............	-	-	-	3	3	-	3	3	-	3	-	3	-
Epidote...........	-	3	3	3	3	3	3	3	3	3	3	3	-
Hornblende........	-	3	3	3	3	3	3	3	3	3	3	3	-
Olivine...........	-	-	-	-	3	2	3	3	3	-	-	3	-
Chlorite..........	3	-	3	-	-	-	3	-	-	-	3	3	-
Feldspar..........	2	1	2	2	1	1	2	2	2	2	2	2	2
Quartz............	3	2	2	2	2	2	2	2	2	2	2	2	1
Rock fragments....	1	1	1	1	1	1	1	1	1	1	1	1	1

	Sample											
	107	108	109	110	111	112	113	114	115	116	117	118
Magnetite.........	-	-	-	-	-	-	-	-	-	-	-	-
Titaniferous magnetite.......	2	2	2	2	2	2	3	2	2	2	2	2
Franklinite.......	-	-	-	-	-	-	-	-	3	3	3	3
Ilmenite..........	3	3	3	3	3	3	3	3	3	3	3	3
Zircon............	3	3	3	3	3	3	3	3	3	3	3	3
Garnet............	-	3	3	3	3	3	3	3	3	3	3	3
Pyroxene..........	2	2	2	2	2	2	2	1	1	2	2	2
Sphene............	3	3	-	3	-	-	-	-	3	-	-	3
Epidote...........	3	3	3	3	3	3	3	3	3	3	3	3
Hornblende........	3	2	3	3	3	3	3	3	3	3	3	3
Olivine...........	3	3	3	3	3	3	-	-	-	-	-	-
Chlorite..........	-	-	-	-	-	-	-	-	-	3	-	-
Feldspar..........	2	2	2	2	2	2	1	1	1	2	2	2
Quartz............	2	2	1	2	2	2	1	1	1	2	2	1
Rock fragments....	1	1	1	1	1	1	1	1	1	1	1	1

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.

TABLE 8. - Petrographic analyses of pan concentrates from the Nushagak Peninsula area (Con.)

Mineral constituent[1]	Sample									
	119	120	121	122	123	124	125	126	127	128
Magnetite..................	-	-	-	-	-	-	-	3	3	3
Titaniferous magnetite.....	2	2	2	2	2	2	2	2	2	2
Franklinite................	-	-	-	-	-	-	-	-	-	-
Ilmenite...................	3	3	3	3	3	3	3	3	3	3
Zircon.....................	3	3	3	3	3	3	3	3	3	3
Garnet.....................	3	3	3	3	3	3	3	3	3	3
Pyroxene...................	2	2	2	2	2	2	2	2	2	2
Sphene.....................	-	-	-	-	-	-	-	3	-	-
Epidote....................	3	3	3	3	3	3	3	3	3	3
Hornblende.................	3	3	-	3	3	3	-	-	3	3
Olivine....................	3	-	3	-	3	3	-	-	-	3
Chlorite...................	-	-	-	-	-	-	-	-	-	-
Feldspar...................	2	2	2	2	2	2	2	2	2	2
Quartz.....................	2	2	2	2	2	2	2	2	2	2
Rock fragments.............	1	1	1	1	1	1	1	1	1	1

	Sample								
	129	130	131	132	133	134	135	136	137
Magnetite..................	3	3	-	-	-	-	-	-	-
Titaniferous magnetite.....	2	2	2	2	2	2	2	2	2
Franklinite................	-	-	-	-	-	-	-	-	-
Ilmenite...................	3	3	2	3	3	3	3	3	3
Zircon.....................	3	3	3	3	3	3	3	3	3
Garnet.....................	3	3	3	3	3	3	3	3	3
Pyroxene...................	2	2	2	2	2	2	2	2	2
Sphene.....................	-	-	3	-	-	-	-	-	-
Epidote....................	3	3	3	3	3	3	3	3	3
Hornblende.................	3	3	3	3	3	3	-	3	3
Olivine....................	-	-	-	-	3	3	3	3	3
Chlorite...................	-	-	-	-	-	-	-	-	-
Feldspar...................	2	2	2	2	2	2	2	2	2
Quartz.....................	2	2	2	2	2	2	2	2	1
Rock fragments.............	1	1	1	1	1	1	1	1	1

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.

TABLE 9. - Auger-hole and shovel-sampling results from the Nushagak Peninsula area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Iron, pounds per cu yd in-place
94...........	1.0	Gravel.............	0.005	2.9
95...........	3.1	Water and sand.....	.005	.6
96...........	2.1	do..........	.004	2.6
97...........	5.1	do..........	.011	.9
98...........	4.7	do..........	.010	2.5

[1] Shovel sample.

TABLE 9. - Auger-hole and shovel-sampling results from the Nushagak Peninsula area (Con.)

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Iron, pounds per cu yd in-place
99	5.7	Water and sand	0.013	3.9
100	4.8	Gravel	.014	1.8
101	5.4	do	.019	1.7
102	6.0	do	.014	2.6
103	8.7	do	.022	1.8
104	6.8	do	.019	2.2
105	4.2	do	.010	3.3
106	2.0	do	.005	3.0
107	2.8	Water and sand	.005	7.3
108	5.2	Water and gravel	.010	2.3
109	13.8	Gravel	.043	1.3
110	14.0	do	.043	1.3
111	6.8	do	.014	3.0
112	10.8	do	.014	3.4
113	5.9	do	.014	2.5
114	9.6	Water and sand	.022	5.0
115	6.5	do	.016	2.8
116	5.5	do	.013	4.2
117	3.6	do	.006	4.6
118	1.7	Frost and sand	.003	5.1
119	13.8	Gravel	.031	2.6
120	12.0	do	.028	2.5
121	13.5	do	.034	1.8
122	12.9	Water and sand	.030	1.2
123	11.0	Gravel	.026	3.2
124	10.6	do	.029	2.7
125	5.6	Silt	.010	1.6
126	9.1	Gravel	.023	3.6
127	13.6	do	.041	2.3
128	10.6	do	.038	2.4
129	7.5	do	.029	2.1
130	6.9	do	.028	2.8
131	(1)	-	.014	3.2
132	(1)	-	.014	2.8
133	2.8	Mud	.007	7.2
134	4.9	Gravel	.014	11.9
135	5.0	do	.019	3.0
136	3.1	do	.008	5.4
137	(1)	-	.005	16.7

[1] Shovel sample.

Egegik

In the Egegik area, (fig. 9) between Egegik Bay and the place where sample 149 was obtained, Recent sand and gravel beaches occur from 100 yards to a mile in width. Along the wider beach a series of semicontinuous sand dunes

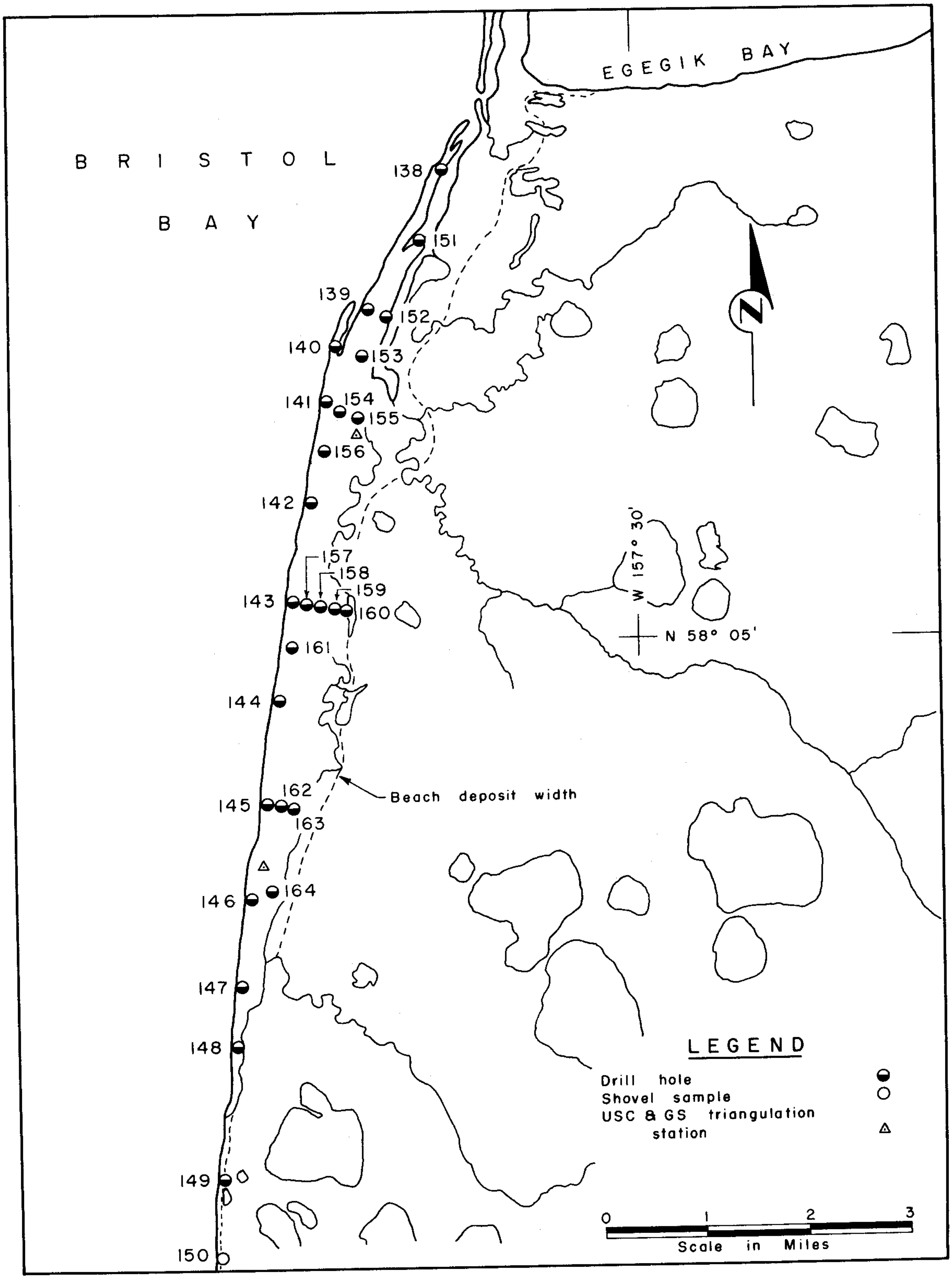


FIGURE 9. - Egegik. Adapted from Geological Survey map.

parallel the strand line. The present beach is sandy, usually hard-packed, and may be used as bush plane fields. Small aircraft or boats are used for access.

A total of 26 auger samples and 1 shovel sample was taken. The mineral constituents of the table concentrates from these samples are shown in table 10. A summary of sampling results is shown in table 11. During aerial reconnaissance considerable black sand was observed along the strand line. Samples taken as shown along the shore are indicative of the extent of surf and aeolian concentration. Within a small area near where sample 140 was found, surface concentrations of black sand were up to 2 feet in thickness. Auger holes drilled on older beach lines inland did not intersect the classified heavy mineral stringers that were found on the outer beach. Traces of flour gold were noted in the pan concentrates of samples 142, 144, 146, and 156.

TABLE 10. - Petrographic analyses of table concentrates from the Egegik area

Mineral constituent[1]	Sample													
	138	139	140	141	142	143	144	145	146	147	148	149	150	151
Titaniferous magnetite	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hematite..............	3	-	3	-	-	-	2	2	2	-	2	3	3	-
Ilmenite..............	2	2	1	2	2	3	2	2	2	2	2	2	-	3
Zircon................	3	-	-	-	-	-	-	3	3	3	-	-	3	3
Garnet................	2	2	1	2	2	2	2	2	2	2	2	2	3	2
Pyroxene..............	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sphene................	-	-	3	-	-	-	3	-	-	3	3	3	-	-
Epidote...............	3	3	3	3	3	3	-	3	3	3	3	3	3	-
Hornblende............	3	3	3	3	3	3	3	-	-	3	3	3	3	-
Olivine...............	3	3	3	-	3	-	3	3	3	3	3	3	-	3
Chlorite..............	-	-	-	-	-	3	-	-	-	-	-	-	3	-
Feldspar..............	2	2	2	2	2	3	3	3	3	2	2	2	1	2

Mineral constituent[1]	Sample												
	152	153	154	155	156	157	158	159	160	161	162	163	164
Titaniferous magnetite	1	1	1	1	1	1	1	1	1	1	1	1	2
Hematite..............	-	3	-	-	3	3	3	3	3	3	3	3	2
Ilmenite..............	2	2	2	2	2	2	3	3	2	2	3	2	3
Zircon................	-	-	-	-	-	-	-	3	-	-	3	-	3
Garnet................	2	2	2	2	2	2	3	2	2	2	2	2	2
Pyroxene..............	1	1	1	1	1	1	1	1	1	1	1	1	1
Sphene................	-	-	-	-	-	-	-	-	3	3	-	3	-
Epidote...............	3	3	3	-	3	3	3	3	3	-	3	-	3
Hornblende............	-	3	3	3	-	3	3	3	3	-	3	3	-
Olivine...............	-	3	-	3	3	3	3	3	3	3	3	3	3
Chlorite..............	-	3	-	-	-	-	-	-	3	-	-	-	-
Feldspar..............	2	2	2	2	2	2	2	2	2	1	2	1	2

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.

TABLE 11. - Auger-hole and shovel-sampling results from the Egegik area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
				Pounds per cu yd in-place		
138.....	3.4	Gravel..........	0.014	5.6	1.4	0.9
139.....	6.6	do.......	.027	8.3	1.9	1.0
140.....	7.2	Water and sand..	.014	245.7	53.2	19.2
141.....	9.4	do.......	.044	21.0	4.8	2.1
142.....	9.4	do.......	.025	66.4	13.8	6.4
143.....	8.6	Gravel..........	.029	12.0	2.6	1.6
144.....	5.3	Water and sand..	.012	25.8	5.9	3.0
145.....	8.9	Gravel..........	.023	17.0	4.0	1.9
146.....	13.0	Water and gravel	.028	19.5	4.4	2.1
147.....	4.1	Gravel..........	.012	36.4	8.0	3.8
148.....	5.1	Water and mud...	.010	83.3	19.4	8.2
149.....	3.6	Water and sand..	.007	68.1	14.5	6.4
150.....	([1])	-	.010	7.7	1.8	1.8
151.....	1.7	Gravel..........	.010	5.7	1.4	.6
152.....	5.0	do.......	.015	18.4	4.4	2.4
153.....	9.5	do.......	.033	20.6	4.9	2.6
154.....	5.6	do.......	.023	13.0	3.0	1.4
155.....	9.3	do.......	.029	7.1	1.7	1.0
156.....	7.3	do.......	.019	21.0	4.7	2.5
157.....	6.8	do.......	.020	4.7	1.1	.8
158.....	6.5	do.......	.024	4.3	1.0	.6
159.....	4.7	do.......	.012	11.6	2.7	1.5
160.....	7.0	do.......	.017	10.0	2.4	1.4
161.....	4.4	do.......	.010	51.8	11.0	5.8
162.....	9.3	Water and sand..	.029	21.3	4.6	1.8
163.....	11.6	do.......	.032	13.4	3.2	1.5
164.....	2.6	Gravel..........	.010	5.4	1.3	1.0

[1] Shovel sample.

Cinder River

The Cinder River (fig. 10) beach deposits are generally narrow and border low, muddy cutbanks. Narrow spits have developed along the outer shores of mudflats. Black-sand deposits observed along the strand line during aerial reconnaissance were found to be thin veneers of surf-concentrated magnetite sands. Abundant pyroxene gave the sands a black cast, which from the air indicated more magnetite than was found in sampling. The coastline south of Cinder River is reached by small bush planes landing on the hard-packed sandy gravel beaches.

A total of 15 auger-hole samples were taken in the area. The mineral constituents of the table concentrates are shown in table 12. A summary of sampling results is shown in table 13. Traces of flour gold were present in the pan concentrates of samples 175 and 177.

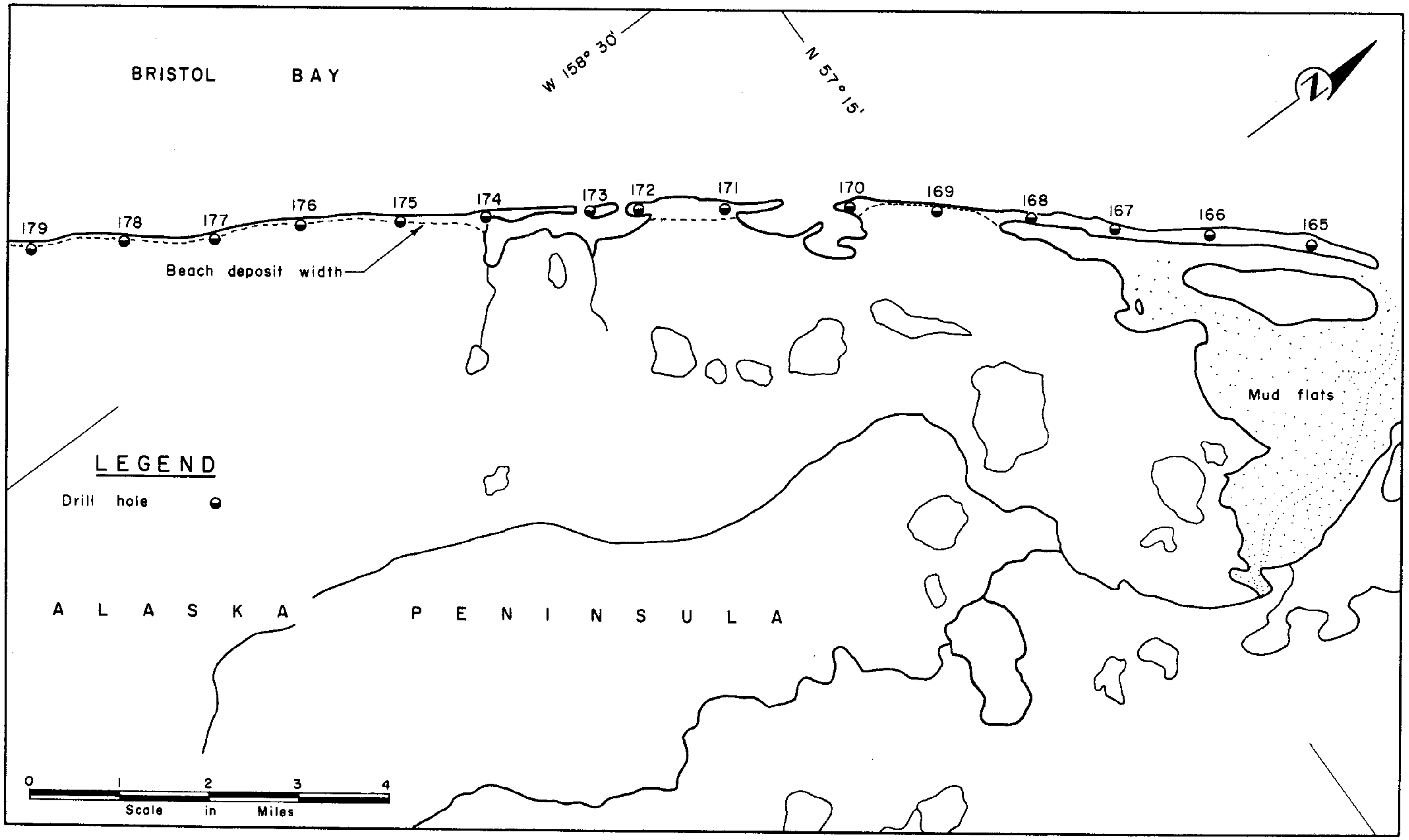


FIGURE 10. - Cinder River. Adapted from Geological Survey map.

TABLE 12. - Petrographic analyses of table concentrates from the Cinder River area

Mineral constituent[1]	[2]165	[2]166	167	168	169	170	171	172	173	174	175	176	[2]177	[2]178	179
Titaniferous magnetite..	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Hematite.....	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Ilmenite.....	3	2	3	3	2	3	2	2	2	2	2	2	2	1	2
Zircon.......	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Garnet.......	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
Pyroxene.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sphene.......	-	-	3	3	3	-	-	-	-	-	3	-	-	-	3
Epidote......	3	-	-	3	-	3	3	3	3	3	3	3	3	-	-
Hornblende...	-	-	3	3	3	3	3	3	3	3	3	3	3	3	3
Olivine......	3	3	2	2	2	3	2	2	3	2	2	2	2	2	2
Chlorite.....	3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Feldspar.....	1	1	2	2	2	2	2	2	1	2	2	2	1	1	2
Quartz.......	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.
[2] Pan-concentrate analysis.

TABLE 13. - Auger-hole sampling results from the Cinder River area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction Iron (Pounds per cu yd in-place)	Magnetic fraction TiO_2 (Pounds per cu yd in-place)	Nonmagnetic fraction TiO_2 (Pounds per cu yd in-place)
[1]165....	4.4	Gravel..........	0.014	10.5	2.2	0.4
[1]166....	3.4	do.......	.013	8.2	1.9	1.2
167....	9.0	Water and gravel	.019	23.2	5.1	1.5
168....	6.9	Mud.............	.013	22.7	5.0	1.2
169....	7.8	Gravel..........	.025	34.7	7.6	1.4
170....	9.0	Water and gravel	.029	13.7	2.9	.7
171....	4.9	do.......	.012	25.2	5.5	1.3
172....	4.0	Gravel..........	.014	15.5	3.6	1.2
173....	7.0	Water and gravel	.014	41.0	9.2	1.3
174....	7.8	do.......	.018	32.5	6.6	1.4
175....	4.9	do.......	.011	3.6	7.1	1.4
176....	7.1	do.......	.014	40.3	8.8	1.6
[1]177....	6.0	Mud.............	.014	32.0	5.7	1.2
[1]178....	9.0	Water and gravel	.020	15.8	3.1	.9
179....	7.9	do.......	.020	8.4	1.5	1.0

[1] Pan-concentrate analyses, insufficient light material to justify table concentration.

Port Heiden

The Port Heiden (fig. 11) beach deposits are narrow spits and bars which have developed along the outer shores of low-lying mudflats. Locally, near samples 191, 198, and 202, the sea is eroding 10- to 70-foot bluffs of

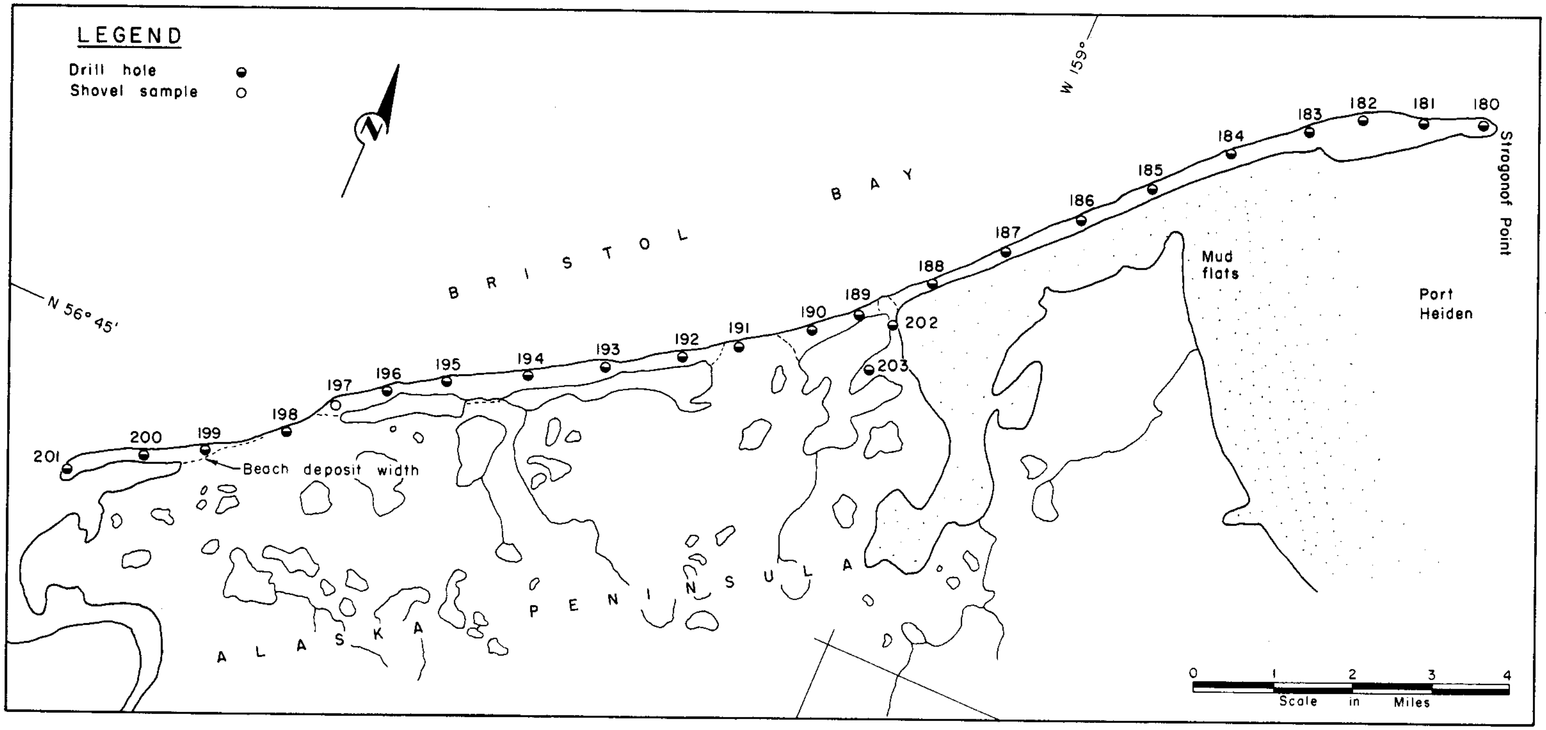


FIGURE 11. - Port Heiden. Adapted from Geological Survey map.

alluvial material, and the bordering beach deposits are narrow and shallow in depth. The beaches are sandy gravel, often loosely packed. Access is provided by small aircraft or boat; a satisfactory aircraft landing area should be selected carefully.

A total of 23 samples were recovered from auger holes in the area; one shovel sample was taken. Petrographic examinations are shown in table 14. Table 15 is a summary of auger-hole and shovel-sampling results.

During aerial reconnaissance black sands were seen throughout the area; sampling indicated magnetite sands occurred as thin surface veneers. Traces of flour gold were found in samples 180, 182, 184, 185, and 197 (fig. 9). Sample 197 is representative of a surface concentration. Samples 202 and 203 are from alluvial material.

TABLE 14. - Petrographic analyses of table concentrates from the Port Heiden area

Mineral constituent[1]	Sample											
	180	[2]181	182	[2]183	184	185	186	187	[2]188	[2]189	190	191
Titaniferous magnetite	1	1	1	1	1	1	1	1	1	1	1	1
Hematite..............	3	3	3	3	3	3	3	3	3	3	3	3
Ilmenite..............	1	2	1	1	1	1	1	1	1	1	1	1
Zircon................	3	3	3	3	3	3	3	3	3	3	3	3
Garnet................	3	3	3	3	3	3	3	3	-	3	3	3
Pyroxene..............	2	2	1	2	1	1	1	2	2	1	2	1
Sphene................	-	-	-	-	-	-	-	-	-	3	-	3
Epidote...............	3	-	3	-	-	-	-	-	3	-	-	-
Hornblende............	3	3	3	-	-	3	-	-	-	-	-	3
Olivine...............	2	2	2	2	2	3	2	2	2	2	2	2
Feldspar..............	2	2	2	1	2	2	2	2	2	2	2	2
Quartz................	-	-	-	-	-	-	-	-	-	-	-	-
Igneous rock fragments	1	1	1	1	1	1	1	1	1	1	2	1
	Sample											
	[2]192	[2]193	194	195	196	[2]197	[2]198	199	200	[2]201	[2]202	[2]203
Titaniferous magnetite	1	1	1	1	1	1	2	1	1	1	1	2
Hematite..............	3	3	3	3	3	3	3	3	3	3	-	3
Ilmenite..............	1	1	1	-	-	1	2	1	1	1	1	2
Zircon................	3	3	3	3	3	3	3	3	3	3	3	3
Garnet................	3	-	3	3	-	3	-	-	-	3	3	-
Pyroxene..............	1	1	1	1	1	2	2	1	2	1	2	2
Sphene................	-	-	-	-	-	-	-	-	-	-	-	-
Epidote...............	-	-	-	3	-	-	3	-	-	-	-	3
Hornblende............	-	-	-	3	-	-	-	-	-	-	3	3
Olivine...............	1	-	1	2	2	3	2	2	2	2	3	-
Feldspar..............	2	2	2	2	2	3	2	2	2	2	1	1
Quartz................	-	-	-	-	-	-	-	-	-	-	-	3
Igneous rock fragments	1	1	1	1	1	3	1	1	1	1	1	1

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.
[2] Pan-concentrate analysis.

TABLE 15. - Auger-hole and shovel-sampling results from the Port Heiden area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction Iron	Magnetic fraction TiO_2	Nonmagnetic fraction TiO_2
				Pounds per cu yd in-place		
180...	10.1	Water and sand..	0.025	4.6	1.0	0.5
[1] 181...	9.5	Water and gravel	.026	7.1	1.8	-
182...	18.5	Coarse gravel...	.051	8.1	1.7	.6
[1] 183...	10.8	Pea gravel......	.029	5.6	1.5	-
184...	8.7	Coarse gravel...	.024	11.9	2.3	.8
185...	16.0	Sand............	.051	22.7	4.1	1.2
186...	12.6	Coarse gravel...	.031	6.9	1.4	.5
187...	11.3	Water and sand..	.038	22.7	4.2	1.1
[1] [2] 188...	8.2	do.......	.027	6.5	1.7	-
[1] [2] 189...	9.3	Water and mud...	.022	5.6	1.3	-
[2] 190...	16.4	Gravel..........	.046	7.5	1.5	.5
[2] 191...	12.4	Coarse gravel...	.037	4.7	1.0	.3
[1] 192...	16.6	Water and sand..	.043	6.1	1.5	-
[1] 193...	14.0	Coarse gravel...	.039	3.8	1.0	-
194...	8.6	Pea gravel......	.028	9.8	2.1	.5
195...	15.4	Water and sand..	.043	6.9	1.5	.4
196...	10.7	Water and gravel	.026	7.1	1.5	.5
[1] [3] 197...	-	-	.005	103.6	21.9	-
[1] 198...	6.0	Water and sand..	.015	2.3	.7	-
199...	15.9	do.......	.036	15.5	3.2	.6
200...	12.1	do.......	.032	4.3	1.0	.3
[1] 201...	10.2	do.......	.029	2.3	.6	-
[1] 202...	8.4	do.......	.019	2.2	.6	-
[1] 203...	5.0	Frozen gravel...	.010	4.1	1.1	-

[1] Pan-concentrate analysis, insufficient sample for tabling and magnetic separation.

[2] Water volume measured.

[3] Shovel sample.

Ilnik

The Ilnik beach deposit (fig. 12) is a long spit bordering low-lying, shallow swamp and mudflats. Opposite Lake Ilnik, the mile-wide spit is capped by extensive sand dunes. The deposit is generally sand or fine, loose gravel. Thin surface veneers of magnetite sand, surf and wind concentrate, occur along the strand line. The extensive dunes between Ilnik and Lake Ilnik are classified, but black sand stringers were not found.

Access to the area is obtained by small plane or boat. During high tide, the inner shores of the Ilnik spit are accessible by shallow draft fishing boats. The sandy beaches are often soft and when serving as landing fields, should be carefully used.

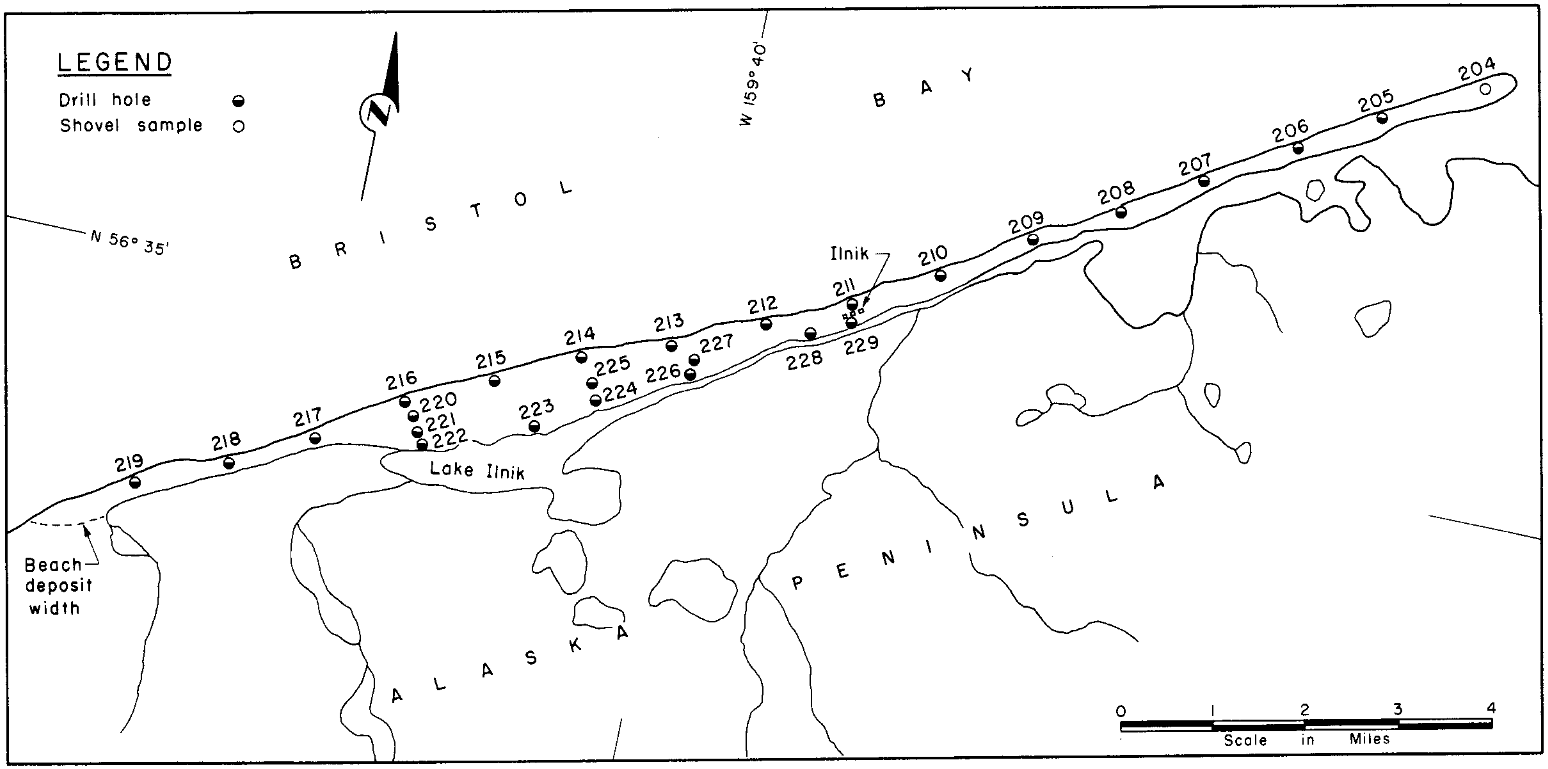


FIGURE 12. - Ilnik. Adapted from Geological Survey map.

The deposits were sampled with 25 auger holes and 1 shovel sample. The mineral constituents of the sands are shown in the summary of petrographic examinations (table 16). A summary of sampling results is shown in table 17.

TABLE 16. - Petrographic analyses of table concentrates from the Ilnik area

Mineral constituent[1]	Sample												
	[2]204	[2]205	206	207	208	209	210	211	212	213	214	215	216
Titaniferous magnetite.......	1	1	1	1	1	1	1	1	1	1	1	1	1
Hematite..........	3	3	3	3	3	3	3	3	3	3	3	3	3
Ilmenite..........	1	1	1	1	1	1	1	1	1	1	1	1	1
Zircon............	3	-	3	3	3	3	3	3	3	3	3	3	3
Garnet............	-	-	3	-	-	-	-	-	-	-	-	3	-
Pyroxene..........	1	1	1	1	1	1	1	1	1	1	1	1	1
Sphene............	3	-	-	-	-	-	-	3	-	-	-	-	-
Hornblende........	3	3	3	-	-	-	3	3	3	-	-	-	-
Olivine...........	2	1	1	1	1	2	1	1	1	2	2	2	2
Feldspar..........	2	3	2	2	2	2	2	2	2	2	1	2	2
Igneous rock fragments.......	1	1	2	1	1	1	1	1	1	1	1	1	1

	Sample												
	[2]217	[2]218	[2]219	[2]220	221	[2]222	223	224	225	[2]226	[2]227	228	229
Titaniferous magnetite.......	1	1	1	1	1	1	1	1	1	1	1	1	1
Hematite..........	3	3	3	3	3	3	3	3	3	3	3	3	3
Ilmenite..........	1	1	1	1	1	1	1	1	1	1	1	1	1
Zircon............	3	3	-	3	3	3	3	3	3	3	3	3	3
Garnet............	-	-	-	-	3	-	3	3	3	-	-	-	-
Pyroxene..........	1	2	2	1	1	1	1	1	1	1	1	1	1
Sphene............	-	-	-	-	-	-	3	-	-	-	-	-	-
Hornblende........	-	-	-	-	-	-	3	-	-	3	-	-	-
Olivine...........	1	1	1	1	2	1	1	2	2	2	1	2	2
Feldspar..........	2	1	1	2	2	1	2	2	2	1	2	2	2
Igneous rock fragments.......	1	1	1	1	1	1	1	1	1	1	1	1	1

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.
[2] Pan-concentrate analysis.

TABLE 17. - Auger-hole and shovel-sampling results from the Ilnik area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
				Pounds per cu yd in-place		
[1] [2] 204...	-	-	0.005	3.5	0.8	-
[2] 205...	2.8	Coarse gravel...	.006	5.3	1.4	-
206...	13.9	Water and sand..	.047	3.6	.8	0.4
207...	15.7	Coarse gravel...	.043	4.4	1.0	.4
208...	13.8	Water and sand..	.038	5.5	1.1	.4
[3] 209...	19.6	Gravel..........	.061	9.1	1.9	.6
[3] 210...	18.5	Water and sand..	.062	9.0	1.9	.5
[3] 211...	18.2	do.......	.046	9.2	1.9	.4
[3] 212...	20.5	Sand............	.058	57.4	11.5	2.1
213...	12.7	Gravel..........	.040	16.8	3.4	1.0
214...	13.0	Water and gravel	.034	14.1	2.8	.6
215...	20.5	Water and sand..	.055	9.3	1.9	.5
216...	15.4	do.......	.043	4.8	1.0	.4
[2] 217...	10.7	do.......	.031	7.7	1.7	-
[2] 218...	5.9	Water and gravel	.016	2.5	.6	-
[2] 219...	6.0	do.......	.016	3.7	.7	-
[2] 220...	11.1	Water and sand..	.029	5.7	1.2	-
221...	13.3	do.......	.034	6.0	1.3	.4
[2] 222...	4.3	Water and gravel	.008	3.6	.9	-
223...	14.7	Water and sand..	.042	5.9	1.2	.3
224...	13.9	do.......	.039	5.5	1.2	.4
[2] 225...	18.3	do.......	.052	7.9	1.6	-
[2] 226...	14.2	do.......	.041	2.6	.7	-
[2] 227...	5.2	Gravel..........	.019	5.4	1.3	-
228...	14.5	Water and sand..	.041	7.2	1.5	.4
229...	17.1	Gravel..........	.062	4.7	1.0	.3

[1] Shovel sample.
[2] Pan-concentrate analyses, insufficient sample for tabling and magnetic separation.
[3] Water volume measured.

Port Moller

The beach deposits near Port Moller (fig. 13) are essentially large, well-developed spits. The largest deposit, on which the Port Moller cannery and airstrip have been constructed, is a long spit extending south from a headland at Franks Lagoon. Windblown sands from the outer shore are slowly filling a shallow between the spit and the mainland. The narrow spit terminating at Harbor Point is probably developing on the arcuate ring of a terminal glacier morain. The Port Moller spit is sandy; the Harbor Point spit is gravel capped by a 1- to 10-foot sand layer.

The beach deposits are accessible by truck and air transportation. An airstrip, suitable for DC-3 or equivalent airplanes, is maintained by the

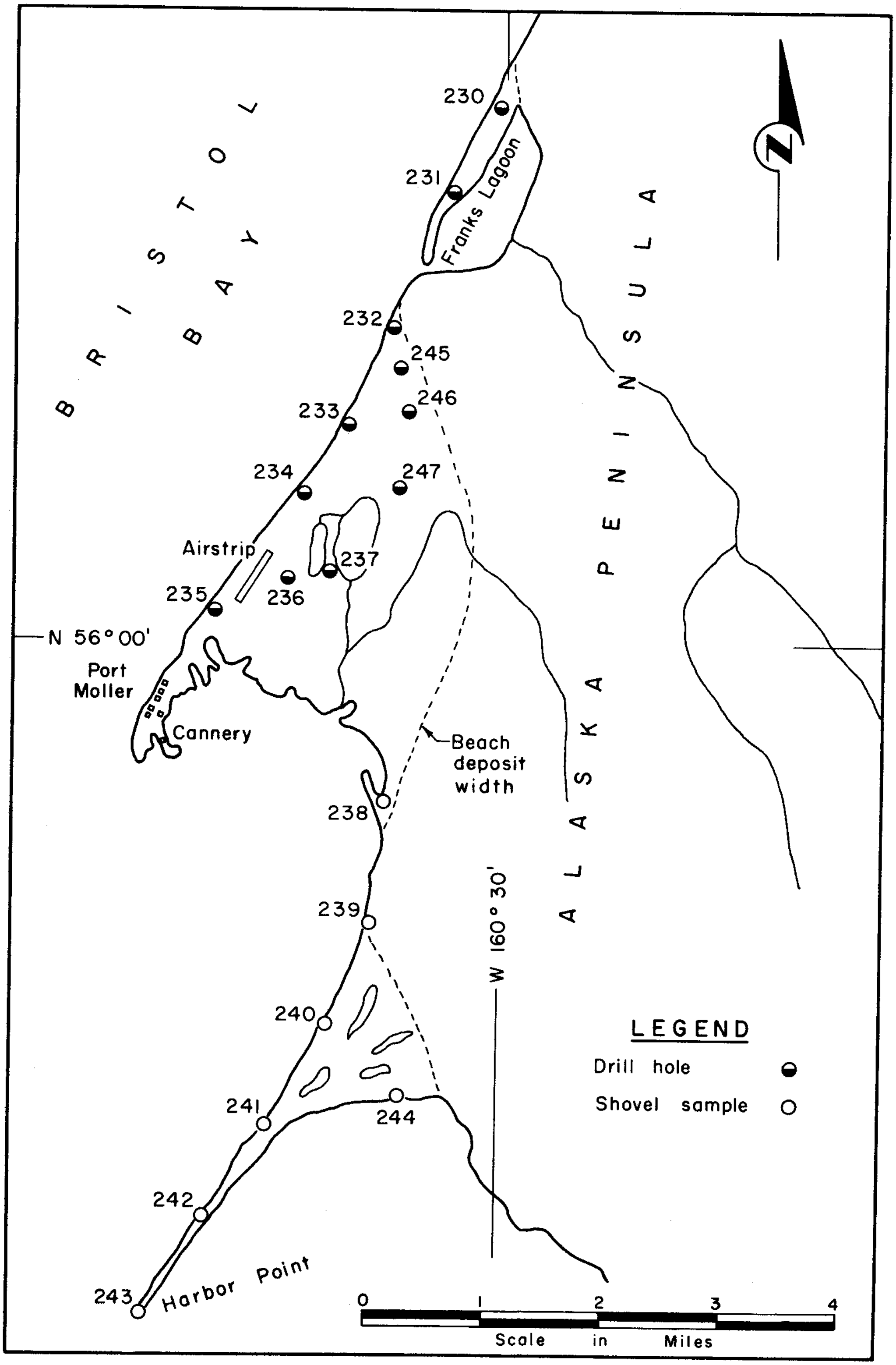


FIGURE 13. - Port Moller. Adapted from Geological Survey map.

military. There are no roads along the shore, but four-wheel drive vehicles travel the hard-packed beaches north to Franks Lagoon. Small bush planes usually land on the hard-packed beaches adjacent to the cannery.

The beach deposits were sampled by 11 auger holes and 7 shovel samples. Petrographic examinations are shown in table 18. Table 19 is a summary of the auger-hole and shovel sampling results. Samples 240 and 241 are representative of surf concentrations; traces of gold are present.

TABLE 18. - Petrographic analyses of table concentrates from the Port Moller area

Mineral constituent[1]	Sample								
	230	[2]231	232	233	[2]234	235	236	237	[2]238
Titaniferous magnetite.....	1	1	1	1	1	1	1	1	1
Hematite..................	3	3	3	3	3	3	3	3	3
Ilmenite..................	2	2	1	2	2	2	2	2	2
Zircon....................	3	3	3	3	3	3	3	3	3
Garnet....................	-	3	3	3	3	3	3	-	-
Pyroxene..................	2	2	1	1	1	1	1	1	1
Epidote...................	-	-	3	-	-	-	-	-	-
Hornblende................	3	-	-	-	-	-	-	-	-
Olivine...................	2	1	1	2	2	2	2	2	3
Feldspar..................	2	2	2	2	2	2	2	2	2
Quartz....................	-	-	-	3	-	-	-	-	2
Igneous rock fragments.....	1	1	1	1	1	1	1	2	1
	Sample								
	[2]239	240	241	[2]242	[2]243	[2]244	245	246	[2]247
Titaniferous magnetite.....	1	1	1	1	1	2	1	1	1
Hematite..................	3	3	3	3	3	-	3	3	3
Ilmenite..................	2	-	-	-	-	2	2	2	2
Zircon....................	3	3	3	3	3	-	3	3	3
Garnet....................	3	3	3	-	3	-	3	3	3
Pyroxene..................	1	1	1	1	2	1	1	1	1
Epidote...................	-	-	-	-	-	-	-	-	-
Hornblende................	-	-	-	-	3	-	3	-	-
Olivine...................	-	2	3	3	3	-	2	2	2
Feldspar..................	2	3	2	3	3	3	2	2	1
Quartz....................	2	-	-	3	-	3	-	-	-
Igneous rock fragments.....	1	2	2	2	1	1	1	1	1

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.
[2] Pan-concentrate analysis.

TABLE 19. - Auger-hole and shovel-sampling results from the Port Moller area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
				Pounds per cu yd in-place		
230...	20.3	Water and gravel	0.059	5.3	1.2	0.3
[1] 231...	9.2	Gravel..........	.022	10.2	2.3	-
232...	20.3	do.......	.062	4.4	1.0	.3
233...	20.3	Water and gravel	.059	5.3	1.2	.3
[1] 234...	11.3	Water and sand..	.025	12.1	2.7	-
235...	12.3	do.......	.033	6.4	1.4	.4
236...	17.9	do.......	.044	5.8	1.4	.5
[1] 237...	18.6	do.......	.049	4.4	1.0	-
[1] [2] 238...	-	-	.005	5.7	1.5	-
[1] [2] 239...	-	-	.005	6.7	2.0	-
[2] 240...	-	-	.005	147.6	32.2	10.3
[2] 241...	-	-	.005	191.4	42.2	10.3
[1] [2] 242...	-	-	.005	9.9	2.7	-
[1] [2] 243...	-	-	.005	19.9	5.0	-
[1] [2] 244...	-	-	.005	1.1	.3	-
245...	9.0	Water and sand..	.022	83.9	18.5	5.2
246...	10.0	do.......	.026	15.7	3.6	1.0
[1] 247...	5.1	do.......	.011	34.4	9.7	-

[1] Pan-concentrate analysis, insufficient sample for tabling and magnetic separation.
[2] Shovel sample.

Nelson Lagoon

The Nelson Lagoon beach deposit (fig. 14) is a long narrow spit which has developed along the outer shore of a shallow mudflat. The spit is covered with large sand dunes up to 40 feet in height above the water table. West of sample 261 the beach deposit is narrow and shallow; sandy gravel beaches lie beneath 10- to 40-foot bluffs of alluvial material.

The deposits in the Nelson Lagoon area are accessible by small airplane, boat, or truck. The sandy northern shores of the Nelson Lagoon spit are hard packed and are excellent for small bush-plane landings. Residents of the small community on the spit travel the spit with four-wheel-drive vehicles; however, there are no permanent roads. The protected inner beach of the lagoon spit is suitable for beaching small boats.

Aerial reconnaissance indicated black-sand deposits along the beaches. On sampling, magnetite sands were found as thin surface veneers along the strand line. Large dunes contained an occasional 1- to 2-inch stringer of magnetite sand; the stringers are attributed to wind concentration.

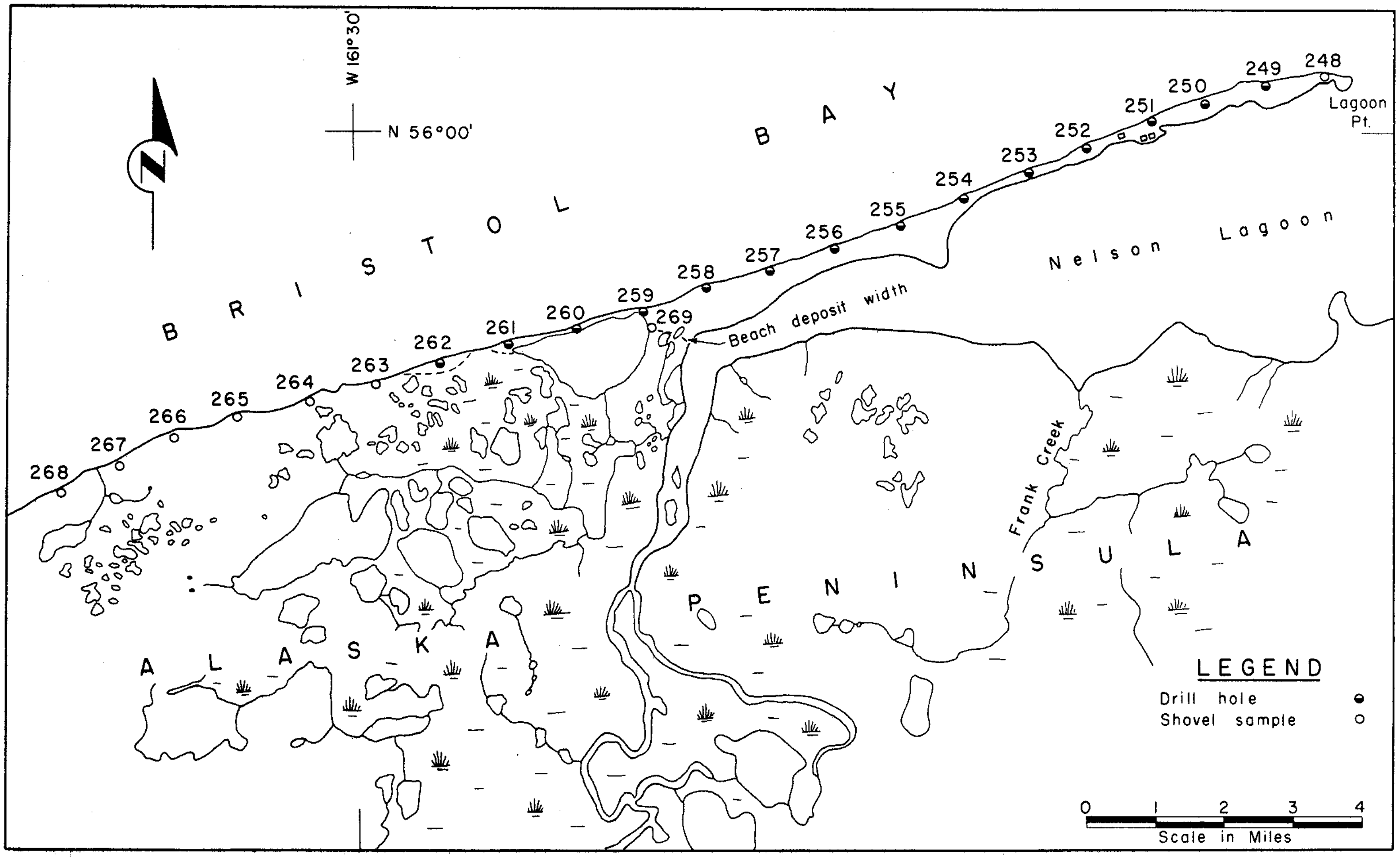


FIGURE 14. - Nelson Lagoon. Adapted from Geological Survey map.

A total of 14 auger-hole samples and 8 shovel samples were taken from the area shown. Table 20 is a summary of petrographic examinations. A summary of the auger-hole and shovel-sampling results is shown in table 21.

TABLE 20. - Petrographic analyses of table concentrates from the Nelson Lagoon area

Mineral constituent[1]	Sample										
	[2]248	249	250	251	252	253	254	255	256	257	258
Titaniferous magnetite.....	1	1	1	1	1	1	1	1	1	1	1
Hematite........	3	3	3	3	3	3	3	3	3	3	3
Ilmenite........	2	2	2	2	2	2	2	2	2	2	2
Zircon..........	3	3	3	3	3	3	3	3	3	3	3
Garnet..........	-	-	3	3	3	3	-	-	3	3	3
Pyroxene........	1	1	1	1	1	1	1	1	1	1	1
Sphene..........	-	-	3	-	-	-	-	-	-	-	3
Epidote.........	3	3	-	-	-	3	3	-	3	-	-
Hornblende......	-	-	3	3	-	3	-	3	-	3	3
Olivine.........	2	2	2	2	2	2	2	2	2	2	2
Feldspar........	2	2	3	-	-	-	3	-	-	-	-
Igneous rock fragments.....	2	2	2	2	2	2	2	2	2	2	2

	Sample										
	259	260	261	262	[2]263	[2]264	[2]265	[2]266	[2]267	[2]268	[2]269
Titaniferous magnetite.....	1	1	1	1	1	1	1	1	1	1	1
Hematite........	3	3	3	3	3	3	3	3	3	3	3
Ilmenite........	2	2	2	2	2	2	2	2	2	3	2
Zircon..........	3	3	3	3	3	3	3	3	-	-	-
Garnet..........	-	-	3	-	-	-	3	-	-	-	-
Pyroxene........	1	1	1	1	1	1	1	1	1	1	1
Sphene..........	3	-	-	-	-	-	-	-	-	-	-
Epidote.........	3	-	3	-	-	-	-	-	-	-	-
Hornblende......	3	-	3	3	-	-	-	3	-	-	-
Olivine.........	2	2	2	2	1	2	2	2	2	2	2
Feldspar........	-	2	3	3	2	2	2	2	2	2	2
Igneous rock fragments.....	2	2	2	2	2	2	2	2	1	1	2

[1] 1 = major constituent; 2 = small amount; 3 = trace; and - = not detected.
[2] Pan-concentrate analysis.

TABLE 21. - Auger-hole and shovel-sampling results from the Nelson Lagoon area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
				Pounds per cu yd in-place		
[1] [2]248...	-	-	0.011	27.4	6.9	-
249...	4.7	Coarse gravel...	.012	309.7	70.2	8.5
250...	9.4	do.......	.025	77.5	17.2	2.1
251...	12.4	Water and sand..	.028	28.7	6.3	1.1
252...	13.9	Coarse gravel...	.038	38.8	8.7	1.1
253...	11.7	do.......	.027	24.1	5.4	.8
254...	11.6	Water and sand..	.029	50.4	11.3	1.8
255...	16.8	Coarse gravel...	.040	93.3	22.2	2.5
256...	18.6	Water and sand..	.047	71.0	15.5	2.0
257...	14.0	Coarse gravel...	.038	44.9	9.9	1.6
258...	16.6	do.......	.036	59.9	13.3	2.3
[3]259...	16.5	do.......	.046	90.4	20.1	2.9
[3]260...	20.5	Sand............	.054	36.9	8.7	1.4
261...	14.7	Gravel..........	.039	99.7	24.7	3.6
262...	7.9	Coarse gravel...	.018	86.4	20.5	3.1
[1] [2]263...	-	-	.005	11.6	2.9	-
[1] [2]264...	-	-	.005	32.6	8.6	-
[1] [2]265...	-	-	.005	15.2	4.0	-
[1] [2]266...	-	-	.005	8.0	1.6	-
[1] [2]267...	-	-	.005	4.9	1.2	-
[1] [2]268...	-	-	.005	7.6	1.5	-
[1] [2]269...	-	-	.005	15.0	3.4	-

[1] Shovel sample.
[2] Pan-concentrate analysis, insufficient sample for tabling and magnetic separation.
[3] Water volume measured.

Moffet Point

The beach deposit of Moffet Point (fig. 15) is a narrow sand peninsula bordering the shallow tideflats of Moffet Bay. The peninsula is overlain by windblown dunes up to 100 feet in height; the outer sand beach is broad and flat. Northeast of the peninsula, beyond sample 273, the beach narrows and ranges between 10 and 100 feet in width. Here, the sea is eroding 30- to 40-foot alluvial bluffs. The beach beneath the bluffs is composed of large boulders embedded in sand and gravel.

The area is accessible by small aircraft or boat. The outer beaches on the southern end of the point are ideal for small aircraft landings. Moffet Bay may also be traveled by small boat.

Extensive aeolian sand dunes contain trace to moderate amounts of magnetite sands. Wind classification of the sands resulted in the occurrence of erratically distributed magnetite sand stringers throughout the area.

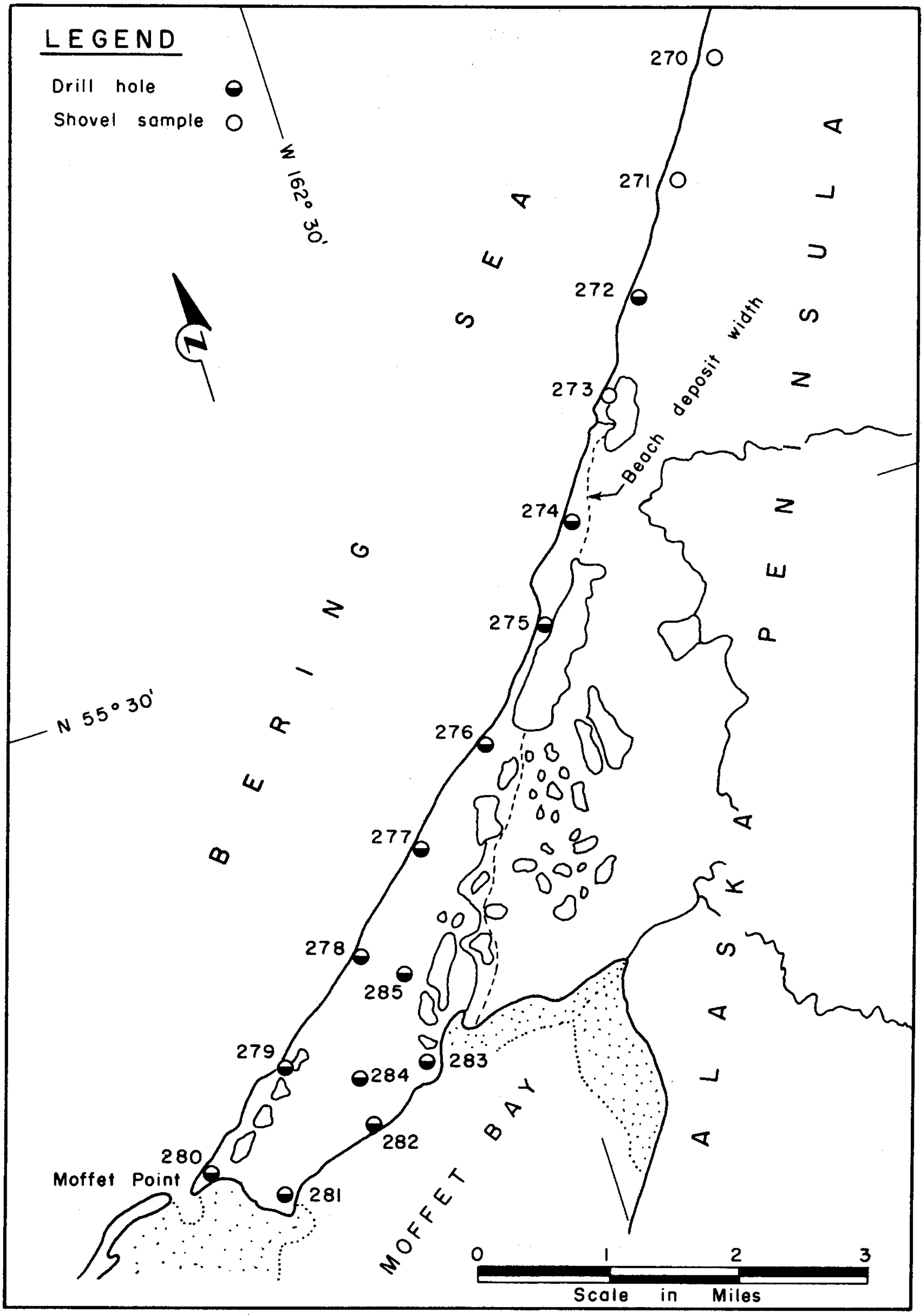


FIGURE 15. - Moffet Point. Adapted from Geological Survey map.

The sandy beaches along Moffet Point were sampled by 13 auger holes and 3 shovel samples. A summary of petrographic examination is given in table 22. Table 23 is a summary of the auger-hole and shovel-sampling results.

TABLE 22. - Petrographic analyses of table concentrates from the Moffet Point area

Mineral constituent[1]	Sample															
	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
Titaniferous magnetite..	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
Franklinite..	3	-	-	-	3	3	3	3	3	3	3	3	3	-	3	3
Hematite.....	3	3	3	3	-	-	-	-	-	3	3	-	3	3	3	3
Ilmenite.....	-	-	-	-	3	3	3	3	3	2	2	3	2	1	2	2
Garnet.......	-	-	3	-	-	-	3	-	-	-	-	-	-	-	-	-
Augite.......	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
Sphene.......	-	-	-	-	3	3	3	3	3	-	-	-	-	-	-	-
Epidote......	3	-	-	-	3	3	3	3	3	-	-	-	-	-	-	-
Hypersthene..	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hornblende...	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Olivine......	2	2	2	2	2	2	2	2	2	2	2	3	2	1	2	2
Feldspar.....	1	1	1	1	3	3	3	3	3	3	3	1	3	1	3	3
Volcanic rock	1	1	1	1	2	2	2	2	2	2	2	1	2	1	2	2

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

TABLE 23. - Auger-hole and shovel-sampling results from the Moffet Point area

Sample	Total depth in feet	Material at bottom of hole	Adjusted measured volume loose, cu yd	Magnetic fraction		Nonmagnetic fraction
				Iron	TiO_2	TiO_2
				Pounds per cu yd in-place		
[1] 270.....	-	-	0.005	12.2	1.4	([2])
[1] 271.....	-	-	.005	5.3	1.9	([2])
272.....	1.3	Boulder.........	.002	13.6	12.4	([2])
[1] 273.....	-	-	.005	25.4	19.0	([2])
[3] 274.....	20.4	Sand............	.056	16.3	3.4	0.7
[3] 275.....	12.9	Water and sand..	.031	104.3	21.0	4.8
[3] 276.....	6.7	do........	.016	108.5	21.5	4.6
277.....	18.5	do........	.046	30.4	6.2	1.5
[3] 278.....	14.0	do........	.034	16.4	3.5	.8
279.....	16.0	do........	.041	24.0	4.7	1.2
280.....	4.7	do........	.010	4.9	1.0	.5
281.....	5.8	do........	.013	.4	([2])	.4
[3] 282.....	16.7	do........	.042	2.2	.5	.1
[3] 283.....	19.0	do........	.048	5.2	1.5	([2])
284.....	12.5	do........	.030	9.1	2.0	.5
[3] 285.....	13.9	do........	.031	23.4	4.7	1.1

[1] Shovel sample. [2] Trace. [3] Water volume measured.

CONCLUSIONS

The reconnaissance studies in Bristol Bay outlined areas along the coast which contain minor quantities of heavy minerals. Some deposits on the northern shores of the Alaska Peninsula contain between 1 and 2 percent combined iron and titania; the iron to titania ratio averages about 4 to 1. Occasional high assays represent small deposits of heavy minerals locally concentrated by wave action.

Petrographic examination of samples from the Moffet Peninsula, Nelson Lagoon, Port Moller, Ilnik, and Port Heiden areas indicated that the minerals were derived from a common source; a genetic relationship with the volcanic activity along the Alaska Peninsula is suggested. Radiometric evaluation of most samples was negative; the occasional analyses containing trace amounts were attributed to the presence of minor quantities of zircon. No detailed physical tests on samples were made.

Field and assay data indicated that the larger deposits were too low grade to justify further investigation.