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RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN THE VICINITIES OF KETCHIKAN, GODDARD HOT SPRINGS, CHICHAGOF, FUNTER BAY, AND JUNEAU, SOUTHEASTERN ALASKA, 1949*

By

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ABSTRACT

Radioactivity reconnaissance during 1949 in the vicinities of Ketchikan, Goddard Hot Springs, Chichagof, Funter Bay, and Juneau revealed no significant concentrations of radioactive materials.

Concentrates from stream gravels and disintegrated bedrock in the vicinity of Goddard Hot Springs were the most radioactive samples collected. They contain from 0.012 to 0.016 percent equivalent uranium. As the chief radioactive mineral in these concentrates is allanite, most of this radioactivity is ascribed to thorium.

INTRODUCTION

During the summer of 1949 reconnaissance examinations for radioactive deposits were made in the vicinities of Ketchikan on Revillagigedo Island, Goddard Hot Springs on Baranof Island, Chichagof on Chichagof Island, Funter Bay on Admiralty Island, and Juneau, southeastern Alaska (fig. 1). This work was conducted by a Geological Survey field party consisting of Walter S. West and Paul D. Benson, geologists, and Arthur E. Nessett, camp assistant, on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

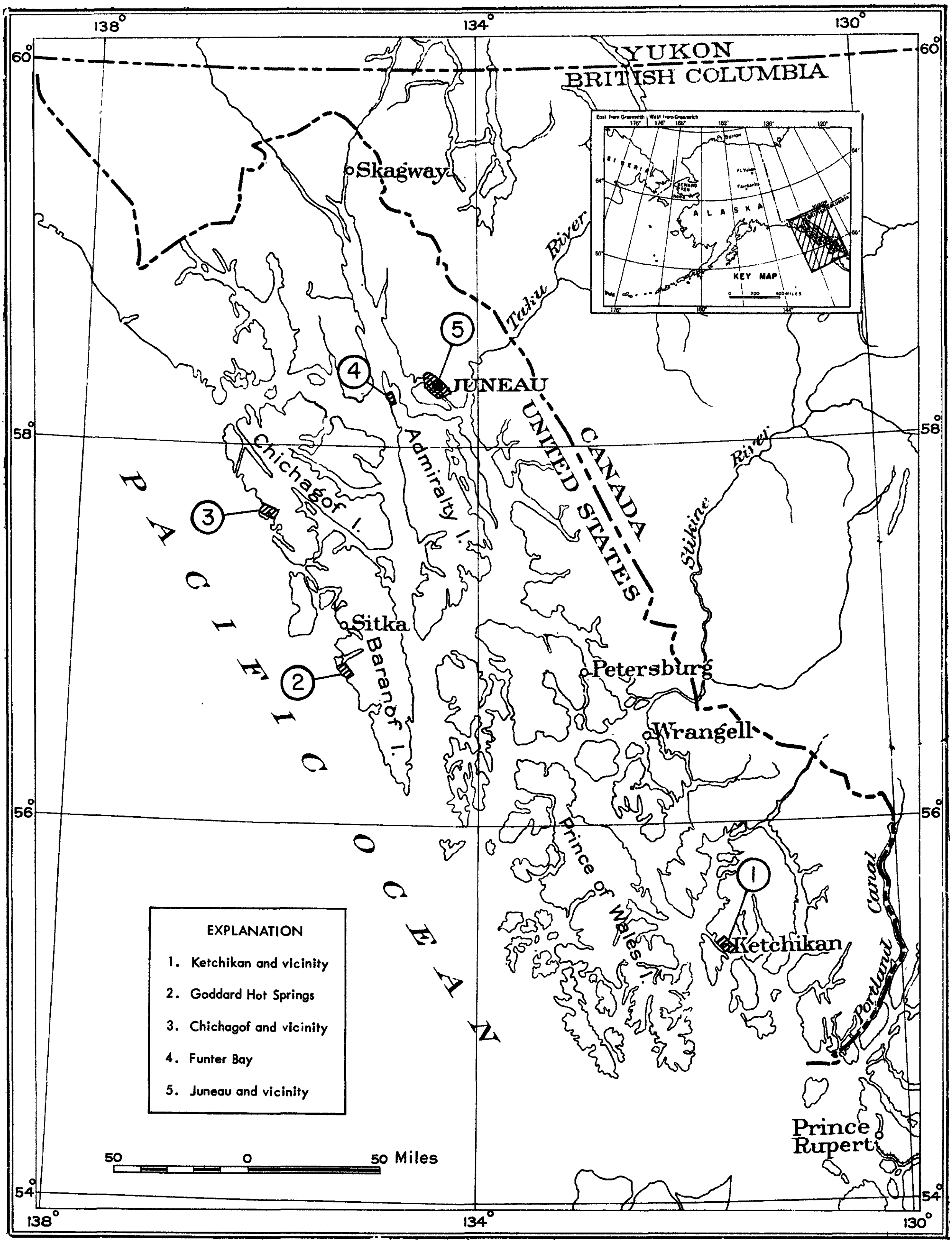

FIGURE 1.--MAP OF SOUTHEASTERN ALASKA SHOWING AREAS INVESTIGATED

Reports of radioactive materials led to the investigations in the Chichagof and Goddard Hot Springs areas. The Funter Bay and Ketchikan areas were examined because ore deposits at both localities contain minerals associated with uranium elsewhere. The examinations of likely radioactive prospects and localities in the Juneau area were made primarily as a matter of convenience while the party was unavoidably detained there by weather several times during the season.

MEASUREMENT OF RADIOACTIVITY

Field measurements of radioactivity were made with standard commercial models of portable survey meters modified to accept probes consisting of four 1-inch by 18-inch gamma tubes connected in parallel as well as the standard 6-inch beta-gamma tube. The large gamma probe was used exclusively for routine traversing, whereas the beta-gamma tube was used for taking selected contact readings on outcrops, talus blocks, ore dumps, exposures of rocks and veins in underground workings and open-cuts, and for scanning drill cores and rock and mineral specimens.

The main emphasis in the investigations was placed on radioactivity traversing and the collection of rock and mineral samples. However, concentrates were taken from the gravels of many streams as a check on the possible presence of radioactive minerals in areas drained by these streams which time did not permit covering by traverses or where there were no bedrock outcrops. Some slopewash samples were also collected where bedrock outcrops were absent. Mine tailings and mill concentrates were obtained wherever possible.

The equivalent-uranium analyses given in this report were made by A. E. Nelson in the Geological Survey laboratory at Washington, D. C.

AREAS INVESTIGATED

Ketchikan and vicinity

Geology and mineral deposits

The geology of the Ketchikan district has been described by Brooks (1902) and Wright and Wright (1908).

The rock formations in the vicinity of Ketchikan are Jurassic(?) greenstone and slate and Upper Jurassic or Lower Cretaceous quartz diorite, which grades locally into granodiorite. The greenstone and slate includes black slate, phyllite, greenstone schist and green, bedded tuff.

The ore deposits occur in mineralized zones in greenstone and slate along the contact of quartz diorite and as quartz fissure veins in the intrusive rock. Metallic minerals are also disseminated in both the greenstones and slate and the quartz diorite. The metallic minerals contained in the veins are free gold, pyrite, chalcopyrite, and arsenopyrite. Small amounts of bismuth (tetradymite) and antimony are reported to occur with gold ores in veins in the quartz diorite on the Wildcat and Hoadley claims, about 1-1/2 to 2 miles north of Ketchikan and 1/2 mile northeast of the beach (Brooks, 1902, p. 61 and Buddington and Chapin, 1929, p. 332).

Radioactivity studies

A radioactivity traverse was made along the road south of Ketchikan for about 2 miles and along the road north of the town for approximately the same distance. Traversing was also done along the network of trails and roads which lie north of

Ketchikan and east of the main road as well as on what was believed to be the Wildcat and Hoadley claims (these claims are so old and so thoroughly covered with thick vegetation that their exact location could not be definitely determined). A sub-surface traverse was made in a prospect tunnel, and a considerable number of ore dumps and prospect pits were scanned and sampled on the assumed Wildcat and Hoadley claims. Some mining properties east of Ketchikan also were traversed and sampled.

No abnormal radioactivity was found in traversing and scanning. As shown in table 1, none of the samples that were analyzed for radioactivity contained more than 0.001 percent equivalent uranium.

Goddard Hot Springs

Geology and mineral deposits

Knopf (1912) gives an account of the geology of the Goddard Hot Springs area.

Goddard Hot Springs consists of four springs listed below in the order of occurrence from west to east.

Magnesia Spring (142° F.)
Main Spring (149° F.)
Sulphur Spring (124° F.)
Old Russian Spring (95° F.)

All four springs issue at the surface from granite which has been cut by narrow dikes of spessartite lamprophyre. The waters of the hot springs probably come from considerable depths through crevices or fissures along contact zones between the intrusive granite and the altered sandstones, conglomerates, graywackes, and slates (Waring, 1917, p. 30).

Table 1.--Equivalent-uranium analyses of the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the vicinity of Ketchikan, southeastern Alaska

Sample number	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3330	Hoadley Creek, 50 feet below falls and 100 yards above road bridge	Sand and gravel from middle bar	10:1	<0.001
3331	Old prospect tunnel about 1/2 mile from beach and 1-1/2 miles north of Ketchikan	Waste rock from floor	61:1	< .001
3332	1st stream north of Sawmill Creek, about 1/2 mile from beach and 1-1/2 miles north of Ketchikan	Sand and gravel from bar	371:1	< .001
3333	Old shaft believed to be on Wildcat claim	Waste rock from dump	233:1	.001
3334	Old prospect tunnel believed to be on Wildcat claim	Waste rock from floor	121:1	.001
3335	Below workings in stream believed to drain Wildcat claim	Sand and gravel from bar	72:1	< .001

In 1942 Merle Colby (1942, p. 175) reported the presence of radium in the Goddard Hot Springs water. Previous mineral analyses of waters from the Main Spring and the Magnesia Spring (Waring, 1917, p. 32) did not show radium as a constituent.

No mineral deposits are known in the immediate vicinity of Goddard Hot Springs. Some quartz veins up to 4 inches in width were observed in the granite. Most of these veins are barren of sulfides, although a small amount of pyrite is found in a few of them.

Radioactivity studies

Radioactivity traverses were made over the granite area at Goddard Hot Springs; south along the coast for two miles to the first major stream and thence up this stream, which connects a series of lakes, for approximately two miles; north along the coast for two miles; and over the trail from Goddard Hot Springs to Redoubt Lake. Numerous rock, stream gravel, and slopewash samples were collected. Water samples were taken from Magnesia, Main, and Sulphur Springs.

The traverses revealed no significant concentrations of radioactive material. However, the background count was considerably higher over the granite areas than over the altered sedimentary rock areas.

The three hot-spring water samples were analyzed for radium by W. R. Champion of the Geological Survey laboratory at Washington, D. C. and were found to contain less than 5×10^{-13} curies (Ra/200 cc).

Equivalent-uranium analyses of some of the samples collected in the Goddard Hot Springs area are given in table 2.

Table 2.--Equivalent-uranium analyses of the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the vicinity of Goddard Hot Springs, Baranof Island, southeastern Alaska

Sample number	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3295	Stream connecting 2 lakes about 1-3/4 miles southeast of Goddard	Sand and gravel	1,335:1	0.009
3296	Stream draining into series of lakes about 1-1/4 miles southeast of Goddard	Sand and gravel	446:1	.004
3297	Stream near Goddard school house about 3/4 mile south of Goddard	Sand and gravel	876:1	.009
3298	Stream about 1/2 mile south of Goddard	Sand and gravel	620:1	.008
3299	Stream formed by hot springs at Goddard	Sand and gravel	1,146:1	.012
3300	Redoubt Lake, about 1-3/4 miles northeast of Goddard	Beach sand	690:1	.009
3301	Stream flowing into Redoubt Lake, about 1-1/2 miles northeast of Goddard	Sand and gravel	447:1	.007
3302	Stream about 3/4 mile northeast of Goddard	Sand and gravel	919:1	.007
3303	Goddard	Beach sand	580:1	.014
3304	Stream about 1/8 mile north of Goddard	Sand and gravel	337:1	.005
3305	Between Main and Magnesia hot springs at Goddard	Granite slopewash	844:1	.016
3312	Stream about 3/4 mile north of Goddard	Sand and gravel	987:1	.015
3313	Outcrop about 3/4 mile north of Goddard	Weathered slate	1,405:1	.001

The heavy-mineral fraction of sample 3305, containing 0.016 percent equivalent uranium and taken from disintegrated rock material between the Main Spring and Magnesia Spring, was the most radioactive sample in the area. The minerals with a specific gravity greater than 2.8 which have been identified in this sample as well as in sample 3299 (0.012 percent equivalent uranium), collected in the stream formed by the hot springs; sample 3302 (0.007 percent equivalent uranium) from stream 1 mile northeast of Goddard; sample 3303 (0.014 percent equivalent uranium) from the beach at Goddard; and sample 3312 (0.015 percent equivalent uranium), panned from a stream draining a lake north of Goddard Hot Springs, are tabulated in table 3.

The radioactivity of the above samples and all other samples from this area is due mainly to the allanite content. Monazite, sphene, and zircon may add to the radioactivity of some samples.

Chichagof and vicinity

Geology and mineral deposits

Reed and Coats (1941) give a detailed account of the geology and ore deposits of the Chichagof mining district.

The country rock in the vicinity of Chichagof consists of both massive and slaty graywacke of Lower Cretaceous(?) age, which has been faulted and intruded by fine-grained light-colored dikes. A few lenses of greenstone and thin beds of conglomerate occur in the graywacke.

The principal ore bodies are masses of mineralized quartz that lie in fault and shear zones. Some mineralization has taken place in quartz veinlets which fill joints, and in one instance fault gouge constituted good ore in the Chichagof mine. The

Table 3.--Mineralogy of the heavy-mineral fractions of selected samples from the vicinity of Goddard Hot Springs, Baranof Island, southeastern Alaska 1/

Minerals	Sample numbers				
	3305	3299	3302	3303	3312
Allanite	6 2/	3	tr	0	7
Apatite	tr 3/	tr	0	0	0
Augite	3	5	tr	tr	3
Biotite	0	tr	0	0	1
Chlorite	tr	0	0	0	1
Clinozoisite	1	1	0	0	tr
Diopside	2	tr	12	5	1
Epidote	tr	1	tr	11	2
Garnet	14	5	23	2	15
Hornblende	6	9	5	15	10
Hypersthene	tr	30	tr	tr	5
Ilmenite	55	40	55	45	44
Limonite	0	0	tr	tr	tr
Magnetite	tr	tr	tr	tr	3
Marcasite	2	0	0	0	0
Monazite	tr	0	tr	0	tr
Pyrite	0	0	0	0	1
Rutile	tr	0	tr	tr	0
Scheelite	tr	0	0	0	tr
Sphene	2	1	0	tr	1
Zircon	7	4	3	20	5

1/ Mineral determinations by B. W. Wilson (samples 3299, 3305, and 3312) and J. J. Matzko (samples 3302 and 3303) of the Alaskan Geology Branch, U. S. Geological Survey.

2/ Numbers indicate estimated volumetric percentages of minerals present in the heavy-mineral fractions of samples

3/ tr - trace

metallic minerals include pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, and gold. None of the metallic minerals are abundant and on the average constitute only a little over two percent of the ore. The gangue materials are quartz, calcite, fault gouge, and fragments of the wall rock, and sparse amounts of albite, sericite, and apatite.

Radioactivity studies

Radioactivity traverses were made along the west shore of Klag Bay and inland a short distance to a point two miles south of Chighagof; from Chichagof around the head of Klag Bay and one mile south along the east shore line; inland one and one-half miles from the east shore of Klag Bay along the power line; over the trail from the Chichagof mine to the Hirst-Chichagof mine on Kimshan Cove; and on the east side of Doolth Mountain to the elevation of the Golden Gate mine. A subsurface traverse was made in the accessible portion of the Golden Gate mine. The ore dumps and tailings piles of the Golden Gate, Chichagof, and Hirst-Chichagof mines as well as several other smaller ore dumps and numerous prospect pits and trenches were scanned for radioactivity.

No radioactive material was disclosed by traversing or scanning. The rock, mineral, flotation and settling tank, mill concentrates, and stream-gravel samples contained no more than 0.002 percent equivalent uranium. Radioactivity data on some of the samples collected in the vicinity of Chichagof are given in table 4.

Table 4.--Equivalent-uranium analyses of the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the vicinity of Chichagof, Chichagof Island, southeastern Alaska

Sample number	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3314	Stream at head of Klag Bay about 1/2 mile from bay	Sand and gravel	392:1	< 0.001
3315	Second stream from head of Klag Bay on east side of bay	Sand and gravel	729:1	< .001
3316	Fifth stream from head of Klag Bay on east side of bay	Sand and gravel	375:1	< .001
3317	Fourth stream from head of Klag Bay on east side of bay	Sand and gravel	461:1	.001
3318	Chichagof mine, Klag Bay	Mill table concentrate	Unknown	< .001
3319	Hirst-Chichagof mine, Kimshan Cove	Flotation and settling tank concentrate	Unknown	.001
3320	Stream that flows into large lake east of Klag Bay along the trail to Sister Lake	Sand and gravel	705:1	< .001
3321	Below old sluice box in stream flowing into northwest end of large lake east of the head of Klag Bay	Sand and gravel	582:1	< .001
3322	Second stream south of Chichagof on west side of Klag Bay	Sand and gravel	700:1	< .001
3323	Third stream south of Chichagof on west side of Klag Bay	Sand and gravel	334:1	.001
3324	Fourth stream south of Chichagof on west side of Klag Bay	Sand and gravel	506:1	< .001
3325	Sixth stream south of Chichagof on west side of Klag Bay	Sand and gravel	380:1	< .001
3326	Fifth stream south of Chichagof on west side of Klag Bay	Sand and gravel	590:1	< .001
3327	Golden Gate mine, Klag Bay	Tailings	2,600:1	.002
3328	Chichagof mine, Klag Bay	Flotation tank concentrate	Unknown	< .001

Funter Bay

Geology and mineral deposits

The geology of the Funter Bay area has been described in detail by Wright (1906), Eakin (1917), Mertie (1921), Buddington (1926), and Reed (1939).

The rocks at Funter Bay are massive greenstones, greenstone schist, chlorite schist, mica schist, quartz-chlorite schist, quartz-chlorite-mica schist, zoisite-chlorite schist, albite-zoisite schist, albite-chlorite schist, albite-mica schist, black graphitic phyllite, albite granite gneiss, albite syenite gneiss, marble, and dikes and sills of olivine diabase, gabbro, albite granite, albite syenite, and albite trachyte. A large part of the area is covered with glacial moraine.

The ore deposits occur mainly as quartz veins although some minerals are disseminated in the country rock. Another type of deposit consists of a gabbro sill (the Mertie Lode), which contains nickel and copper. In the latter, pentlandite, chalcopyrite, and pyrrhotite were among the latest minerals to crystallize in the sill and are mostly interstitial to the silicate minerals. The metallic minerals found in the vein deposits are gold, pyrite, pyrrhotite, galena, sphalerite, and arsenopyrite.

Radioactivity studies

The radioactivity studies in the Funter Bay area were confined to the property of Admiralty-Alaska Gold Mining Company which consists of 52 claims. The limited time available permitted only partial coverage of this property.

A radioactivity traverse was made on foot along the shore of Funter Bay within the property limits and inland a short distance on a trail which runs parallel to the beach. Another traverse was made from the mill to the end of the narrow-gauge

railroad, then south along a water ditch to the first stream, and thence to the head of this stream which has an elevation of over 2,000 feet; upon returning to the ditch, the traverse was continued south to the end of the ditch, and part of the area west of the ditch was traversed on the way back to the mill. A subsurface traverse was made in the Big Tunnel. All of the available drill cores on the property were scanned for radioactivity. These drill cores were reported to have been obtained from the Mertie Lode and surrounding rock formations. The material in the ore shoots and bins in the mill, several ore dumps, and many prospect pits and trenches were scanned for radioactivity. Samples were panned from the gravels of two streams which drained areas that were not sampled or traversed.

No radioactivity anomalies were discovered by traversing, and no anomalous radioactivity was detected in the scanning of the drill cores. As shown in table 5, none of the samples were found to contain more than 0.001 percent equivalent uranium.

Juneau and vicinity

Geology and mineral deposits

The geology and mineral deposits of the Juneau area has been discussed in detail by Buddington and Chapin (1929).

The various types of rocks, which form nearly straight, parallel, northwest-trending bands in the Juneau area, named in order from the interior on the mainland in a southwesterly direction across Gastineau Channel and Douglas Island to Stephens Passage are as follows:

(1) the Coast Range diorite and associated aplite dikes;

(2) schists;

Table 5.--Equivalent-uranium analyses of the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the vicinity of Funter Bay, Admiralty Island, southeastern Alaska

Sample number	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3291	Stream near ore dump from Mertie Lode	Sand and gravel	48:1	< 0.001
3292	Mertie Lode ore dump	Crushed rock	282:1	.001
3293	Alder Creek	Sand and gravel	261:1	.001
3294	Ore bin in Admiralty-Alaska Gold Mining Company mill (material probably from Uncle Sam vein)	Crushed rock	105:1	< .001

(3) black slates intruded by a large number of diorite masses genetically related to the Coast Range diorite, older intrusions of gabbro, and younger dikes of basalt and related rocks;

(4) bedded greenstones and greenstone schists with intercalated slate strata;

(5) black slates with intercalated bands of greenstone and intruded by diorite dikes related to the Coast Range intrusives and dikes of diorite porphyry;

(6) massive bedded greenstone.

The ore deposits in the area occur as veins, impregnated masses of rock, and mixed deposits in which veining and impregnation are both present. The vein deposits are confined essentially to the black slates while the other two types of deposits are found mainly in the diorite, gabbro, and diorite porphyry dikes. Some of the schists and greenstones have been mineralized but have not been found to contain important mineral deposits. The metallic minerals found in the deposits of this area are pyrite, pyrrhotite, sphalerite, galena, gold, chalcopyrite, arsenopyrite, molybdenite, and native arsenic. Realgar and orpiment also occur in some of the deposits. The gangue minerals are quartz, calcite, siderite, rutile, dolomite, sericite, chlorite, biotite, tourmaline, albite, and zoisite.

Radioactivity studies

A radioactivity traverse was made by automobile along the Auk Bay road north of Juneau and along the road from Juneau to the Alaska-Treadwell Gold Mining Company property on Douglas Island. The latter traverse was extended on foot from the Treadwell property south along the shore of Gastineau Channel to the Ready Bullion mine and along the road running north from the Gastineau Channel bridge on

Douglas Island for approximately two miles. Another traverse was made on foot along the road and shore south of Juneau for about three miles. None of these traverses revealed significant radioactivity anomalies.

A sluice-box concentrate from the Ready Bullion mine tailings contained 0.001 percent equivalent uranium. The heavier-than-bromoform minerals (those greater than 2.8 specific gravity) identified (by B. W. Wilson of the Geological Survey) in this sample in order of decreasing abundance are magnetite, pyrite, epidote, garnet, ilmenite, barite, actinolite, gold, ankerite, augite, limonite, hornblende, hypersthene, muscovite, sphene, scheelite, and zircon.

A sluice-box concentrate from the Alaska-Juneau mine tailings contained 0.001 percent equivalent uranium. The heavier-than-bromoform minerals identified (by B. W. Wilson of the Geological Survey) in this sample in order of decreasing abundance are magnetite, pyrite, sphalerite, ankerite, hornblende, limonite, garnet, galena, gold, chlorite, epidote, ilmenite, zircon, scheelite, and feldspar. A spectrographic analysis (by J. C. Rabbitt of Harvard University) of an Alaska-Juneau mine tailings sample collected in 1943 showed the sample to contain 0.03 percent vanadium, 0.02 percent nickel, 0.003 percent cobalt, 0.001 percent molybdenum, and less than 0.001 of antimony, beryllium, bismuth, cadmium, niobium, germanium, indium, mercury, platinum, rhenium, tantalum, tin, and tungsten.

The radioactivity of a two-ton rhyolitic glacial boulder at Lena Point north of Juneau was called to the attention of the Survey by a local prospector. When examined in the field the rhyolitic boulder gave a uniform reading of approximately three times the normal background count. A heavier-than-bromoform mineral concentrate (concentration ratio 86:1) from a piece of the boulder, however, was found to contain only 0.002 percent equivalent uranium.

CONCLUSIONS

No uranium deposits of commercial value were discovered in the course of the 1949 investigations in the vicinities of Ketchikan, Goddard Hot Springs, Chichagof, Funter Bay, and Juneau.

On the basis of field and laboratory studies no further reconnaissance for radioactive deposits is recommended in the restricted parts of the five areas examined. In these areas the metallic minerals are so scarce and constitute such a small percentage of the ore that other mineral deposits having the same source and occurring in the same formations even beyond the immediate limits of the areas thus far examined do not appear to be favorable for the occurrence of uranium of commercial grade.

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