Investigations for Radioactive Deposits in Southeastern Alaska

By WALTER S. WEST and PAUL D. BENSON

MINERAL RESOURCES OF ALASKA, 1954

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INVESTIGATIONS FOR RADIOACTIVE DEPOSITS IN SOUTHEASTERN ALASKA

By Walter S. West and Paul D. Benson

ABSTRACT

A radioactivity investigation during 1949 in the Hyder district, southeastern Alaska, revealed that radioactive material is widely distributed on the property of the Mountain View Gold Mining Company. However, no uranium deposits of commercial value were found in the small part of the district covered by this investigation.

Above-normal radioactivity was detected at a number of localities on the Mountain View property, but the source could not be determined at all sites. The most highly radioactive unconcentrated vein sample collected in 1949 contained 0.049 percent equivalent uranium, and the most intensely radioactive vein-material concentrate (specific gravity greater than 2.89) contained 0.398 percent equivalent uranium. Both samples were from the Skookum tunnel on the Mountain View property.

The radioactive material on the properties investigated in the Hyder district appears to be chiefly uranium, which occurs in an unidentified highly radioactive opaque mineral and in trace amounts in the sulfides of the vein deposits. Some of the radioactive material, however, is disseminated in the igneous rocks of the district and, to a minor extent, occurs as thin secondary coatings on fracture surfaces in veins and rocks. In addition to the unidentified highly radioactive opaque mineral and 2 distinct secondary uranium-bearing minerals, the following 16 minerals were found to contain uranium in minor amounts: biotite, chalcopyrite, chlorite, galena, hematite, limonite, magnetite, marcasite, molybdenite, pyrite, pyrrhotite, scheelite, sericite, sphalerite, sphene, and zircon.

Investigations for radioactive deposits during 1949 in the vicinities of Ketchikan, Goddard Hot Springs, Chichagof, Funter Bay, and Juneau, southeastern Alaska, revealed no significant concentrations of radioactive materials. Concentrates from stream gravels and disintegrated bedrock near Goddard Hot Springs were the most radioactive samples collected in these areas. They contain from 0.012 to 0.016 percent equivalent uranium. As the chief radioactive mineral in these concentrates is allanite, most of the radioactivity is ascribed to thorium.

INTRODUCTION

Early in the summer of 1949, Howard M. Fowler, a mining engineer of the Territorial Department of Mines, made a brief radioactivity investigation on the property of the Mountain View Gold Mining

Company in the Hyder district (see pl. 7, pl. 9). Several significant radioactive anomalies were detected, but the source material could not be determined. On the basis of Fowler's work, a Geological Survey party spent several weeks in August and September, 1949, making additional studies in an effort to determine the source of the radioactivity and to attempt to locate and study other possible radioactive deposits in the Hyder district. The Geological Survey field party consisted of Walter S. West and Paul D. Benson, geologists, and Arthur E. Nessett, camp and field assistant. This work was done on

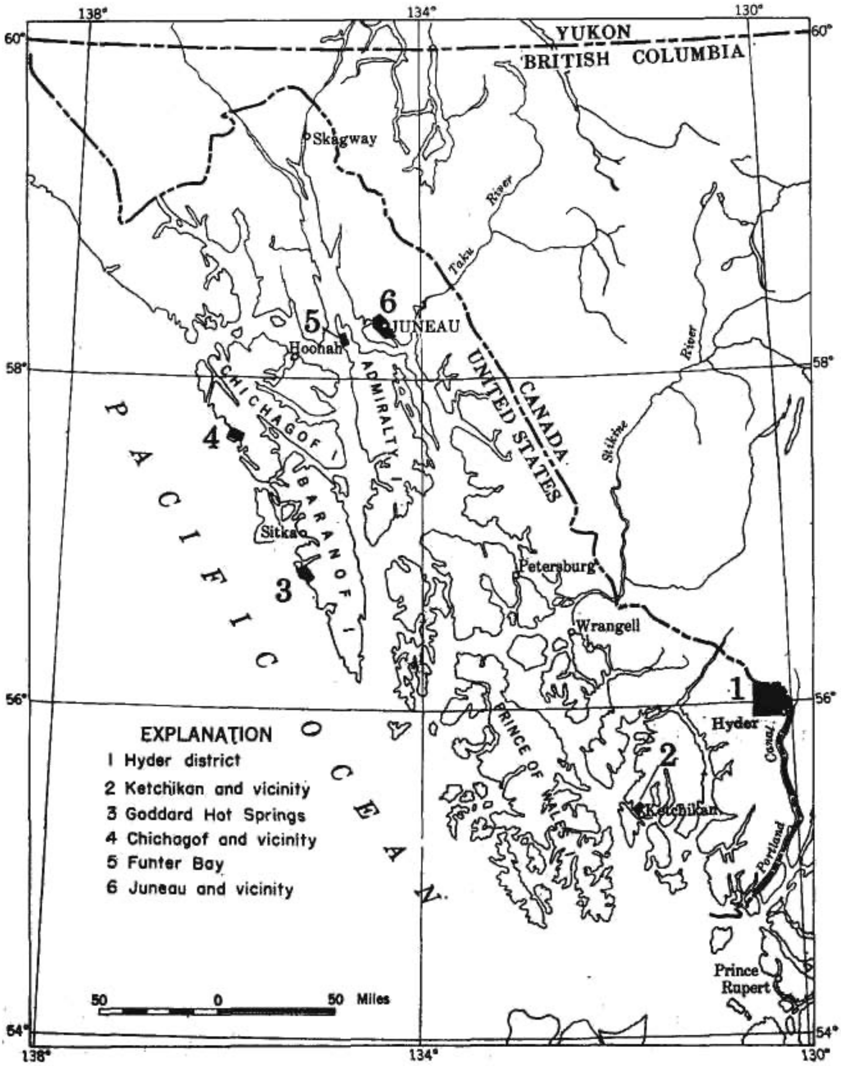

FIGURE 5.—Map of southwestern Alaska showing areas investigated.

behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. In addition to surface and underground radioactivity investigations on the Mountain View property, brief reconnaissance examinations were made of several other properties and along most of the roads and some of the trails in the district. To supplement sampling done by the Geological Survey, Arthur O. Moa, manager of the Mountain View Gold Mining Company, kindly submitted additional samples from various radioactive veins that he had located on the property.

Reports of radioactive materials led to the investigations in the Chichagof area on Chichagof Island and the Goddard Hot Springs area on Baranof Island. The Funter Bay area on Admiralty Island and the Ketchikan area on Revillagigedo Island were examined because ore deposits at both localities contain minerals commonly associated with uranium elsewhere in the world. The examination of likely radioactive prospects and localities in the Juneau area, southeastern Alaska, were made primarily as a matter of convenience while the party was unavoidably detained there several times by weather. (See fig. 5.)

The staff of the Washington laboratories of the Geological Survey conducted intensive mineralogic studies of specified samples and the personnel of the Alaskan Geology Branch assisted in the radiometric analyses and part of the mineralogic determinations of the samples. The authors received valuable information and many kindnesses in the field from many prospectors and residents of Alaska. The authors are especially indebted to Arthur E. Nessett of Missoula, Mont., for the consistently effective service he rendered in furthering the work as field and camp assistant.

HYDER DISTRICT

GEOGRAPHY

The Hyder district of southeastern Alaska is situated near the head of the Portland Canal and comprises the area drained by the Salmon River (fig. 5, pl. 7). Its limits are defined on the north and east by the international boundary, on the west by the divide between the headwaters of the streams tributary to the Salmon River and those tributary to the Chickamin River, and on the south by the Portland Canal. The property of the Mountain View Gold Mining Company is about 5 miles north of Hyder, near the junction of Skookum Creek with Fish Creek. The town of Hyder is near the mouth of the Salmon River and extends along the Portland Canal to the international boundary.

Supplies for the area are obtained from Hyder or from Stewart, British Columbia, which is 2 miles northeast of Hyder at the head of the Portland Canal. These towns are accessible the year round by both seaplane and boat.

Many of the mining properties in the district are accessible from Hyder and Stewart by roads and trails (pl. 7). A good gravel road between Hyder and the Premier mine in Canada affords access to some of the mineral deposits east of the Salmon River. About 11 miles of this road is in Alaska. Another narrow road has been constructed from the bridge across Salmon River above Ninemile, where the road connects with the main highway, to the vicinity of Texas Lake at the head of the West Fork valley. The road follows the West Fork of Texas Creek for a distance of about 10 miles. Some of the properties not accessible by road may be reached by pack trials built and maintained by the U. S. Forest Service.

The Hyder district is a mountainous region of great relief. The valley floors of Salmon River and Texas Creek, which represent the only relatively level land in the district, rise from sea level to about 500 feet; and the mountains extend steeply upward to heights of 4,000 to 6,000 feet. The area in general is heavily forested to altitudes of 3,000 to 4,000 feet. The timber, mainly western and black hemlock and Sitka spruce, is of sufficient quantity and quality to supply local mining needs. Within this forested zone thick underbrush constitutes a hindrance to exploration in many places. From the timberline up to the lower limit of the snow and ice fields is a zone of alternating bare rock, talus, and glacial debris covered in part by heather, scrawny trees, and patches of snow. Snow and ice caps cover all large areas above 5,000 feet, and glaciers are found in protected basins and valleys at much lower altitudes. Some of the glaciers, such as Texas, Casey, Ferguson, and Thumb, are retreating quite rapidly. The major streams in the area are glacial streams containing a large quantity of mud, silt, and suspended triturated rock. On some of the properties there are clear mountain streams sufficient in volume to furnish adequate waterpower for prospecting and, in a few places, for mining.

The area is subject to extremely heavy snowfalls, and, because of this fact, prospecting and development have been seriously retarded. The heaviest precipitation occurs in the late fall and winter months, mostly in the form of snow. The average annual snowfall is about 18 feet in the lowest areas and occasionally amounts to as much as 40 to 60 feet at higher altitudes. The summer season is relatively short. Properties that lie at the higher altitudes rarely have more than 4 to 5 months of open season, whereas those, such as the Mountain View, lying at altitudes of less than 1,500 feet are favored with an open season of from 7 to 8 months during the year. The rainfall is moderately heavy during late spring, summer, and early fall. It is least in May and June and greatest in July, August, September, and October. The mean annual temperature at sea level is 40°F and the winter temperatures rarely fall below zero.

GEOLOGY

The geology and the ore deposits of the Hyder district have been described by Brooks (1902), Wright and Wright (1908), Chapin (1916), Mertie (1921), Westgate (1921), Buddington (1925 and 1929), Jewell (1927), Buddington and Chapin (1929), and Erickson (1946). The geology of the Hyder district as described below is taken mostly from Buddington (1929).

The district lies adjacent to and includes a part of the northeastern border of the Coast Range batholith, which parallels the shoreline of British Columbia and southeastern Alaska for about 1,100 miles and ranges from 20 to 110 miles in width. The batholith at the latitude of Hyder is about 50 miles wide; the batholith and the outlying dikes, sills, and stocks genetically related to it affect an area more than 100 miles wide. Mineral deposits are widespread in this border belt, which is generally referred to as the eastern or interior belt of mineralization.

The four major rock units (pl. 7) distinguished in the Hyder district are as follows:

Hazelton group: A sequence of bedded rock which are both volcanic and sedimentary in origin and which consist of greenstone, tuff, volcanic breccia, graywacke, slate, argillite, quartzite, and rarely limestone.

Texas Creek granodiorite: A central batholithic mass of gray granodiorite which is bounded on the east and west by, and is intrusive into, the Hazelton group.

Hyder quartz monzonite: A batholith of pinkish quartz monzonite which lies along the southern border of, and is intrusive into, the Hazelton group and the Texas Creek granodiorite.

Boundary granodiorite: A pink granodiorite stock lying on the north side of, and intrusive into, the Hazelton group and the Texas Creek granodiorite.

The Hazelton group is considered to be of Jurassic(?) age; and the Texas Creek, Hyder, and Boundary granitic rocks, all of which are facies of the Coast Range batholith, are probably of Jurassic or Cretaceous age. Small stocks and dikes of gray sheared porphyry, genetically related to the Texas Creek granodiorite, cut the sedimentary and volcanic rocks of the Hazelton group. Also, both the Texas Creek granodiorite and the rocks of the Hazelton group are intruded at numerous places by dikes of pink and white granodiorite or dark diorite porphyry which are allied genetically with the Hyder quartz monzonite and the Boundary granodiorite. All four major groups of rocks and the associated dikes and stocks are cut by narrow lamprophyre dikes. Aplite dikes are also found in all four groups of rocks.

Fluvial, glaciofluvial, and glacial debris of Pleistocene and Recent age has been deposited along the flood plains of the main streams, on benches along the stream valleys, in some of the tributary valleys, and on the less steep mountain slopes.

At the present time large quantities of silt, sand, gravel, and cobblestones are being deposited on the floors of the Salmon River and Texas Creek valleys; and the upper valleys of West Fork and Thumb Creek are likewise being aggraded with the same kinds of material. The Salmon River is building a delta into the Portland Canal. Terminal and lateral moraines are being formed by many of the glaciers. Rock waste in the form of talus and landslide aggregates continues to accumulate at the bottoms of cliffs and on the sides and near the bases of the steep mountains.

The rocks of the Hazelton group and the Texas Creek granodiorite have been subjected to a considerable amount of minor faulting, but no fault of any great magnitude has been observed. Although joints have been developed in the Texas Creek granodiorite, there appears to be no constancy in the direction of their strike or dip except locally. A better defined joint system occurs in the Hyder quartz monzonite.

Only the Texas Creek batholith, with its associated outlying stocks and dikes, and the rocks of the Hazelton group are known to contain mineral deposits of economic importance. Some of the mineral veins, which occur along or near the contact between the batholith and the Hazelton group, are cut by granodiorite and diorite porphyry dikes that are associated with the Hyder quartz monzonite and the Boundary granodiorite. Some mineral veins are cut by still younger lamprophyre dikes.

The mineral deposits of economic importance in the Hyder district have been classified by Buddington (1929) and are somewhat modified and condensed by the authors as follows:

Quartz fissure veins of the lead-silver type: The veins are found principally within the Texas Creek granodiorite but are found also in the rocks of the Hazelton group and within outlying stocks and dikes of porphyry associated with the Texas Creek granodiorite. The sulfides are in shoots within the quartz veins. The predominant metalliferous minerals are galena and pyrite. Sphalerite, chalcopyrite, tetrahedrite, pyrrhotite, and native gold are present in lesser amounts. Barite is the most common gangue mineral. Examples of the lead-silver type are found on the Fish Creek, Mountain View, Homestake, Riverside, Cantu, and Texas Comstock properties and constitute one of the major types of veins in the district.

Veins of the gold type: An example of this type is a siliceous heavy-sulfide body of ore in the Premier mine in Canada (Schofield and Hanson, 1921). A similar mineral aggregate seems to occur in the Texas Creek batholith on the Cantu property and possibly on the Mountain View property in the Hyder district. The predominant minerals are quartz and pyrite, and small amounts of chalcopyrite, sphalerite, and galena are present. Assays show that the ore contains moderate to high amounts of gold and practically no silver.

Disseminated and lenticular replacement deposits: Deposits of these types are mainly in the greenstone parallel to the schistose structure and are principally of the base-metal types. The predominant metalliferous minerals are pyrite, galena, sphalerite, and pyrrhotite, or pyrrhotite with minor amounts of chalcopyrite, arsenopyrite, and sphalerite. Gold is found in the sphalerite. Chalcopyrite is the predominant ore mineral in some deposits, and tetrahedrite is present in many deposits. The gangue minerals are quartz, calcite, and barite. Examples of this type are found on the Daly-Alaska, Virginia, Hobo, and Stoner properties and form one of the major types of deposits in the district.

Mineralized fissure zones: The zones are approximately parallel to the structure in the slate and the tuffaceous graywacke of the Hazelton group. The deposits consist in part of fissure fillings and in part of partly replaced country rock. Galena and sphalerite are the most common sulfides; the amounts of pyrite, chalcopyrite, pyrrhotite, tetrahedrite, and arsenopyrite differ in each deposit. Examples of this type are found on the Silver Bell and Iron Cap claims.

GEOLOGY AND DEVELOPMENT OF THE MOUNTAIN VIEW PROPERTY

The eastern contact between the Texas Creek granodiorite and the rocks of the Hazelton group extends approximately through the middle of the Mountain View property and strikes a little east of north (pl. 8). The following data on geology and development of the property have been extracted principally from Buddington (1929) and from an unpublished report prepared in 1928 for the Mountain View Gold Mining Company by J. E. Kania and kindly made available to the authors by Arthur O. Moa.

Rock outcrops are few because the property is covered by a layer of glacial till, decomposed rock, and vegetation. The youngest known igneous rocks on this property are fine-grained lamprophyre dikes of moderate widths (pl. 8). They strike either northeast or northwest and have dips consistently to the west. Before the injection of these mafic dikes there was the intrusion of at least one quartz porphyry dike believed to be genetically related to the Hyder quartz monzonite. Before the intrusion of the quartz porphyry dike there was a period during which a few aplite dikes, thick barren quartz veins, and large rather siliceous granodiorite dikes and stocks were injected, as the acid end products of the batholithic invasion of the Texas Creek granodiorite, into the already cooled periphery of the batholith and into the rocks of the Hazelton group. The Hazelton group on the Mountain View property is composed chiefly of volcanic rocks.

The period of primary mineralization is believed to have followed closely upon the intrusion of the Texas Creek batholith and its associated dikes and stocks, but there is a possibility that some of the mineral veins were formed before the invasion of some of the dikes. The ore bodies are cut by the lamprophyre dikes and by many fractures and minor faults, as evidenced in the Skookum tunnel and in the surface strippings of the Gray Copper vein.

The primary mineral deposits were formed at considerable depths beneath the surface, and they are represented by veins belonging to the high- and intermediate-temperature types and by combinations of both. Secondary minerals have been deposited by circulating meteoric waters.

Some of the mineralized veins on the property have been traced for distances of several hundred feet on the surface by trenching and for corresponding distances in depth by drifts. For example, the Gray Copper vein has been traced in trenches, pits, a drift, a crosscut, and a shaft for 460 feet along its strike; underground drifting (stations 24–29W, pl. 8) in the Skookum tunnel has exposed this vein for a distance of 315 feet, and the distance up the dip between this drift and the surface outcrop is 360 feet. The Gray Copper vein pinches and swells and is probably typical of most of the other veins on the property in physical characteristics. The pinched segments are shattered, contain thin traces of gouge, and are sparsely mineralized; the wider parts of the vein display only slight shattering, no gouge, and are generally well mineralized.

The most extensive underground development on the property is the Skookum tunnel, which consists of more than 4,200 linear feet of drifting and crosscutting (pl. 8). Cross sections of the drifts and crosscuts in this tunnel range from 5 by 7 to 9 by 9 feet. The roofs and walls throughout the tunnel stand without timbering, and water seepage presents no problem because of a gravity drain. In 1949 the tunnel was equipped with mine track (12-pound rail), 2 ore cars, and 1 flat car. Besides the Skookum tunnel, several smaller drifts and many prospect holes have been made on the property. The one shaft that has been sunk on the Gray Copper vein is almost filled with water and is inaccessible for study.

RADIOACTIVITY INVESTIGATIONS

FIELD METHODS

The instruments used for field radioactivity studies in the Hyder district were standard commercial models of portable survey meters modified to accept probes consisting of 6-inch beta-gamma tubes or a gang of four 1- by 18-inch brass-walled gamma tubes connected in parallel. For radioactivity traverses on foot, the survey meters equipped with the gamma probes were mounted on packboards; for spot checking outcrops, underground workings, ore dumps, talus blocks, veins, dikes, and rock and mineral specimens, 6-inch beta-gamma probes were used in place of the large gamma probes.

Surface traverses were made along the Salmon River and Texas

Lake roads from Hyder to Texas Lake, along the Mountain View and Titan trails, and over parts of the Mountain View, Ambrose, Adanac, Titan, Sixmile, and Riverside claims (pl. 7). Subsurface traverses were made in the Sixmile, Titan, and Skookum tunnels and in the Riverside mine as well as in several other drifts on the Mountain View property. In addition, 43 rock and mineral samples collected in 1949 by William H. Kerns of the U. S. Bureau of Mines on the Mountain View, Ambrose, Last Shot, Howard, Sixmile, Hobo, Daly-Alaska, Stoner, and Liberty claims were scanned for radioactivity with a portable survey meter.

During the course of the investigation 72 rock and mineral samples, 2 slope-wash samples, 13 stream sand and gravel samples, 1 mill-shipping concentrate, and 1 mine-water sample were collected. Many of the rock and mineral samples obtained in the Skookum tunnel and from various prospect holes and outcrops on the Mountain View property were crushed in a portable lever-action jaw crusher and a hand-operated wheel-type jaw crusher on the property. A large part of each crushed sample was screened and partly concentrated by panning to reduce the size and weight of the sample and to concentrate the heavy minerals. This concentrate was saved for later studies in the Geological Survey's Washington laboratories. The localities from which samples were collected in the Hyder district beyond the limits of the Mountain View property are shown on plate 7. The localities of the surface samples from the Mountain View property are given on plate 9. Plate 8 shows the localities of the underground samples from the Mountain View property.

LABORATORY METHODS

Selected rock and lode samples were crushed and screened in the laboratory. Measurement of the equivalent-uranium content of the minus 20- plus 150-mesh size material of each sample was made with a standard commercial model of a laboratory beta counter. The samples were treated then with bromoform to float off the minerals with a specific gravity of less than 2.89, and the heavy residues were analyzed for radioactivity. The rock and mineral, slope wash, and stream sand and gravel samples, which had been concentrated by panning in the field, were screened to minus 20-mesh size and split according to standard laboratory procedure. A split of the minus 20-mesh size material of each sample was further concentrated with bromoform, and the equivalent-uranium content of the heavier-than-bromoform mineral fraction was determined. The analyses for equivalent-uranium content of the samples were made principally by Arthur E. Nelson and Paul D. Benson of the Geological Survey at Washington, D. C. The percent of equivalent uranium for each sample is given in table 1.

TABLE 1.—*Equivalent-uranium content and uranium-bearing minerals of samples from the Mountain View Gold Mining Co. property and other parts of the Hyder district, 1949*

[The parts of the concentrates analyzed for equivalent uranium were the heavy-mineral fractions with a specific gravity greater than 2.89. The presence of uranium in the minerals listed as uranium bearing was determined qualitatively by sodium fluoride flux tests in the Washington laboratories of the Geological Survey]

	Location	Type of sample	Concentration ratio	Percent equivalent uranium		Uranium-bearing minerals
				Raw sample	Concentrate	
3336	Floor of first tunnel north of Fourmile along the Salmon River road on the Sixmile claim.	Waste rock	40:1		0.007	Hematite and limonite
3337	Second stream north of Fourmile along the Salmon River road.	Sand and gravel			.002	
3338	First stream north of Riverside mine along the Salmon River road.	do			.002	
3339	Fish Creek, just above the road bridge at Fourmile.	do	260:1		.002	
3341	Salmon River, about 1 mile north of Hyder.	do			.007	Zircon.
3342	Hyder quartz monzonite about 2 miles north of Hyder along the road.	Slope wash	240:1		.002	
3343	First stream north of Hyder along the Salmon River road.	Sand and gravel	300:1		.01	Sphene.
3344	Floor of first right side cut from the portal in Skookum tunnel.	Waste rock	110:1		.002	
3345	Floor of second right side cut from the portal in Skookum tunnel.	do	135:1		.001	
3346	Floor of third right side cut from the portal in Skookum tunnel.	do	55:1		.002	
3347	Floor of fourth side cut from the portal in Skookum tunnel.	do	60:1		.004	
3348	Floor of fifth and sixth side cuts from the portal in Skookum tunnel.	do	55:1		.002	
3349	Floor of seventh side cut from the portal in Skookum tunnel.	do	500:1		.002	
3350	Floor of eighth side cut from the portal in Skookum tunnel.	do	1,440:1		.007	
3351	Floor of ninth side cut from the portal in Skookum tunnel.	do	120:1		.002	
3352	Floor of Skookum tunnel at station 12.	do	90:1		.005	
3353	Floor of 10th side cut near station 18 in Skookum tunnel.	do	50:1		.003	
3354	Floor of Skookum tunnel at station 20 and 12 ft in both directions along the right wall.	do	45:1		.014	
3355	Floor of Skookum tunnel at and near station 22.	do	90:1		.009	
3356	Wall of side cut near station 24 in Skookum tunnel.	Wall rock	270:1		.006	
3357	Floor of side cut near station 24 in Skookum tunnel.	Waste rock	80:1		.042	Molybdenite, pyrite (with hematitic coating), pyrrhotite, scheelite, and an unidentified opaque cubic mineral.
3358	do	do	260:1		.012	Molybdenite, pyrite (with hematitic coating), pyrrhotite, and an unidentified opaque cubic mineral.
3359	do	do	150:1		.019	Do.

TABLE 1.—*Equivalent-uranium content and uranium-bearing minerals of samples from the Mountain View Gold Mining Co. property and other parts of the Hyder district, 1949*—Continued

	Location	Type of sample	Concentration ratio	Percent equivalent uranium		Uranium-bearing minerals
				Raw sample	Concentrate	
3360	Floor in end extension of Skookum tunnel beyond station 24.	Waste rock	100:1		0.006	
3361	Floor near the end of long left side cut near station 29 in Skookum tunnel.	do	25:1		.003	
3362	Floor of Skookum tunnel along the base of right wall between stations 51 and 52 and in left side cut at station 52.	do	140:1		.008	
3363	Floor of right side cut near station 54 in Skookum tunnel.	do	390:1		.040	Molybdenite.
3364	Floor of left side cut at station 58 in Skookum tunnel.	do	400:1		.029	Do.
3365	Floor of right side cut at station 61 in Skookum tunnel.	do	50:1		.001	
3366	Floor of left side cut at station 62 in Skookum tunnel.	do	50:1		.003	
3367	Floor of Skookum tunnel along right wall at station 64.	do	30:1		.001	
3368	Floor near the termination of Skookum tunnel beyond station 65.	do	50:1		.002	
3369	Walls at station 12 and 15 ft in both directions in Skookum tunnel.	Wall rock	100:1		.003	
3370	Skookum Creek, 40 yd above the portal of Skookum tunnel.	Sand and gravel			.002	
3371	Fish Creek, just below the Mountain View powerhouse.	do	150:1		.001	
3372	Adanac Creek, 15 yd below the Mountain View trail bridge.	do			.002	
3373	First major tributary to Fish Creek below Adanac Creek.	do			.001	
3374	Third tributary to Fish Creek below Adanac Creek.	do			.001	
3375	Fourth tributary to Fish Creek below Adanac Creek.	do			.001	
3376	Floor of the Gray Copper vein prospect tunnel, Mountain View property.	Waste rock	12:1		.001	
3377	First small tributary to Fish Creek below Adanac Creek.	Sand and gravel	220:1		.001	
3378	Fifth tributary to Fish Creek below Adanac Creek.	do			.003	
3379	Rock dust removed from the walls of Skookum tunnel at station 12 and a short distance in both directions.	Rock dust	55:1		.006	Molybdenite, and pyrite (with hematitic coating).
3380	Riverside mine	Mill concentrate			.001	
3381	Wall of Skookum tunnel at station 6.	Wall rock	190:1	0.003	.044	
3382	Gray Copper vein in Skookum tunnel between stations 26W and 27W.	Vein	14:1		.001	
3383	Wall of Skookum tunnel at station 8.	Wall rock	45:1		.006	
3384	Wall of Skookum tunnel between stations 17 and 18 (2 locations).	do	75:1		.003	
3385	Wall of Skookum tunnel between stations 14 and 15 (2 locations).	do	55:1		.002	
3386	Wall of Skookum tunnel between stations 51 and 52.	do	100:1	.004	.015	Molybdenite and pyrite.
3387	Wall of Skookum tunnel between stations 55 and 56.	do	120:1	.006	.034	Molybdenite, galena, and pyrite.

TABLE 1.—*Equivalent-uranium content and uranium-bearing minerals of samples from the Mountain View Gold Mining Co. property and other parts of the Hyder district, 1949*—Continued

	Location	Type of sample	Concentration ratio	Percent equivalent uranium		Uranium-bearing minerals
				Raw sample	Concentrate	
3388	Wall of Skookum tunnel between stations 58 and 59.	Wall rock	280:1	-------	0.023	Galena, molybdenite, pyrite, and sphalerite.
3389	Wall of Skookum tunnel at station 60.	do	230:1	0.005	.015	Biotite, galena, molybdenite, and pyrite.
3390	Floor of south drift on Sixmile claim along the Salmon River road.	Waste rock	50:1	-------	.003	
3392	Lode in right wall of Skookum tunnel about 4 ft from end of the right side cut at station 24.	Vein material	12:1	.028	.245	Molybdenite, pyrite, pyrrhotite, and an unidentified opaque cubic mineral.
3393	Right wall of Skookum tunnel about 4 ft from end of the right side cut at station 24.	Wall rock and vein material.	20:1	.012	.059	Do.
3394	Right wall of Skookum tunnel between stations 55 and 56.	Vein material	4:1	.049	.089	Molybdenite.
3395	Lode material on the floor of Skookum tunnel in right side cut at station 24.	do	3:1	.035	.071	
3396	Right wall of the Skookum tunnel between stations 58 and 59.	Vein material and wall rock.	60:1	.016	.398	Pyrrhotite.
3732	Near "Blue Gouge" cut	Rock	40:1	.004	.005	Galena, pyrite, and sphalerite.
3733	"Blue Gouge" cut	do	540:1	-------	.005	
3734	"Blue Gouge" cut, 7 ft south of sample 3733.	Vein material	2:1	.001	.001	
3735	West end of cut on Marsh vein	do	25:1	-------	.003	
3736	Marsh vein cut, 5 ft east of sample 3735.	Rock	970:1	-------	.051	Biotite, hematite, molybdenite, and pyrite.
3737	Marsh vein	Vein material	1:1	.001	-------	
3738	Near Marsh vein	Dike	1,100:1	-------	.032	Galena, hematite, limonite, pyrite, and chalcopyrite.
3739	Outcrop about 100 ft north of sample 3738.	do	180:1	-------	.137	Hematite and limonite.
3740	Hanging wall of Canyon vein on the south side of Fish Creek and about 1,000 ft south of the Skookum tunnel portal.	Rock and vein material.	210:1	-------	.258	Biotite, galena, molybdenite, pyrite, and sphalerite.
3741	Hanging wall of Canyon vein on the south side of Fish Creek.	Rock	320:1	-------	.042	
3742	Canyon vein on the south side of Fish Creek.	do	25:1	.009	.049	Biotite, molybdenite, and pyrite.
3743	West side of upper tunnel on Silver Falls vein, footwall side of vein, and about 2,000 ft south of Skookum tunnel portal.	do	14:1	-------	.002	
3744	Silver Falls vein, near sample 3743.	do	5:1	.007	.007	
3745	Bluff about 100 ft south of sample 3743.	do	270:1	-------	.006	
3746	Slide vein, east of Fish Creek and the Silver Falls vein.	do	1,450:1	-------	.032	
3747	Slide vein, near sample 3746	do	140:1	.005	.025	
3748	Discovery outcrop on the Morning claim, about 3,300 ft south of the Skookum tunnel portal.	do	30:1	-------	.002	
3749	Two-inch stringer near Canyon vein on the east side of Fish Creek.	Vein material	4:1	.002	.006	
3750	Footwall side of Canyon vein	Rock	350:1	-------	.012	
3751	do	do	230:1	.004	.039	Chlorite, marcasite, and sericite.
3752	Western opencut on Ruby Silver vein.	Rock	45:1	-------	.001	

TABLE 1.—*Equivalent-uranium content and uranium-bearing minerals of samples from the Mountain View Gold Mining Co. property and other parts of the Hyder district, 1949*—Continued

	Location	Type of sample	Concentration ratio	Percent equivalent uranium		Uranium-bearing minerals
				Raw sample	Concentrate	
3753	Ruby Silver vein	Rock and vein material.	90:1	--------	0.005	
3754	Bluff just above the upper tunnel on Ruby Silver vein.	Rock	450:1	--------	.019	Molybdenite, pyrite, and marcasite.
3755	Cliff about 75 ft north of the upper tunnel on Ruby Silver vein.	do	100:1	--------	.012	Hematite, limonite, magnetite, pyrrhotite, and molybdenite.
3756	Canyon vein	Rock and vein material.	110:1	--------	.003	
3757	Rampart vein, west of Canyon vein.	do	45:1	--------	.002	
3758	Cliff vein, about 100 ft south and a little west of sample 3757.	do	100:1	--------	.002	
3759	Cliff vein	Rock	80:1	0.001	.005	Pyrite and marcasite.

In order to expedite microscopic, spectrographic, X-ray, and chemical analyses the heavier-than-bromoform mineral fractions of certain samples were further concentrated with methylene iodide (specific gravity 3.3) and separated by an isodynamic separator into magnetic and nonmagnetic subfractions. Mineralogic determinations of the heavier-than-bromoform mineral fractions of some samples were completed without necessitating further heavy-mineral concentration or fractionation by the foregoing methods. All of the mineralogic, spectographic, X-ray, and chemical studies of the samples, with the exception of those made by the authors, were made by Joseph Berman, E. H. Cisney, M. H. Fletcher, Robert Meyrowitz, Kiyoko Onoda, J. N. Stich, and C. L. Waring, all of the Geological Survey's Washington laboratories.

MINERALOGY

Time has not permitted a thorough study of the mineralogy of all the samples from the Mountain View Gold Mining Company property and other parts of the Hyder district. Sample 3396 (table 1 and pl. 8) has the most radioactive (0.398 percent equivalent uranium) heavy-mineral fraction (specific gravity greater than 2.89) of all the samples collected in the Hyder district in 1949. A mineralogic analysis of this sample by the authors showed that it contains major amounts of pyrrhotite, rutile (with an opaque coating), molybdenite, and pyrite, and minor amounts of chlorite, prehnite, apatite, amphibole, monazite(?), carbonate minerals, and an unidentified brownish-black isotropic mineral. The heavy mineral fractions (specific gravity greater than 2.89) of 36 other samples were analyzed for their mineral content in the Washington laboratories of the Geological Survey; the samples

TABLE 2.—*Mineral composition of selected radioactive heavy-mineral fractions (specific gravity greater than 2.89) of samples from the Mountain View Gold Mining Co. property and other parts of the Hyder district*

[Numbers indicate estimated volumetric percent of minerals present in the heavy-mineral fractions of the samples; (*) indicates mineral giving a positive qualitative test for uranium; tr indicates trace]

Minerals	Sample no.																	
	3336	3337	3338	3341	3343	3357	3358	3359	3363	3364	3370	3371	3372	3379	3381	3382	3386	3387
Amphibole	20	20	2	10		15		2					tr					
Amphibole and chlorite															10			
Apatite		2		3														
Barite										2								
Biotite	tr		10	2	4	tr	tr	tr						tr				
Bornite						tr												
Calcite	tr					tr	tr	tr	5	1								
Calcite and prehnite														27				
Celestite									10									
Cerussite	1																	
Chlorite						21		11			tr	tr		25			45	tr
Clinozoisite		5																
Diopside			3															
Epidote	1	tr			1	tr			1	tr	5	5	3	3			5	15
Fluorite										2								
Galena						tr		tr		tr					tr		3	
Garnet						tr					2	1	2					tr
Gold												tr						
Hematite					tr													
Hematite and limonite	*20	25	15	5					5	10	10	10	15		5	1		
Hornblende					2													
Magnetite	80	2	15	15	80	tr			5	10	5	5	5		5		3	7
Molybdenite						*2	*1	*4	*15	*5				*2			*2	
Molybdenite and galena																		*3
Muscovite	tr		tr				tr							tr				
Olivine				10	1													
Prehnite							2	tr							5			
Pyrite	1	1									3				25	9	*15	*55
Pyrite with hematite coatings and chalcopyrite						*24	*18	*35						*10				
Pyrite and marcasite									25	30								
Pyrite and pyrrhotite				3														
Pyrolusite													tr					
Pyroxene					2													
Pyrrhotite		tr				*7	*18	*7						3		85		
Rock fragments	5	45	55	*45	5	*15	*44	*46						25	40		27	20

Rutile				tr		tr	tr	tr			5	1						
Scheelite						*15	2	4						5		5		
Sericite	2			5					34	40	70	78	75		10			
Sphene					*5									tr				
Talc						1												
Tetrahedrite													tr					
Unidentified opaque cubic mineral						*tr	*tr	*tr										
Wulfenite	5																	
Zircon				*2		tr	tr					tr		tr				

TABLE 2.—*Mineral composition of selected radioactive heavy-mineral fractions (specific gravity greater than 2.89) of samples from the Mountain View Gold Mining Co. property and other parts of the Hyder district*—Continued

[Numbers indicate estimated volumetric percent of minerals present in the heavy-mineral fractions of the samples; (*) indicates mineral giving a positive qualitative test for uranium; tr indicates trace]

Minerals	Sample no.																	
	3388	3389	3392	3393	3394	3732	3736	3738	3739	3740	3742	3744	3747	3751	3754	3755	3757	3759
Amphibole				5														
Biotite		*tr	tr	tr			*tr			*tr	*tr							
Calcite			tr	tr														
Chalcopyrite					1					tr								
Chlorite	3	3	4	4	tr		5		20	15				*10			5	
Chlorite and talc								10							3	2		
Epidote	tr						tr		tr				tr					
Galena	*3	*2				*5		*3	tr	*1								
Hematite							*5		*16									
Hematite and limonite								*12		35					10	*10	10	
Limonite									*25									
Magnetite	50	85				2	15	25	30		2		20	45			5	20
Magnetite and pyrrhotite																*5		
Marcasite													10	*10				
Molybdenite	*4	*5	*2	*2			*2	tr	tr	*2	*1				*tr	*3		
Molybdenite with prehnite and quartz					*98													
Prehnite			4		tr													
Prehnite and quartz									10									
Pyrite	*17	*25	*2		1	*3	*10		tr	*5	*2							
Pyrite with hematite coatings and chalcopyrite				*2														
Pyrite and chalcopyrite								*5										
Pyrite and marcasite												5			*2	5	25	*15
Pyrrhotite			*50	*35														
Quartz-barite rock																		85
Quartz-barite carbonate rock												95						
Rock fragments	18	*30	22	62		50	*60	45		*40	*95		20					
Rutile			tr	tr														
Sericite													60	*35	85	75	55	
Sphalerite	*6					*40		tr		*2								
Talc				tr			3											
Unidentified opaque cubic mineral			*tr	*tr														

were selected on the basis of their equivalent-uranium content or location. These mineralogic studies indicated the presence of the sulfides: bornite, chalcopyrite, galena, marcasite, molybdenite, pyrite, pyrrhotite, sphalerite, and tetrahedrite; the oxides: hematite, limonite, magnetite, and pyrolusite; and also: apatite, barite, biotite, celestite, cerussite, chlorite, clinozoisite, diopside, epidote, fluorite, garnet, gold, hornblende, muscovite, olivine, prehnite, pyroxene, rutile, scheelite, sericite, sphene, wulfenite, and zircon. The minerals identified in each of the 36 samples are given in table 2. Table 2 also shows the estimated volumetric percent of minerals present in each sample and indicates the minerals which gave a positive qualitative test for uranium.

The mineral deposits in the Hyder district in some respects resemble the uraninite-bearing veins lying to the east in British Columbia (Stevenson, 1950). Therefore detailed mineralogic studies were made of the heavy-mineral fractions of samples 3357, 3392, and 3393 (table 2 and pl. 8) from the vicinity of station 24 in the Skookum tunnel on the Mountain View property in an attempt to determine whether uraninite was the cause for all or part of the radioactivity at this site. The site was selected because it was believed to be fairly representative of the several locations of above-normal radioactivity in the Skookum tunnel. The work of Cisney, Fletcher, Onoda, and Stich (written communication, January 24, 1950) shows that a primary uranium oxide mineral was not identified as the cause of the radioactivity in the samples studied. According to their studies the uranium in these samples occurs in a highly radioactive opaque cubic mineral closely associated with rutile (TiO_2), which is present in only limited quantities, and in the metallic sulfides in trace amounts. Whether the highly radioactive opaque cubic mineral occurs as intergrowths or as inclusions in the rutile is not known. Spectrographic analysis of this mineral shows that it also contains titanium, iron, and niobium. Chemical analyses of impure concentrates of the mineral obtained largely by handpicking under the binocular microscope show that it may contain as much as 7 percent uranium.

In addition to the highly radioactive cubic mineral associated with rutile in samples 3357, 3358, 3359, 3392, and 3393, sodium fluoride flux tests indicate that minor amounts of uranium occur, probably as an impurity, in the following minerals identified in these and other samples from the Hyder district:

biotite	magnetite	sericite
chalcopyrite	marcasite	sphalerite
chlorite	molybdenite	sphene
galena	pyrite	zircon
hematite	pyrrhotite	
limonite	scheelite	

The uranium-bearing minerals identified in each sample are given in table 1.

Two secondary uranium-bearing minerals are known to occur as thin coatings on certain weathered rock surfaces, fracture surfaces in veins, and mineralized dikes on the Mountain View property. One is a fluorescent mineral that has a wide distribution and is best represented in samples 3742 and 3744 from the Canyon and Silver Falls veins, respectively (table 1 and pl. 9). This mineral is very fine grained and granular and occurs generally as crystalline aggregates. It gives a positive qualitative test for uranium, and, according to K. J. Murata (oral communication), it exhibits strong uranium lines through a hand spectroscope. A qualitative spectrographic analysis by Stich showed the major constituents to be calcium, aluminum, and silicon; the minor constituents are magnesium and iron and a trace of manganese. Cisney indicates that the X-ray powder pattern of this mineral resembles that of the feldspar group, but no specific name could be assigned to this mineral. The other secondary mineral showed a positive qualitative test for uranium and appears as a thin yellow coating on fracture surfaces. It is fine grained, nonpleochroic, and nonfluorescent under short wave ultraviolet light. This mineral is closely associated with quartz and hydromica on the weathered rock surfaces and was found to be most abundant in sample 3732 from the vicinity of the Ruby Silver vein (table 1 and pl. 9). Sufficient material could not be separated, however, for X-ray or spectrographic analysis, and this mineral was not identified.

A sample of mine water collected from the drainage ditch in the Skookum tunnel at station 11 (pl. 8) was analyzed for uranium and other metals. The residue of the water sample was found to contain 3 parts per billion of uranium when analyzed fluorimetrically by Meyrowitz. Because the sample was not acidified when taken, it is likely that the uranium content shown by this analysis is relatively low.[1] A spectrographic analysis by Waring of the residue of part of the mine-water sample showed the following elements:

Mg, Ca, Na	More than 10 percent.
Fe, Si, Cu, Sr	0.1 to 1.0 percent.
Sn	.01 to 0.1 percent.

A qualitative spectrographic analysis by Stich of a mill concentrate from the Riverside mine (sample 3380, table 1 and pl. 7) showed the major constituents to be lead, copper, silver, iron, and silicon; cobalt, bismuth, nickel, and manganese were looked for but not found.

[1] Milkey, R. G., 1953, Stability of metallic ions in dilute solution: U. S. Geol. Survey Trace Elements Inv. Rept. 373.

DISTRIBUTION OF RADIOACTIVE MATERIAL

Radioactive material has a rather widespread distribution on the property of the Mountain View Gold Mining Company and seems to be principally associated with sulfides in veins and veinlets. However, some of it occurs in disseminated deposits and, to a minor extent, in the form of thin secondary coatings on rock and vein fracture surfaces.

The largest lode occurrence of radioactive material found during the 1949 investigations occurs in the Skookum tunnel on the right wall about breast high and 4 feet from the end of the right side cut at station 24 (pl. 8, sample 3392). The most highly radioactive samples collected in this tunnel were sample 3396 from a vein on the right wall half way between stations 58 and 59 and sample 3394 from a vein on the right wall between stations 55 and 56. Probably additional occurrences of radioactive material could be found in the Skookum tunnel by employing a more detailed study than was possible in the time allotted for this investigation and by washing the heavy coating of mine dust from the walls and ceiling wherever anomalous radioactivity is detected.

The most highly radioactive surface sample on the Mountain View property was 3740 collected by Mr. Moa from the hanging wall of the Canyon vein on the south side of Fish Creek about 1,000 feet south of the Skookum tunnel portal (pl. 9). Because very little time was available for studying the outcrops, not only on the Mountain View property but also along the entire extent of the contact in the Hyder district of the Texas Creek granodiorite and the Hazelton group, there appears to be a very good possibility that radioactive deposits have a more widespread distribution than is known now. More detailed studies or additional prospecting in the Hyder district may show that occurrences of radioactive materials are not only near the contact between the Texas Creek granodiorite and the Hazelton group, but may also occur some distance from the contact in these or other formations in the area.

A highly radioactive area was found during the course of the investigation at station 12 and for about 20 feet in both directions from this station in the Skookum tunnel (pl. 8). Although samples were collected from the floor, from the walls and ceiling, and from the mine dust that forms a thick coating on the walls and ceiling of the tunnel within this zone, they showed only small amounts of equivalent uranium (samples 3351, 3352, 3369, and 3379, table 1). The intense radioactivity may be due to a concentration of radon in this part of the tunnel. However, this seems unlikely as the meters on the instruments did not continue to show higher-than-normal readings after being carried beyond the limits of the highly radioactive zone or after being brought out of the prospect tunnel, thus indicating that the instruments had not been contaminated with radon gas. In the presence of radon, instruments which do not have their probes tightly sealed with plastic or rubber covers readily become contaminated and continue to give readings above background for some time after being removed from an area of radon gas concentration. Perhaps deep channel sampling or drilling would reveal the source of the material that is responsible for the abnormal radioactivity.

No significant radioactivity anomalies were detected by foot traverses made along the Mountain View trail from the Salmon River road to the buildings on the Mountain View property, along the Titan trail from its junction with the Mountain View trail to the Titan tunnel, along the Salmon River and Texas Lake roads from Hyder to Texas Lake, and over parts of the Adanac and Ambrose claims; nor were anomalies found in underground traverses in the Sixmile and Titan drifts and the Riverside mine (see pl. 7). The scanning of 43 samples collected by the U. S. Bureau of Mines in the area during 1949 did not show that any of them were abnormally radioactive.

ECONOMIC OUTLOOK

The Hyder district, readily accessible by water transportation the year round, is a highly mineralized region and seems to contain ore deposits of potential commercial value. The known ore and gangue minerals of the district (Buddington, 1929) are listed below:

anglesite	fluorite	pyrite
ankerite	freibergite	pyrolusite
arsenopyrite	galena	pyrrhotite
azurite	gold	quartz
barite	hematite	rutile
bornite	limonite	scheelite
calcite	magnetite	silver
cerrusite	malachite	specularite
chalcopyrite	marcasite	sphalerite
covellite	molybdenite	tetrahedrite
cubanite	proustite	wulfenite

The most valuable metals of the ores are gold, silver, and lead; zinc, tungsten, and molybdenum also have been found in abundance locally. The Riverside mine has produced lead, silver, and gold for a number of years. In addition, the barren quartz veins, which attain a width of as much as 50 feet on the Mountain View property, represent a possible economic source of silica flux.

It appears that the Hyder district may contain uranium in commercial quantities, and prospecting in this district should include the search for radioactive ores as well as for other metals. The radioactivity anomalies found, the discovery of minor amounts of uranium in 16 different minerals, the occurrence of an unidentified highly radioactive uranium-bearing mineral associated with rutile, and the 2 secondary uranium-bearing minerals in the small area covered by this investigation indicate that prospecting for uranium in the Hyder district should be encouraged.

A detailed radioactivity investigation and the use of more sensitive instruments for measuring radiation intensities might prove successful in locating a primary source of the uranium, and might determine whether uranium occurs in commercial quantities anywhere on the property of the Mountain View Gold Mining Company. A more extensive reconnaissance for radioactive deposits in the Hyder district than was possible in 1949 might reveal other areas that warrant intensive study and would eliminate the areas least favorable for the occurrence of uranium deposits. Geochemical methods of prospecting, such as water, soil, or vegetation sampling, might be successful for locating uranium deposits in localities which are believed to have been mineralized but where there are few outcrops. Also, the collecting and testing of heavy mineral concentrates from stream gravels, slope wash, and disintegrated bedrock for radioactivity, in a fashion similar to that used in 1947 by West and Matzko (Gault, Killeen, West, and others, 1953) and in 1948 by West (1953) on the eastern part of the Seward Peninsula, Alaska, might help to determine where uranium-bearing minerals occur in some parts of the Hyder district.

KETCHIKAN, GODDARD HOT SPRINGS, CHICHAGOF, FUNTER BAY, AND JUNEAU AREAS

MEASUREMENT OF RADIOACTIVITY

Field measurements of radioactivity in the Ketchikan, Goddard Hot Springs, Chichagof, Funter Bay, and Juneau areas, southeastern Alaska (see fig. 5), were made with modified commercial models of portable survey meters adapted for the attachment of 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 tubes were used for routine radioactivity traversing, and the beta-gamma probe was used for taking selected contact readings on outcrops, talus blocks, ore dumps, mine tailings piles, exposures of rocks and veins in underground workings and prospect holes, and for scanning drill cores and rock and mineral specimens.

The main emphases in the investigations were placed on radioacitivity traversing and the collection of rock and mineral samples. However, concentrates were taken from the gravels of many streams to test for the possible presence of radioactive minerals transported by the streams from areas which time did not permit covering by traverses or where there were no bedrock outcrops. Some slope-wash samples were also collected where bedrock outcrops were absent. Mine tailings and mill concentrates were obtained wherever possible.

The same laboratory methods were used for the samples collected in the Ketchikan, Goddard Hot Springs, Chichagof, Funter Bay, and Juneau areas that were used for the preparation and the radiometric and mineralogic analyses of the samples from the Hyder district. The equivalent uranium analyses given in this section were made by A. E. Nelson and P. D. Benson in the Geological Survey laboratory at Washington, D. C. The mineralogic determinations of the samples not made by the authors were made by B. W. Wilson and J. J. Matzko of the Geological Survey.

AREAS INVESTIGATED

KETCHIKAN AREA

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 also Upper Jurassic or Lower Cretaceous quartz diorite which grades locally into granodiorite. The greenstone and slate include black slate, phyllite, greenstone schist, and green bedded tuff.

The ore deposits occur as quartz fissure veins in quartz diorite and in mineralized zones in greenstone and slate along their contacts with the quartz diorite. Metallic minerals are also disseminated in both the greenstone and slate and in the quartz diorite. The metallic minerals 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 quartz diorite on the Wildcat and Hoadley claims about 1½ to 2 miles north of Ketchikan and half a mile northeast of the beach (Brooks, 1902, p. 61, and Buddington and Chapin, 1929, p. 332).

RADIOACTIVITY STUDIES

A radioactivity traverse was made on foot along the road south of Ketchikan for about 2 miles and along the road north of 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. Some traversing also was done on what was believed to be the Wildcat and Hoadley claims, but these claims are so old and so thoroughly covered with thick vegetation that their exact location could not be definitely determined. A subsurface radioactivity 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 were traversed and sampled.

No abnormal radioactivity was found in traversing and scanning. As shown in table 3, none of the samples that were analyzed for radioactivity contained more than 0.001 percent equivalent uranium.

TABLE 3.—*Analyses showing equivalent uranium of the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the Ketchikan area Revillagigedo Island*

No.	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3330	Hoadley Creek, 50 ft below falls and 100 yd above the road bridge.	Sand and gravel from middle bar.	10:1	<0.001
3331	Old prospect tunnel about one-half mile from beach and 1½ miles north of Ketchikan.	Waste rock from floor	61:1	<.001
3332	First stream north of Sawmill Creek, about one-half mile from the beach and 1½ miles north of Ketchikan.	Sand and gravel from bar.	371:1	<.001
3333	Old shaft believed to be on the Wildcat claim	Waste rock from dump	233:1	.001
3334	Old prospect tunnel believed to be on the Wildcat claim.	Waste rock from floor	121:1	.001
3335	Below workings in the stream believed to drain the Wildcat claim.	Sand and gravel from bar.	72:1	<.001

GODDARD HOT SPRINGS AREA

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 (with temperature of the water) from west to east:

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

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 as wide as 4 inches were observed in the granite. Most of these veins have no sulfides, but a small amount of pyrite is found in a few of them.

RADIOACTIVITY STUDIES

Several radioactivity traverses were made on foot in the Goddard Hot Springs area. The first was a systematic traverse over the granite areas in the immediate vicinity of Goddard. The second was south along the coast for 2 miles to the first major stream and up this stream, which connects a series of lakes, for approximately 2 miles. The third was north along the coast for 2 miles. And the fourth was over the trail from Goddard Hot Springs to Redoubt Lake. Many rock, stream gravel and sand, and slope-wash 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 areas of altered sedimentary rocks.

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 per 200 cc).

Equivalent-uranium analyses of some of the samples collected in the Goddard Hot Springs area are given in table 4.

TABLE 4.—*Analyses showing equivalent uranium in the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the Goddard Hot Springs area, Baranof Island*

No.	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3295	Stream connecting two lakes about 1¾ miles southeast of Goddard.	Sand and gravel	1,335:1	0.009
3296	Stream draining into a series of lakes about 1¼ miles southeast of Goddard.	do	446:1	.004
3297	Stream near the Goddard schoolhouse about three-fourths mile south of Goddard.	do	876:1	.009
3298	Stream about one-half mile south of Goddard	do	620:1	.008
3299	Stream formed by hot springs at Goddard	do	1,146:1	.012
3300	Redoubt Lake, about 1¾ miles northeast of Goddard.	Beach sand	690:1	.009
3301	Stream flowing into Redoubt Lake about 1½ miles northeast of Goddard.	Sand and gravel	447:1	.007
3302	Stream about three-fourths mile northeast of Goddard.	do	919:1	.007
3303	Goddard	Beach sand	580:1	.014
3304	Stream one-eighth mile north of Goddard	Sand and gravel	337:1	.005
3305	Between Main and Magnesia Springs at Goddard.	Granite slopewash	844:1	.016
3312	Stream about three-fourths mile north of Goddard.	Sand and gravel	987:1	.015
3313	Outcrop about three-fourths 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 collected in the area. The minerals with a specific gravity greater than 2.8 which have been identified in the following samples are tabulated in table 5. The samples listed are 3305; 3299 (0.012 percent equivalent uranium), collected in the stream formed by the hot springs; 3302 (0.007 percent equivalent uranium) from a stream 1 mile northeast of Goddard; 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.

TABLE 5.—*Mineralogy of the heavy-mineral fractions of selected samples collected in the Goddard Hot Springs area, Baranof Island*

[Mineral determinations are 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; numbers indicate estimated volumetric percent of minerals present in the heavy-mineral fractions of samples; tr indicates trace]

Minerals	Sample no.				
	3305	3299	3302	3303	3312
Allanite	6	3	tr	0	7
Apatite	tr	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

Except for sample 3303, the radioactivity of the above samples and most of the 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 AREA

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 Chichagof area consists of both massive and slaty graywacke of Early Cretaceous(?) age which has been faulted and cut 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 metallic minerals include pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, and gold. None of the metallic minerals are abundant, and on the average they constitute only a little more than 2 percent of the ore. The gangue materials are quartz and calcite; fault gouge and fragments of the wall rock; and sparse amounts of albite, sericite, and apatite.

RADIOACTIVITY STUDIES

Radioactivity traverses in the Chichagof area were made on foot: along the west shore of Klag Bay and inland a short distance to a point 2 miles south of Chichagof; from Chichagof around the head of Klag Bay and 1 mile south along the east shoreline: inland 1½ miles from the east shore of Klag Bay along the powerline; 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 part 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 many prospect pits and trenches, were traversed and scanned for radioactivity.

No radioactive material was disclosed by traversing or scanning. The rock, mineral, flotation and settling-tank concentrate, mill concentrate, sluice-box concentrate, and stream gravel and sand samples contained no more than 0.002 percent equivalent uranium. Radioactivity data on some of the samples collected in the Chichagof area are given in table 6.

TABLE 6.—*Analyses showing equivalent uranium in the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the Chichagof area, Chichagof Island*

No.	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3314	Stream at head of Klag Bay about one-half mile from bay.	Sand and gravel	392:1	<0.001
3315	Second stream from head of Klag Bay on the east side of bay.	do	729:1	<.001
3316	Fifth stream from head of Klag Bay on the east side of bay.	do	375:1	<.001
3317	Fourth stream from head of Klag Bay on the east side of bay.	do	461:1	.001
3318	Chichagof mine, Klag Bay	Mill-table concentrate	(1)	<.001
3319	Hirst-Chichagof mine, Kimshan Cove	Flotation- and settling-tank concentrate.	(1)	.001
3320	Stream, along the trail to Sister Lake, that flows into large lake east of Klag Bay.	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.	do	582:1	<.001
3322	Second stream south of Chichagof on the west side of Klag Bay.	do	700:1	<.001
3323	Third stream south of Chichagof on the west side of Klag Bay.	do	334:1	.001
3324	Fourth stream south of Chichagof on the west side of Klag Bay.	do	506:1	<.001
3325	Sixth stream south of Chichagof on the west side of Klag Bay.	do	380:1	<.001
3326	Fifth stream south of Chichagof on the west side of Klag Bay.	do	590:1	<.001
3327	Golden Gate mine, Klag Bay	Tailings	2,600:1	.002
3328	Chichagof mine, Klag Bay	Flotation-tank concentrate.	(1)	<.001

[1] Unknown.

FUNTER BAY AREA

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, and marble. Dikes and sills are 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, but 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, galena, sphalerite, chalcopyrite, and arsenopyrite.

RADIOACTIVITY STUDIES

The radioactivity studies in the Funter Bay area were confined to the property of the Admiralty-Alaska Gold Mining Company, which consists of 52 claims. The short 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 then to the head of the stream, which has an elevation of more than 2,000 feet; the stream was retraced to its junction with the ditch, and the traverse was continued south to the end of the ditch. 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 the available drill cores on the property were scanned for radioactivity. These drill cores were principally from the Mertie lode and surrounding rock formations. The materials in the ore shoots and bins in the mill, in several ore dumps, and in many prospect pits and trenches were scanned for radioactivity. Samples were panned from the gravels of two streams which drain areas that were not sampled or traversed.

No radioactivity anomalies were discovered by traversing or by scanning. As shown in table 7, none of the samples, which were submitted to the laboratory for radiometric analyses, contained more than 0.001 percent equivalent uranium.

TABLE 7.—*Analyses showing equivalent uranium in the heavy-mineral fractions (those greater than 2.8 specific gravity) of samples collected in the Funter Bay area, Admiralty Island*

No.	Location	Type of sample	Concentration ratio	Equivalent uranium (percent)
3291	Stream near the 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 the Admiralty-Alaska Gold Mining Co. mill (material probably from Uncle Sam vein).	Crushed rock	105:1	<.001

JUNEAU AREA

GEOLOGY AND MINERAL DEPOSITS

The geology and mineral deposits of the Juneau area have been discussed in detail by Spencer (1906) and Buddington and Chapin (1929).

The various types of rocks, which form nearly straight parallel northwest-trending bands in the Juneau area, are listed below. They are named in order from the interior on the mainland southwestward across Gastineau Channel and Douglas Island to Stephens Passage.

Diorite of the Coast Range intrusives and associated aplite dikes.
Schist and phyllite.
Black slates intruded by gabbro. The slates were intruded again later by a large number of diorite masses genetically related to the Coast Range intrusives and still later by dikes of basalt and related rocks.
Bedded greenstones and greenstone schists with intercalated slate strata.
Black slates, with intercalated bands of greenstone, intruded by diorite dikes related to the Coast Range intrusives and by younger dikes of diorite porphyry.
Massive bedded greenstone.

The ores in the area occur in veins, in impregnated masses of rock, and as mixed deposits in which veining and impregnation are both present. The vein deposits are confined mainly to the black slates, and the other two types of deposits are found mostly in the diorite, gabbro, and diorite porphyry dikes. Some of the schists and greenstones have been mineralized, but they 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 for 2 miles along the road running north from the Gastineau Channel bridge on Douglas Island. Another traverse was made for about 3 miles on foot along the road and shore south of Juneau. 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 2.89 specific gravity) identified (by B. W. Wilson) in this sample are in order of decreasing abundance: 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 and W. S. West) in this sample are in order of decreasing abundance: magnetite, pyrite, sphalerite, ankerite, hornblende, limonite, garnet, galena, gold, chlorite, epidote, ilmenite, zircon, scheelite, and feldspar. A spectrographic analysis (by J. C. Rabbitt) 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 percent of antimony, beryllium, bismuth, cadmium, niobium, germanium, indium, mercury, platinum, rhenium, tantalum, tin, and tungsten.

The radioactivity of a 2-ton rhyolitic glacial boulder at Lena Point, north of Juneau, was called to the attention of the Survey party in 1949 by Lee Dunlap, a local prospector and Civil Aeronautics Authority employee. 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.

ECONOMIC OUTLOOK

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 investigations for radioactive deposits are recommended in the small parts of the five areas examined. In these areas the metallic minerals are so scarce and constitute such a small part 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 likely to contain uranium ore of commercial grade.

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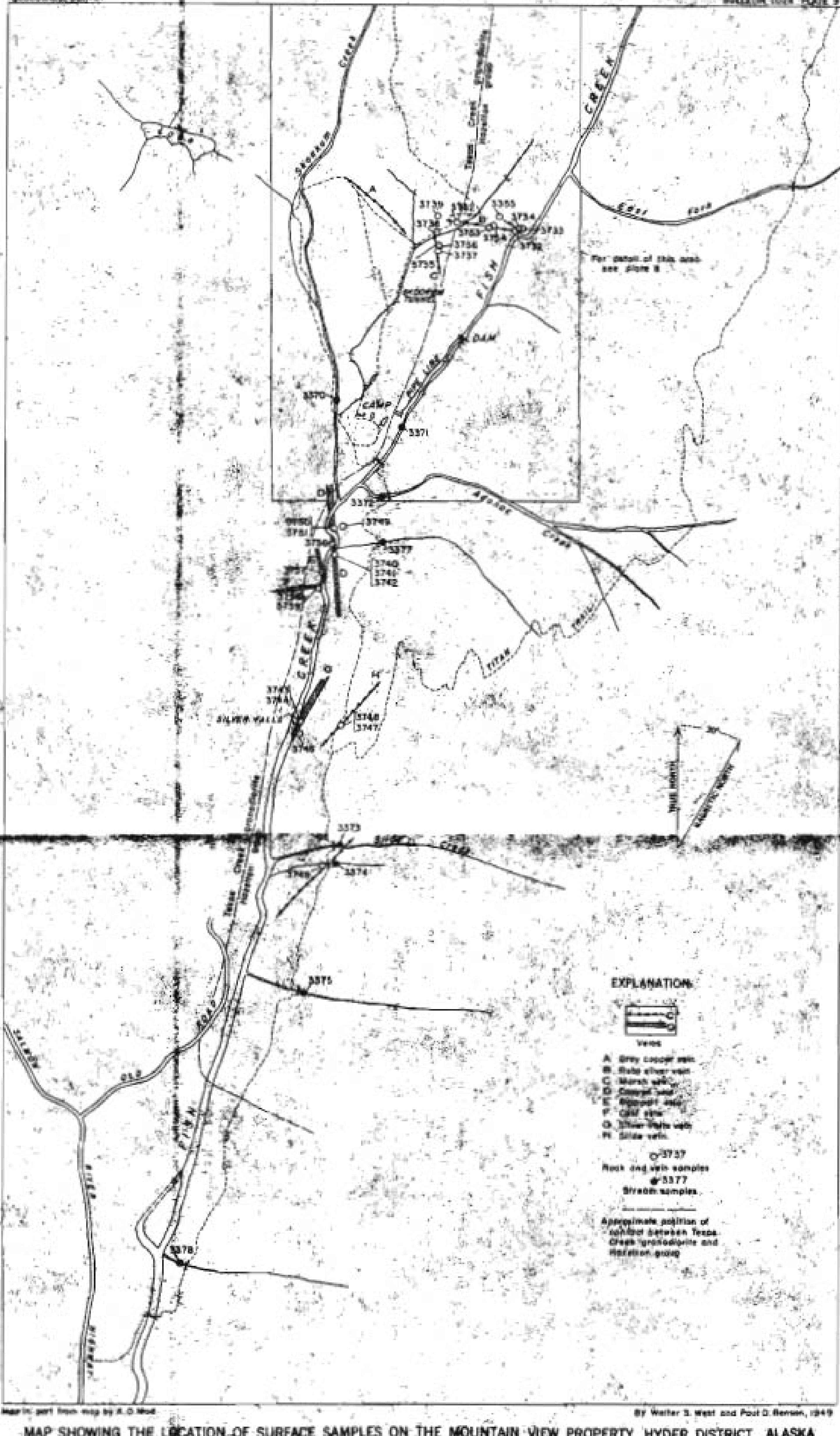

Map in part from map by A.O. Mod

By Walter S. West and Paul D. Benson, 1949

MAP SHOWING THE LOCATION OF SURFACE SAMPLES ON THE MOUNTAIN VIEW PROPERTY, HYDER DISTRICT, ALASKA

1000 0 2000 Feet

334318 O - 55 (In pocket)