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GEOLOGICAL SURVEY CIRCULAR 317

RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN THE MANLEY HOT SPRINGS-RAMPART DISTRICT EAST-CENTRAL ALASKA, 1948

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FROM:
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By Robert M. Moxham

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ABSTRACT

The occurrence of cobalt in lead-silver deposits near Manley Hot Springs, Alaska, is mentioned in several of the earlier publications of the Geological Survey; additional mineralogic data are sparse. In 1945 and 1947 radioactivity and mineralogic studies of Alaskan placer samples disclosed the presence of five radioactive minerals—eschynite, ellsworthite, columbite, monazite, and zircon—in association with extensive gold-tin placer deposits in the Tofty area, a few miles north of the lead-silver deposits. On the basis of the mineral associations and the geographic relationship between the two types of deposits, field studies seemed warranted and were undertaken in 1948.

Field work failed to disclose the bedrock source of the radioactive minerals in the gold-tin placers. None of the material collected from the lead-silver deposits showed any radioactivity, although the granite country rock has an average equivalent uranium content of 0.003 percent which is attributed mostly to disseminated monazite. No field evidence could be found to establish a geomorphic relationship between the two types of deposits.

A few concentrates from gold-placer mines in the Eureka area northeast of Manley Hot Springs contain small amounts of monazite and radioactive zircon. Granitic rocks at nearby Elephant Mountain are also slightly radioactive due to monazite and are probably the ultimate source of the radioactive minerals in the placers of the Eureka area.

INTRODUCTION

The Manley Hot Springs-Rampart district (fig. 1) of east-central Alaska is one of the few areas in Alaska from which radioactive minerals had been reported prior to the initiation in 1944 of the Trace Elements program of the Geological Survey. Waters (1934) had identified monazite, eschynite, and xenotime in concentrates from the Tofty tin belt of this district. The radioactivity study of the Alaskan placer concentrate

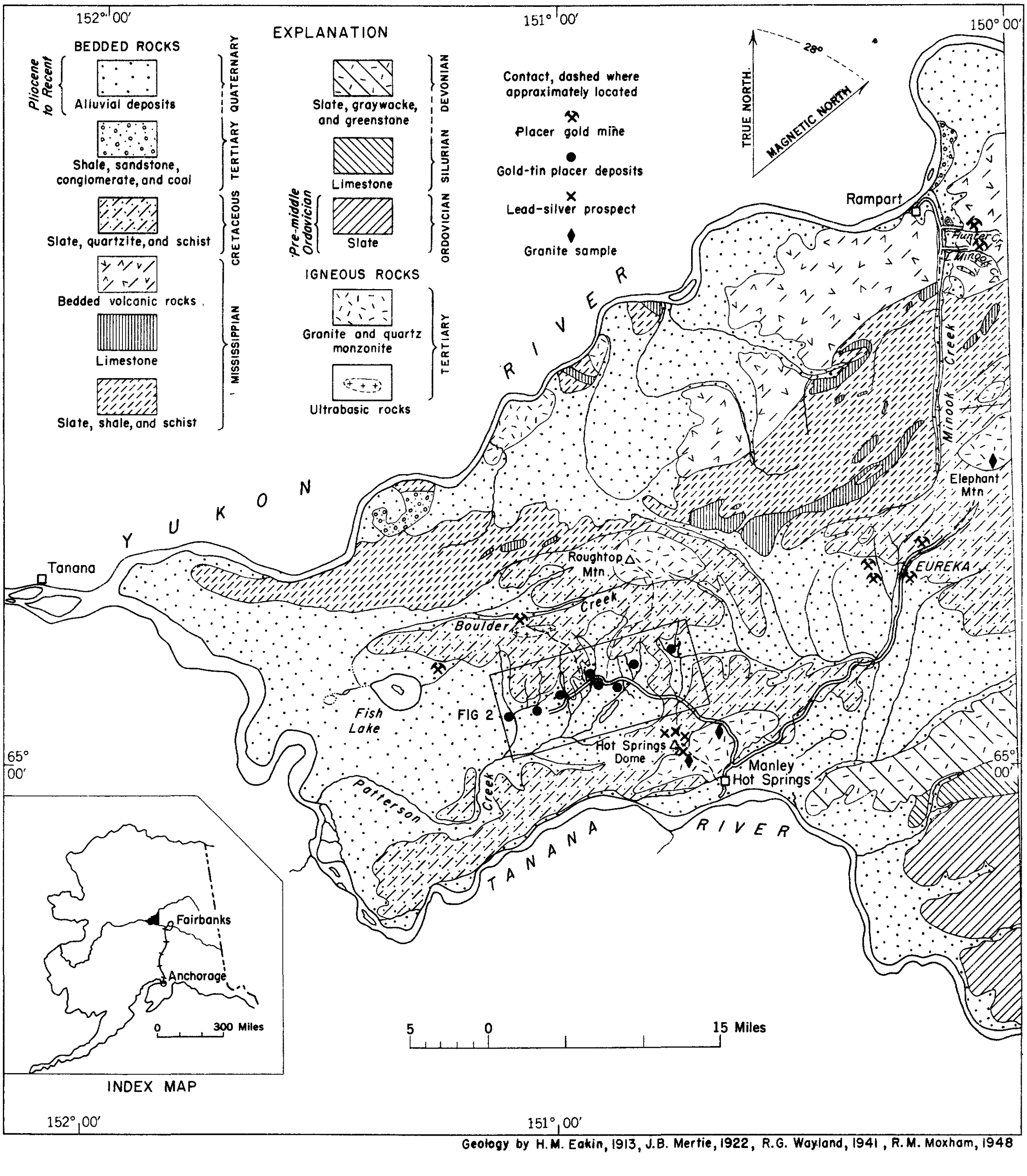

Figure 1.—Geologic map of the Manley Hot Springs-Rampart district, east-central Alaska.

collection, in 1944 and 1945,[1] revealed the widespread occurrence of radioactive materials in the concentrates from the Tofty belt. Mineralogic study of the Tofty concentrates by the author in 1947 showed that ellsworthite, columbite, and radioactive zircon were present in addition to the minerals reported by Waters (1934).

The proximity of these radioactive minerals to a cobaltiferous lead-silver lode on Hot Springs Dome led to the belief that uraniferous lodes might occur in the same vicinity either with the lead-silver deposit or in its immediate vicinity. A field investigation was therefore undertaken in 1948 with the following objectives: (1) To investigate the Hot Springs Dome lead-silver deposit and other possible bedrock sources of the radioactive minerals in the Tofty placers; (2) to determine whether the Tofty placers or tailings from the mining of these placers contained sufficient radioactive material to warrant recovery as a byproduct of placer mining for gold and tin; (3) to carry the investigations to the adjacent Eureka and Rampart mining areas which were readily accessible by road, if time permitted.

The field party consisted of Robert M. Moxham, geologist, and John C. Whitaker, Fred Freitag, and Russell J. Wolfgram, camp assistants. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOGRAPHY

The Manley Hot Springs-Rampart district (fig. 1) is situated between the Yukon and Tanana Rivers, west of the 150th meridian in the Tanana and Kantishna River quadrangles (Alaska reconnaissance topographic series, scale 1:250,000). The center of the area is approximately 90 miles west of Fairbanks. The total permanent population, concentrated mainly at the villages of Tanana, Rampart, and Manley Hot Springs, is about 400. Aircraft are used almost exclusively for the transportation of passengers and light freight to the district, whereas heavy cargo is transported by barge on the Tanana River. Dirt roads, passable most of the year, connect the Tofty and Eureka mining areas with Manley Hot Springs, and the Hunter Creek and Little Minook Creek mining areas with Rampart.

GEOLOGY

The oldest rocks of the Manley Hot Springs-Rampart district (fig. 1) are pre-Middle Ordovician strata, chiefly slate. These rocks form the low hills in the southeastern part of the district. Successively younger formations crop out to the northwest, including the Middle Silurian Tolovana limestone and Devonian slate, graywacke, and greenstone. Three Mississippian units have been recognized: (1) Slate, shale, schist, and quartzite crop out north of the Yukon-Tanana divide; (2) limestone forms the divide in the central part of the area; and (3) the Rampart group, comprising bedded volcanic rocks and associated sedimentary strata, crops out between the divide and the Yukon River. Cretaceous slate, quartzite, and schist crop out between the Tanana River and the divide. Tertiary shale, sandstone, conglomerate, and coal occur in small isolated areas near the Yukon River.

Pliocene gravels are found on the tops of ridges at elevations up to 1,500 feet in the Rampart area. A series of regional uplifts between Pliocene and Recent time are indicated by the remnants of terraces in the major valleys in this area. In some of the valleys and lowlands in the Tofty, Eureka, and Rampart areas, there are buried deposits of late Tertiary or early Quaternary gravel, ranging from less than 1 foot to 40 feet in thickness. Boulders and pebbles of graywacke, phyllite, sandstone, and quartzite, all apparently of local derivation, are the predominant constituents. The gravel is overlain by late Pleistocene glaciofluvatile and aeolian deposits, from 5 to 90 feet thick, which consist of a complex frozen mixture of peat, gravel lenses, vegetal debris, silt, and muck.

The principal igneous rocks of the area are the granites and monzonites which form Hot Springs Dome, Roughtop Mountain, Elephant Mountain, and the "Ramparts" along the Yukon River. Small bodies of mafic intrusive rock are found in the headwaters area of Patterson Creek.

Detailed descriptions of the geology of the Manley Hot Springs-Rampart district are given by Eakin (1913), Mertie (1934), and Wayland.[2]

RADIOACTIVITY INVESTIGATIONS

Measurement of radioactivity

Radioactivity surveys carried out by a jeep and on foot were made with a standard portable survey meter utilizing a probe of two 1- by 14-inch gamma tubes connected in parallel. Semiquantitative tests were made with a 6-inch beta tube.

Areas investigated

The radioactivity investigations were confined to the three principal mining areas in the Manley Hot Springs-Rampart district: the Hot Springs Dome area, in the western part of the district; the Eureka area, in the east-central part of the district; and the Rampart area, in the northeastern part of the district.

Hot Springs Dome area

Hot Springs Dome lead-silver deposit. —Lead-silver veins occur on the summit of Hot Springs Dome at the Barrett prospect, about 5 miles northwest of Manley Hot Springs (fig. 1). Mineralization has taken place in a shear zone in the hornfels and schist which form the aureole of a biotite granite stock. Metallic minerals occur in a zone from 20 to 35 feet wide which has been traced horizontally for a distance of 2,000 feet. Ores found in the oxidized zone are chiefly limonite and cerussite, with locally abundant siderite and small amounts of copper carbonate. Ore found on the dumps

[1] Harder, J. O., and Reed, J. C., 1945, Preliminary report on radioactivity of some Alaskan placer samples: U. S. Geol. Survey Trace Elements Inv. Rept. 6. [Unpublished.]

[2] Wayland, R. G., The Tofty tin belt [Alaska], manuscript report in files of Alaskan Geology Branch, U. S. Geol. Survey.

indicates galena to be the most abundant primary sulfide, with lesser amounts of chalcopyrite, pyrrhotite, and pyrite. A careful search of the mineralized zone yielded only one piece of siderite carrying a thin encrustation of erythrite (cobalt bloom).

All of the accessible test pits and trenches were examined and the dump material tested. No underground workings could be entered owing to flooding or caving but all dump material was scanned. No radioactive material was found. Eleven representative samples of the various types of ore, including the erythrite, were tested in the laboratory. All showed an equivalent uranium content of less than 0.001 percent.

Granite at Hot Springs Dome.—In conjunction with the study of the lead-silver veins which are found in the metamorphosed country rock north of the granite at Hot Springs Dome, a series of traverses were made over parts of the intrusive mass. Anomalous radiation was indicated in all areas of the granite outcrop. The radiation was noticeably less in the aureole surrounding this stock and also in those areas covered by appreciable amounts of soil and vegetation. Inasmuch as most of the streams draining the granite outcrop area contain considerable monazite, the anomalous conditions are probably due to this and other disseminated radioactive accessory minerals.

Six samples of the granite have an average equivalent uranium content of 0.003 percent.

Tofty tin belt.—Most of the Tofty tin belt (fig. 2) lies in the area drained by the headwaters of Patterson Creek. The commercial placers are found in a northeast-trending belt extending from Woodchopper Creek to Killarney Creek, a distance of about 12 miles. The placers comprise a series of subparallel deposits oriented normal to the trend of the belt. In general the northern limits of the deposits are sharply defined, and the definiteness of the boundaries and the concentration of valuable metals gradually decrease southward. The gravels are late Tertiary or early Quaternary in age and are buried beneath 15 to 80 feet of frozen silt and muck of Pleistocene age. Gold and cassiterite are the only minerals recovered at present, although considerable chromite occurs at the western end of the belt.

Although the exposed country rock along the tin belt shows intense shearing and intrusion by numerous quartz veins, no metalliferous lodes have been found despite considerable prospecting, nor has cassiterite been found on the surface in gravels of the present drainage cycle. The absence of tin lodes has resulted in the formulation of two theories for the origin of these placers. The first requires a lode source at some distance from the present deposits, presumably associated with the granite mass at Hot Springs Dome. It is suggested that a major stream flowing westward from this area deposited the Tertiary gravel in the general orientation of the present tin belt. A change of baselevel followed, resulting in the redistribution of the material to its present position by subsequent southward-flowing streams. The second

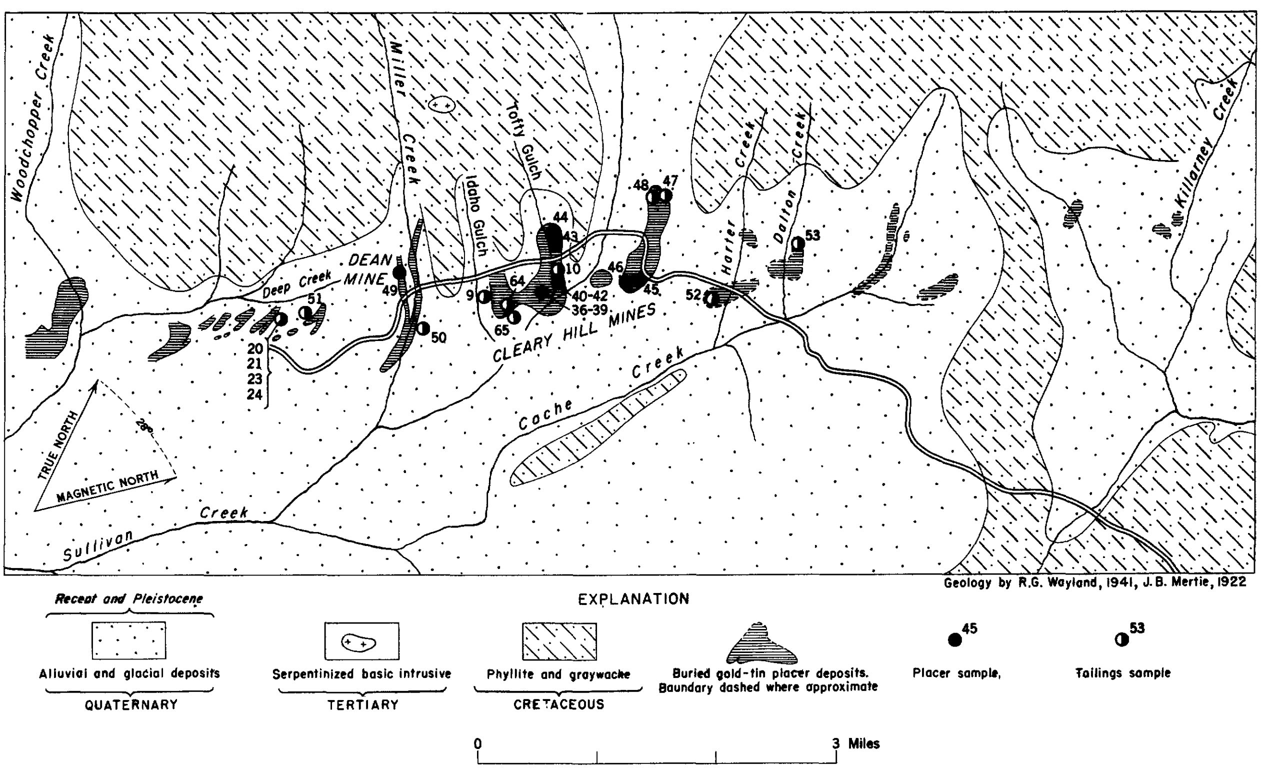

Figure 2.—Geologic map of the Tofty tin belt showing gold-tin placer deposits and sample localities.

theory suggests that the tin mineralization originated from a local, unexposed magmatic source and was emplaced along the shear zone which parallels the tin belt. The cycle of erosion which resulted in the formation of the placers continued until the source lodes were completely removed. The placers therefore are eluvial in character, having accumulated approximately in place. Both theories are discussed in detail by Mertie (1934) and Waters (1934).

In 1941, R. G. Wayland[3] collected tailings concentrates throughout the tin belt as well as sluice-box and drilling concentrates from active mining operations. Preliminary scanning of this material for radioactivity in 1945[4] gave the following results:

Number of samples	Type of concentrate	Average eU[1] content (percent)
58	Tailings----------------	0.063
24	Drill-hole--------------	.003
3	Sluice-box--------------	.011

[1] Equivalent uranium.

The most radioactive sample, a concentrate of tailings found on Idaho Gulch, contained 2.3 percent equivalent uranium.

These preliminary results, although indicating the tenor of the placer material, gave little information relating to the concentration of radioactive minerals in the placer gravel either in place or in the tailings.

During the 1948 investigations the buried placers could be tested only at localities where mines were in operation. These included the opencut workings of Cleary Hill Mines, Inc., on Sullivan Creek and Tofty Gulch; and the Dean drift mine on Miller Creek. Representative samples of the tailings were collected over the entire placer belt. As the radioactive material in the placer and tailings is confined to the heavy minerals, a concentration of the samples was effected to remove the light material. The heavy residue obtained would approach that recoverable by Humphrey spirals or other gravity methods. Results of tests for radioactivity in the heavy concentrates are given in table 1. The amount of heavy concentrate in both the placer gravels and tailings is very small. The Tertiary gravel contains heavy fractions (those greater than 3.3 specific gravity) in an average ratio of 19,425:1. Removal of slimes during mining operations results in a higher ratio—10,900:1—in the tailings.

Five radioactive minerals have been identified in the concentrates from the tin-gold placers in the Tofty area:

ellsworthite	$CaO.Nb_2O_5.2H_2O$
eschynite	$(Ce, Ca, Fe, Th) (Ti, Nb)_2O_6$
columbite	$(Fe, Mn) (Nb, Ta)_2O_6$
monazite	$(Ce, La, Di) PO_4$
zircon	$Zr SiO_4$

Ellsworthite has been found previously in only one other locality—near Hybla, Ontario—where it is associated with a pegmatitic facies of a pre-Cambrian granite gneiss complex (Walker and Parson, 1923). The mineral is chocolate brown and has a vitreous luster. Two chemical analyses of the Canadian specimen averaged 19 percent uranium oxide. The X-ray pattern of the Tofty material is identical with that of a specimen from Hybla. Spectrographic examination of the mineral from Tofty showed uranium to be a major constituent. No thorium was found.

[3] Wayland, R. G., op. cit.

[4] Harder, J. O., and Reed, J. C., op. cit.

Table 1.—Radioactivity data on heavy-mineral concentrates collected in 1948 from the Tofty tin belt.

Location	Sample no.	eU[1] (percent)	Type of material
Dalton Creek---	53	0.007	Tailings.
Harter Creek---	52	.030	Do..
Sullivan Creek-	45	.019	Tertiary gravel.
Do-----------	46	.014	Do.
Do-----------	47	.009	Tailings.
Do-----------	48	.027	Do.
Do-----------	8	.017	Tertiary gravel.
Tofty Gulch----	36	.012	Do.
Do-----------	37	.015	Do.
Do-----------	38	.013	Do.
Do-----------	39	.011	Do.
Do-----------	40	.014	Tailings.
Do-----------	41	.012	Do.
Do-----------	42	.011	Do.
Do-----------	43	.016	Tertiary gravel.
Do-----------	44	.017	Do.
Idaho Gulch----	9	.035	Tailings.
Do-----------	64	035	Do.
Do-----------	65	.015	Do.
Miller Creek---	49	.026	Tertiary gravel.
Do-----------	50	.017	Tailings.
Deep Creek-----	20	.015	Do.
Do-----------	21	.011	Do.
Do-----------	23	.014	Do.
Do-----------	24	.016	Do.
Do-----------	51	.026	Do.

[1] Equivalent uranium.

Eschynite is commonly associated with plutonic rocks or high-temperature veins. It is reddish brown, with a dull to vitreous luster. Spectrographic analyses of the Tofty eschynite showed less than 1 percent thorium and no uranium.

Columbite usually occurs in pegmatite veins. It is black, with a submetallic luster. Sodium fluoride bead tests for uranium on the Tofty material were negative, although in the presence of a high percentage of niobium the tests are not always dependable. Rough quantitative radioactivity tests indicate a content of approximately 0.1 percent equivalent uranium.

Tests of the monazite show the equivalent uranium content probably does not exceed 1 percent.

The average equivalent uranium content of the zircon from six samples is 0.072 percent.

A mineralogical examination of the concentrates from the Tertiary gravel of the Tofty tin belt shows that with the exception of ellsworthite, the radioactive minerals have a rather even distribution throughout the length of the tin belt. Ellsworthite was found in only three samples and the quantity was relatively small. The other four radioactive minerals were found in all of the samples studied in detail.

In an effort to locate the bedrock source of the placer material a radioactivity survey by foot and jeep was made along the valley slopes and upland areas adjacent to the lowlands in which the tin placers are found, but no radioactivity anomalies were detected. It was apparent, however, that the thick cover of tundra and soil which was present over a large percentage of the area probably would reduce any radiation to a low, perhaps undetectable, level.

Although the 1948 field work failed to find direct evidence of the source of the heavy minerals found in the placer deposits, one occurrence in favor of the theory of local origin was disclosed. It will be recalled that chromite is found in considerable quantity in the buried placers in the western part of the tin belt, particularly in the area between Miller and Woodchopper Creeks. Investigation of the region at the head of these creeks, on the ridge between Woodchopper and Boulder Creeks, revealed an area of serpentinized ultramafic rocks. A considerable quantity of chromite float was found on the slope south of the ridge and small lenses and stringers of chromite were found in place on the ridge top. Although it is extremely unlikely that tin and radioactive minerals are associated with these particular rocks, it does suggest that at least some of the source rocks of the placer constituents are present in the immediate area of the tin belt.

Roughtop Mountain-Boulder Creek area.—The Roughtop Mountain-Boulder Creek area (fig. 1) is a short distance north of the Tofty tin belt. Roughtop Mountain, which has been formed from a quartz monzonite stock, has been unsuccessfully prospected as a source of the tin lodes. Many trenches and pits were examined, but little evidence of metallization was seen. As no radioactivity of significance was detected, no samples were collected at Roughtop Mountain.

Placer gold has been mined sporadically for many years from the Tertiary gravel on Boulder Creek and its tributaries. No radioactivity anomalies were found in this area and the only radioactive minerals in the placers were zircon and monazite, probably derived from the quartz monzonite of Roughtop Mountain.

Several samples of stream pebbles, reportedly collected from Boulder Creek, were submitted to the Territorial Department of Mines in 1949 by a resident of Hot Springs. The New York laboratory of the Atomic Energy Commission reported that one of these samples contained 0.21 percent equivalent uranium oxide and the other was moderately radioactive. Eschynite was tentatively identified as the radioactive mineral. No further information relating to the material is available. However, the occurrence of this mineral in the Boulder Creek gravels would seem to substantiate the inferences that the ultimate source of the tin and radioactive minerals lies north or northeast of the Tofty tin belt rather than in the vicinity of Hot Springs Dome.

Eureka area

Slightly anomalous radiation was indicated in the outcrop area of granite at Elephant Mountain near Eureka (fig. 1), but no concentration of radioactive material was found. Three samples of the quartz monzonite average 0.004 percent equivalent uranium, due chiefly to monazite.

In the course of the investigation in the vicinity of Eureka, placer samples were collected from various mining operations in the area. The equivalent uranium content of the concentrates ranges from 0.004 to 0.042 percent with an average of 0.019. The radioactivity is due almost entirely to monazite.

Rampart area

Placer concentrates were collected from all of the operating mines in the Rampart area (fig. 1). The equivalent uranium content of the concentrates ranges from less than 0.001 to 0.010 percent. A small amount of zircon is thought to be responsible for the higher radioactivity.

A thin lignite bed cropping out near the mouth of Hunter Creek contains 0.001 percent equivalent uranium.

CONCLUSIONS

Radioactivity surveys in the Manley Hot Springs-Rampart district were for the most part ineffectual because of the thick tundra and muck cover which conceals the bedrock. Although the bedrock source of the radioactive minerals in the Tofty tin placers could not be located, the existence of a local bedrock source for both the radioactive minerals and the cassiterite in the Tofty area is suggested by geologic data. The presence of the thick tundra cover would necessitate a detailed trenching program to locate the possible source. No radioactive material appears to be associated with the cobaltiferous lead-silver deposit on Hot Springs Dome, nor could field evidence establish a geomorphic relationship between this lode deposit and the placers of the Tofty tin belt.

The concentration of radioactive minerals in the Tofty placers is probably too low to warrant recovery as a byproduct of gold and tin mining under present economic conditions.

None of the other mines or prospects in the district seem to hold any commercial possibilities as sources of radioactive minerals.

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