Radioactivity Investigations At Ear Mountain Seward Peninsula Alaska, 1945

GEOLOGICAL SURVEY BULLETIN 1024-C

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By P L KILLEEN *and* R J ORDWAY

MINERAL RESOURCES OF ALASKA

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RADIOACTIVITY INVESTIGATIONS AT EAR MOUNTAIN SEWARD PENINSULA, ALASKA, 1945

By P. L. Killeen and R. J. Ordway

ABSTRACT

Radioactive material in apparently significant amounts was recognized in heavy-mineral concentrates from the gravels of four streams that head in Ear Mountain, Alaska, when collections of the United States Geological Survey were examined for radioactivity in the winter of 1944–45 This area, on the north side of the Seward Peninsula, attracted attention in 1901–02 when cassiterite was discovered in the streams Subsequent attempts were made to develop copper- and tin-bearing lode deposits

As a result of further field and laboratory studies in 1945–46, uranium has been determined chemically in heavy-mineral concentrates from the stream gravels and in a replacement-type lode Thorium is probably also present, for the amount of equivalent uranium as determined by beta and gamma counts is greater than the amount of uranium determined chemically The probable thorium content in the stream concentrates is 3 to 10 times that of the uranium content, whereas in the lode the uranium content is 2 to 3 times that of the thorium

The uranium and thorium of the stream concentrates is believed to be in monazite and perhaps in zircon, both are accessory minerals in the granite of the exposed stock However, the principal radioactive mineral in the oxidized portion of the lode deposit has not been identified, and trenching has not been deep enough to reach unoxidized material, a minor amount of a secondary light-green tabular mineral has been identified as intermediate between metazeunerite and metatorbernite

The radioactive-minerals content of the gravels is low, concentration by panning was necessary to obtain samples showing any gamma count with a portable Geiger counter that was definitely above background count of the area. Ratios of the weights of original gravels to concentrates ranged between 97 to 1 and 4,600 to 1 The calculated average equivalent uranium content of the gravels in place is approximately 0 00005 percent; the richest natural concentration contained 0 00035 percent equivalent uranium The largest recovery of radioactive minerals was from a site on Eldorado Creek that yielded 10 pounds of panned concentrate per cubic yard with an equivalent uranium content of 0 111 percent Nonradioactive heavy minerals are present in the concentrates in such proportion that the maximum concentration of radioactive minerals effected by panning was 0 290 percent equivalent uranium from gravels that yielded only 1 pound of heavy concentrate per cubic yard The volume of gravel containing radioactive minerals is estimated as 1,016,500 cubic yards

Outcrop or surface counting at sites where the counter tube was laid directly on the rock surface showed relatively greater radioactivity near and on the granite stock and local areas of distinctly higher count irregularly distributed within the boundary of the granite Attempts to relate this variation in surface gamma count either to specifically delineated portions of the granite or to an expressable content of radioactive minerals in crushed samples of the normal granite were not successful Monazite and zircon had been known as microscopic accessory constituents in the granite of Ear Mountain before their radioactivity in stream concentrates was recognized These accessory minerals, as would be expected, are distributed throughout the granite as shown by their presence in the gravels of streams in all parts of the granite stock However, the amount of monazite and zircon in the granite apparently is too small to give an appreciable count on the field instrument in fragments of hand-size or in crushed granite samples about 25 cubic inches in volume

The one distinctly radioactive lode found in the area is a replacement along a tourmalinized mafic dike and an associated vein filling of quartz and tourmaline. The dike and vein can be traced across the granite stock by float rock for nearly a mile An 8-foot channel sample from 1 of 2 trenches dug across the lode included portions of the granite wall rock on each side of the lode and contained 0 016 percent equivalent uranium An 18-inch channel sample across a zone of red oxidized material within the lode contained 0 045 percent equivalent uranium. The actual uranium content of these samples was chemically determined as 0 010 and 0 035 percent, respectively, the difference between the equivalent uranium and uranium figures is believed to be due to thorium The equivalent uranium content of the lode in the second trench, 0 012 percent, was indicated by a field gamma count The 2,500-foot segment of the lode between the 2 trenches may contain 960 tons of material per foot of depth with an equivalent uranium content of 0 014 percent No separate estimate of the tonnage of the narrower and more highly radioactive zone has been made because in the second trench the red material is not confined to a single zone but occurs as patches throughout the lode

At least one other lode of this type is indicated by float but was not located in trial trenching Other masses of tourmaline and associated fine-grained granite were found to show distinct radioactivity although less than in lodes which contain red hematite

INTRODUCTION

The Ear Mountain area (fig. 6) has been examined previously by 4 field parties of the Geological Survey, but these examinations were of brief duration, at intervals of 6 to 22 years, and for the specific purposes either of initial reconnaissance or to determine the status of tin prospecting The field work in 1945 likewise had a limited scope; thus, no comprehensive study of the geology of Ear Mountain has as yet been made.

This topographically prominent area is of interest because of the mineralization that accompanied the intrusion of a granite stock, which is now exposed within its metamorphic aureole. The area was prospected for placer gold in 1900–1901, and attempts have been made to develop lodes chiefly of tin but also of copper and lead sulfides. The tin content of the stream gravels was tested by pros-

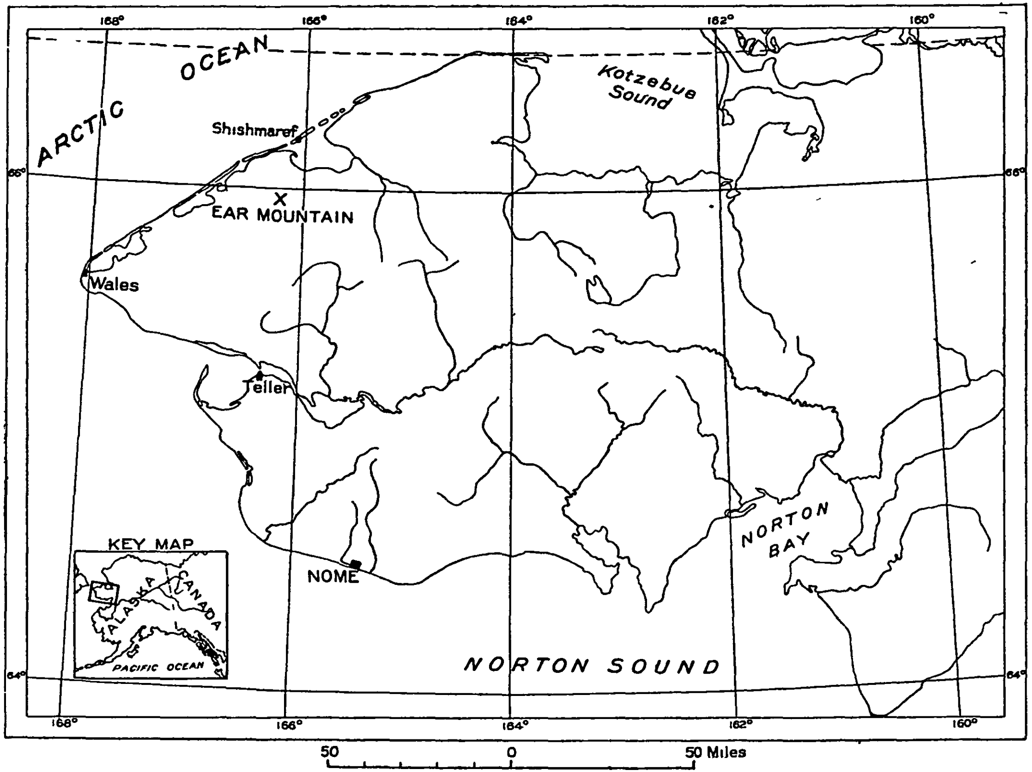

Figure 6—Index map of Seward Peninsula, Alaska, showing location of Ear Mountain

pectors and by the Geological Survey in 1940[1] and more thoroughly by drilling in 1953 and 1954. (See Collier, 1902, p. 9, 14, 20, 25, 28–30, 35, 52, 53, and 1904, p. 26–28; Knopf, 1908, p. 25–32; and Steidtmann and Cathcart, 1922, p. 102–111.)

Radioactive material was recognized in heavy-mineral concentrates from the gravels of streams heading in Ear Mountain when collections of the Geological Survey were scanned for radioactivity in the winter of 1944–45.[2] The occurrence of these radioactive minerals was investigated at Ear Mountain between July 4 and September 23, 1945. The field party consisted of P. L. Killeen and R. J. Ordway, geologists; Isidore Chamaris, cook; and John Otoyuk, Solomon Kopok, and Melton Henry, Eskimo camphands, who were employed for various periods during the season. Beta counts and chemical analyses were made in the laboratory of the Geological Survey. Aid was given in the field by Mr. and Mrs. George Goshaw of Shishmaref, Mrs Peterson and Mrs. Marx of Teller, Otto Geist of the Alaska Territorial Guard at Nome, and personnel of the Wien Alaska Airlines and the Army post at Wales.

This report is essentially unmodified from the original manuscript as prepared in 1945–46 and is retained in that form partly as a record of the problems and uncertainties in what was then a new type of investigation when instruments and techniques were in an experimental stage. Retention of the original form also accounts for the fact, without repetitious statement at several places in the report, that some phases of the work—such as the mineralogy of the concentrates and more precise determination of the minerals responsible for the radioactivity—were not carried to more adequate completion despite the interval since manuscript preparation. The authors had no subsequent opportunity to study the samples.

GEOGRAPHY

ACCESSIBILITY, SOURCES OF SUPPLIES, AND WEATHER

Ear Mountain is on the north side of the Seward Peninsula, Alaska, approximately 58 miles east-northeast of Wales, at the extremity of the peninsula, and 12 miles southwest of Shishmaref Inlet. The town of Nome is 100 miles south-southeast of the mountain. (See fig 6.) Access to the area during the field season is limited to plane travel from Nome, except by pack animal or a tracked vehicle. The airfield at Ear Mountain, more than a mile northeast of the mountain front, is about 1,000 feet long; the surface is not firm

[1] Coats, R R 1942, Unpublished preliminary report on the tin deposits of the Ear Mountain area, Seward Peninsula, Alaska U S Geol Survey

[2] Harder, J O and Reed, J C, 1945 Unpublished preliminary report on radioactivity of some Alaskan placer samples U S. Geol Survey.

enough for heavily loaded planes, and a cross wind is frequently troublesome. A dog sled trail between the villages of Shishmaref and Teller extends around the east side of the mountain In summer the tundra and swamp of the Arctic coastal plain, between the narrow courses of streams entering Shishmaref Inlet, makes the mountain difficult to reach from Shishmaref, although the route from Shishmaref by barge and tracked vehicles was used in the drilling project of 1953. Wagons were used by the early prospectors approaching the mountain from Teller to the south.

The nearest village is Shishmaref, which lies 20 miles to the north on Sarichef Island, a part of the sand bar that separates Shishmaref Inlet from the Arctic Ocean. This Eskimo village has a post office, mission, school, radio station, store, and had a fox farm in 1945. Planes land on the beach, and coastwise ships anchor offshore to unload supplies by native boats or barges Teller, a larger village with 2 stores, is about 46 miles south of Ear Mountain on an arm of the Bering Sea However, the principal supply point for the area is Nome, on the south coast of the peninsula.

No prospectors were in the Ear Mountain area during the field season of 1945, although one man was reported to have made a brief prospecting trip up the Arctic River a short distance east of the mountain. The remains of previous habitations in the area comprise two partly dilapidated cabins, the site of a third cabin, a canvas-covered wood-frame shack, and a few scattered campsites

Fuel for camp use must be brought into the area Willows, scattered in clumps along several of the creeks, reach a height of only 4 feet and are inadequate for fuel The amount of water in the creeks is meager despite the almost continuous dull weather and frequent driving rains Only parts of the creeks were actually dry at various times during the season of 1945, but generally the water was only a few inches in depth However, their depths fluctuate, and the creeks rapidly become torrents several feet in depth after a moderate rainfall Snowbanks persist until late July along certain streams and against the lower flanks of the mountain. The ground is permanently frozen at shallow depth, locally not much more than a foot below the surface.

The weather is generally wet, windy, and cold. In 1945 the first 12 days of July were exceptionally warm and clear, but only 5 good days were counted in the rest of the season A heavy snowfall covered the area on August 7, and several additional snowstorms deposited from 6 inches to a foot of snow before the party left the field on September 24. Weather conditions on the isolated mountain often differ from those of the surrounding lowland, and on many days when work on the mountain was difficult because of fog, rain, or wind, the camp on

Kreuger Creek had good weather. Temperatures only rarely dropped to the point where a thin coat of ice formed on water.

PHYSIOGRAPHY

Ear Mountain [3] is about 3½ miles in diameter at its base and has an altitude of 2,297 feet. The maximum relief is about 1,400 feet, for the steeper mountain slopes meet the more gentle slope of the surrounding low plateau at approximately 900 feet above sea level. Ear Mountain and Potato and Cape Mountains, which are farther west toward the end of the peninsula, are three prominent isolated highlands just south of the Arctic coastal plain on the outer edge of the rolling dissected plateau which extends southward and eastward to the larger highland area of the York Mountains. These three isolated peaks and several smaller hills, which stand above the plateau nearer to the York Mountains, apparently owe their relief to resistant stocks, dikes, or contact-metamorphosed sedimentary rocks.

The mountain has three separate peaks West Peak, altitude 2,297 feet; Ears Peak, altitude 2,200 feet; and East Peak, altitude 1,930 feet. A shallow swale also isolates the top of North Hill, altitude 1,630 feet, but the hill is not conspicuous enough to be called a fourth peak.

Four principal streams head in the mountain (See pl. 10 and 11.) Eldorado Creek heads between East Peak and North Hill, and flows eastward to join southward-flowing Kreuger Creek, which skirts the mountain on the east and is a tributary of the Arctic River. The Arctic River flows eastward and then northward to Shishmaref Inlet. Two prominent gulches have been cut in the south side of the mountain: Pinnacle Gulch between East Peak and Ears Peak contains the head of Pinnacle Creek, and Step Gulch between Ears Peak and West Peak is the head of Step Gulch Creek. These new names for the gulches, approved by the U S Board on Geographic Names, eliminate the recurrence of the error that was made once in calling Step Gulch the head of Deer Creek. These creeks, of which Pinnacle is the larger, extend across the gently sloping lowland at the base of Ear Mountain and join Crosby Creek, which skirts the mountain on the south and flows westward to the Kugrupaga River. The head of Crosby Creek is in the low plateau area east of the base of the mountain. Deer, Willow, and Dinsmore Creeks join Crosby Creek from the north in that order downstream from Step Gulch Creek Tuttle Creek drains the north side of the mountain, flows northward beyond the mountain front, and then turns westward and joins the Kugrupaga River. Quartz Creek, which heads in the west side of the mountain, is a trib-

[3] Ear Mountain was first charted by Captain Beechey in 1826 and named "The Ears" because of two prominent rock pinnacles visible at sea

utary of Tuttle Creek. The Kugrupaga River enters the Arctic Ocean about 20 miles southwest of Shishmaref Inlet. Several streams head in the lowland north of Ear Mountain and reach the Arctic Ocean between Shishmaref Inlet and the mouth of the Kugrupaga River. The major streams are shown on the inset map of plate 10.

The names of the following minor streams are used for the first time in this report and have been approved by the Board on Geographic Names. Middle Fork is the small tributary of Eldorado Creek that flows from the conspicuous gulch on the northeast side of East Peak. South Fork, another small tributary of Eldorado Creek from the south, heads in the low plateau at the base of East Peak and joins Eldorado Creek downstream from Middle Fork. Short Creek rises in the low plateau area east of East Peak and joins Kreuger Creek downstream from the mouth of Eldorado Creek. Saddle Creek heads on the flat shoulder south of the higher part of East Peak and flows southeastward and southward to Crosby Creek.

The plateau area surrounding the mountain has a rolling surface as a result of stream dissection and is largely tundra covered. However, on the crests of the flat interstream ridges the cover of moss and grass is scattered or thin, and disintegrated fragments of the underlying rock are abundant The surface of much of the mountain area is mantled by frost-riven fragments and blocks of various sizes, generally to a depth of only a few feet although locally much deeper. Bedrock exposures are not abundant and are essentially confined to pinnacles of granite or, more rarely, of limestone that crop out on several of the ridges or on slopes of spurs. A few outcrops are found at falls in the creeks, and a small number of prominent ledges of banded schistose limestone or marble occur around the base of the mountain. Rarely, the more resistant lime-silicate rocks crop out on slopes. Disintegrated rock is nearly in place on the flat crests of the hills, and dikes or veins generally can be traced readily by linear streaks of broken rock fragments.

GEOLOGY

Ear Mountain is one of several areas where erosion has exposed small dikelike or stocklike intrusive bodies of granite in the more widespread limestone and shale bedrock of the northern part of the peninsula. The granite stock at Ear Mountain is nearly 2 miles in diameter and constitutes the central part of the mountain. (See pl. 11.) Numerous granite dikes penetrate the surrounding sedimentary rocks for distances of several thousand feet. Slaty schist—comprising shale, slate, and blocky fine-grained laminated quartzite—is conspicuous on the upper parts of West Peak, East Peak, and the ridge northwest from Ears Peak. Thin beds of similar rocks are interbedded with the limestone strata in Quartz Creek, and slates are present in the low plateau area east of the mountain at the head of South Fork of the Eldorado Creek drainage. No attempt was made to work out in detail the distribution of these shaly and quartzitic rocks on the basis of float.

A small mass of altered gabbro, intruded in the slates, occupies part of the crest of West Peak Float of a similar rock was also obtained from the east side of East Peak. Gabbro or greenstone intrusive bodies are common in the shales of the western part of the Seward Peninsula.

A schistose limestone is the most widely distributed rock type in those parts of the mountain outside the granite stock and in the adjacent tundra-covered plateau. No fossils have been found in the limestone of Ear Mountain, but fossiliferous limestone of Ordovician age is known at localities not far from the mountain.

Lime-silicate rocks developed at the contact of the granite and limestone are characterized by garnet, hedenbergite, vesuvianite, and scapolite. Axinite and tourmaline are also frequently associated The axinite occurs both as bands parallel to and as veins crosscutting the structure of the altered limestone. Minor amounts of hornblende, datolite, magnetite, and pyrite are also present.

Several generally dark-gray mafic dikes cut both the granite and the limestone. Two of these dikes can be traced in pits and by float rock for 2 to 2½ miles, and they range from a few feet to 12 feet in width. The dikes are clearly emplaced along structures that formed after the granite had solidified, but many are partly replaced by tourmaline or are cut by tourmaline veinlets and are probably differentiates from the magma of which the granite is an earlier product. Some light-colored central portions are present in the dike that extends from the Winfield shaft to the head of Tin Creek. In earlier studies of this area these dikes were called quartz-augite porphyry or augite-dacites (Knopf, 1908, p. 29; Steidtmann and Cathcart, 1922, p 108) and biotite basalt porphyry.[4] At least two dikes show conspicuous biotite phenocrysts.

Evidence of veins of several types are conspicuous in the float rock, and a few veins can be examined in place in the rock pinnacles or in pits that have been dug to bedrock Feldspar veins and pegmatites, ranging from a fraction of an inch to 18 inches in width, are indicated by the float at a few places The wider pegmatites are fine grained with veinlike segregations of mica as much as three-fourths of an inch in thickness that are parallel to the walls of the pegmatite. Coarser aggregates of feldspar and quartz, with mica plates half an inch in diameter, were found as float and probably came from veins several inches in width. Nearly pure feldspar veins with only minor amounts

[4] Coats, op. cit.

of tourmaline, or rarely fluorite, were found in granite dikes cutting the limestone, in marginal areas of the granite stock, and as float in limestone areas close to the contact. Some feldspar veins are solid, others are vuggy with individual grains well crystallized; the crystals in the vuggy types may be as much as an inch in length. One float fragment of a feldspar vein showed an adjacent vein of danburite (?) with a columnar structure normal to the vein.

Veins of quartz and black tourmaline, in varying proportions, are the most numerous and largest in the area and were found only within the margins of the granite stock, yet tourmalinization of some of the limestone has occurred, and tourmaline veins also cut the mafic dikes that extend well beyond the margin of the granite. Many of the veins are between 2 and 6 inches in width and are aggregates of tourmaline and quartz having a granitic texture. In some of the veins the quartz is a mass of solid intergrown crystals, in others it is an aggregate of vuggy well-formed crystals.

Quartz veins of several other types are indicated by the float, although nowhere are they conspicuous by number or size. Narrow quartz stringers flanked by mica or by highly micaceous granite (greisen) form zones as much as a few inches in width in some pieces of granite float. Float at two places showed glassy gray to milky-white vein quartz enclosing or flanked by a mass of small prisms of bright blue tourmaline and some hard dark-brown limonite; the size of the fragments indicates that the veins are from 3 inches to a foot in width. Barren white quartz veins, a fraction of an inch to slightly more than a foot in width, are indicated by float at several places in the granite. Loose fragments of quartz with small patches of red hematite or with considerable red hematite stain, probably from veins several inches in width, are present in the limestone area east of the granite stock. Float from other quartz veins contains small patches of hard brown limonite. One vein of cassiterite with minor quartz, three-sixteenths inch in width, was found in granite float on the crest of North Hill. Quartz veins with pyrite have been reported previously on Crosby Creek (Collier, 1902, p. 53), but none was seen by the writers Unmodified quartz veins, quartz veins that have been shattered and cemented with calcite, and calcite veins are fairly conspicuous in the limestone east of the granite stock as far as the hill on the north side of upper Kreuger Creek. Exceptionally fine-grained or dense quartz veins ranging from a fraction of an inch to 3 inches in width are fairly common locally in the granite float, some are rhythmically banded.

Narrow veins stained red with iron oxide and commonly ½ to 1 inch in width can be traced through the residual broken rock at the surface in a few places in the limestone area east of the granite stock. Some of these veins consist of calcite and earthy red hematite; fragments of one may have a small content of radioactive material which has not yet been identified. Fragments of veins composed of cubes of limonite, probably pseudomorphs after pyrite, were found west of the landing field on the hill north of the head of Kreuger Creek.

Narrow coatings of black serpentinous or chloritic material on shear zones were found as fragments in the soil near iron-stained zones in the limestone on the east side of North Hill.

A small amount of sulfide minerals is present in the mafic dikes and in the metamorphosed limestones. The largest mass of sulfide minerals found in the area is exposed in the Winfield shaft near the contact of the granite and limestone and in the vicinity of mafic and granitic dikes on the north crest of North Hill. Although chalcopyrite and coarse fluorite are the prominent minerals on the dump, pyrrhotite, arsenopyrite, galena, and sphalerite have also been reported. Cassiterite was found in the same workings. The most prominent sulfide float seen elsewhere was pyrite and chalcopyrite, with fluorite and limonite, several hundred feet beyond the head of the gully in which is the Vatney shaft or about 2,000 feet east of the Winfield shaft, an area in the general vicinity of the granite and limestone contact.

Cassiterite has been mentioned in the above statements in connection with quartz vein float and with the sulfide deposit in the altered limestone along the granite contact at the Winfield shaft. Tin mineralization has been the main item of interest since prospecting began in the area, and cassiterite has been found in the stream gravels, in float rock, and in bedrock deposits. Except for some earlier misguided prospecting along the mafic dikes, most of the search for tin deposits has been in the contact metamorphic zone. In addition to cassiterite, minor amounts of the tin borate mineral pageite have been found. A tentative identification in the 1945 samples of stokesite, the hydrous tin-calcium silicate, suggests that there may be an even greater diversity of tin minerals in the area. The most recent study of the tin, at least for one locality, indicates that the cassiterite may be closely related to alaskite apophyses, but the relative ages of tin and sulfide mineralization has not yet been determined.

Radioactive minerals, the most recent discoveries in the area, likewise cannot be discussed as yet with respect to their age or sequence in relation to the sulfides, tin, and other vein minerals. The minerals with high thorium to uranium ratios occur as accessory constituents in the bulk facies of the granite, whereas the minerals with the reverse ratio occur in the latest lode deposits in the area.

PROSPECTING HISTORY

Initial prospecting in the Ear Mountain area, in 1900 and 1901, was part of an extensive search for gold-bearing gravels on the Seward

Peninsula after the discovery of the rich placer deposits at Nome in 1899 (Collier, 1902, p. 25, 51, 53). No verified record of any visible placer gold from the gravels near Ear Mountain is known to the writers, and no gold was obtained in any concentrates panned by the Survey parties either in 1940–41 or 1945. Traces of gold and silver have been determined in commercial assays of ore from the Winfield shaft, and a gold content of 14 to 42 cents per ton of concentrate was calculated in some samples from the gravels prospected for tin on Tuttle Creek in 1940.

Cassiterite pebbles said to be as large as a fist were found in 1901–02 on the riffles of Eldorado Creek, and possibly pieces of that size could be found in 1907 also, but the small amount of gravel did not warrant placer mining (Knopf, 1907, p. 26). Only small crystals of cassiterite were seen by the field party in 1945 at the single locality in the bed of Eldorado Creek where bedrock was then exposed. The gravels of Tuttle Creek, beyond the mountain, were tested for cassiterite by eight lines of shallow holes in 1940 and were found to be of too low tenor to be mined unless better concentrations occurred on bedrock. Deeper placer drilling in 1953 showed a somewhat higher cassiterite content but not high enough to be mined at current tin prices. Cassiterite is present in the headwaters of all the principal streams.

The discovery of cassiterite in the creek gravels led to the prospecting of the area for lode deposits of tin, and garnet, tourmaline, and augite were sometimes mistaken for cassiterite After some unsuccessful pitting, tin claims at the Winfield site were staked in 1903 and a shaft was sunk. Essentially all subsequent prospecting and development was confined to that general area on North Hill. Cassiterite generally is not visible in the ore, but assays show tin, and cassiterite has been found in thin sections prepared for microscope study. Thus, cassiterite is verified microscopically in greisenized portions of the normal facies of the granite, in and adjacent to an alaskite dike, with tourmaline-sulfide-siderite or quartz-calcite-axinite associations in the altered lime schist [5] and in offshoots of the granite where cassiterite is enclosed in muscovite (Knopf, p. 28).

Cassiterite with axinite was seen in 1945 in the vicinity of a shallow trench west-southwest of the main headwater fork of Tuttle Creek on the small low spur that extends northward from the base of Ears Peak. Cassiterite apparently may occur in any of the bedrock as fracture fillings and as a replacement, although in muscovite granite dikes the cassiterite is reported in the muscovite itself (Knopf, 1908, p 28; Steidtmann and Cathcart, 1922, p. 110). There probably is a close relationship between the latest granitic offshoots and the solutions or vapors that transported the tin When tin had not been found in

[5] Coats, op cit

commercial quantities by 1907, the interest of prospectors shifted to copper ores, but apparently insufficient ore was available No traces of recent prospecting were seen in the area, but claim notices show one claim staked in the lode area west-northwest of the Winfield shaft and another on placer ground near the junction of Eldorado and Kreuger Creeks in 1940.

More than 50 old prospect pits can still be seen at various places on the mountain Most of these pits either did not reach firm bedrock or they have slumped so that it is no longer exposed. The site of the most extensive prospecting is the Winfield shaft and the underground workings connected with it. Another prominent site is the Vatney shaft on the east slope of North Hill. A partly timbered prospect at the head of Quartz Creek may indicate some extensive work, but a slide has now almost covered the prospect. The other prospecting sites are pits which for the most part are shallow and small, although a trench more than 100 feet in length was dug on the west side of a small spur at the base of the north slope of Ears Peak. Many of these pits are on the eastern and northern parts of the 2 more prominent mafic dikes, a large number are in granite debris and show a little tourmaline or vein quartz, 1 is in a granitic dike cutting limestone, some are in various types of contact metamorphic rock, and 2 are on feldspathic veins Pits were dug in 1945 in six areas of the mountain by the Survey party in search of radioactive lodes in bedrock.

RADIOACTIVE-MINERALS INVESTIGATIONS

PRELIMINARY INVESTIGATION

Possible sources of radioactive minerals in Alaska were sought during the winter of 1944–45 by examination of the 600-odd placer concentrates in a collection of the Geological Survey The radioactivity of heavy-mineral concentrates from creek gravels in the vicinity of Ear Mountain was sufficient to place this area among the more promising represented in the collection.

Twelve samples, collected from the Ear Mountain area in 1940 by R R Coats of the Geological Survey in the course of a brief investigation of tin-bearing deposits, were tested Eleven were concentrates panned from gravels of the 4 principal creeks that head in the mountain, and the other was a concentrate panned from more or less residual disintegrated rock on the dump of 2 pits about 1,000 feet west of the Winfield shaft These concentrates had been used previously in laboratory studies connected with the tin investigations, and some had been separated into several gravity fractions by the use of bromoform and methylene iodide. Uncertainty existed as to whether or not the samples represented all of the concentrate that had been panned originally from the gravels The amount of concentrate, or of the various gravity fractions, was too small in many samples for accurate determination of the percent equivalent uranium by beta count, or for chemical determination of the uranium. The data for these concentrates are listed in table 1.

TABLE 1.—*Equivalent uranium content of samples collected at Ear Mountain, Alaska, in 1940*

Placer file no.	Coats' field no.	Weight (grams)	Gravity fractions: Sp g	Gravity fractions: Weight (grams)	Equivalent uranium (percent)	Remarks
Quartz Creek						
611	617	1.3			[1] 0.215	Upper end.
612	621	1.3			[1] .146	Middle part.
613	625	.4			.175	Lower end.
Tuttle Creek						
614	626	0.5	2.8–3.3	0.05	0.202	Upper end of claim 8-below.
			>3.3	.45	.370	
615	627	12.7			[1] .021	Upstream 2,600 feet, opposite east tributary.
616	628	3.95	<2.8	2.7	[1] .009	Upstream 5,700 feet from sample 627, about N. 88° W. of Winfield shaft; cassiterite removed.
			2.8–3.3	.3	.310	
			>3.3	.25	.310	
617	629	2.4			[1] .026	Upstream 3,000 feet from sample 628, around bend.
618	630	.55			.200	Upstream 2,400 feet, N. 52° E. of sample 629.
Other locations						
619	631	2.0	<2.8	0.05	0.005	Eldorado Creek; 1.2 grams of cassiterite removed.
			2.8–3.3	.55	.153	
			>3.3	.10	.520	
620	649	.3	2.8–3.3	.1	.000	Pinnacle Creek, at Coats' camp IV.
			>3.3	.2	1.000	
610	616	2.6			[1] .142	Step Gulch, at 1,300-foot altitude.
621	652	.2			[1] .007	Dump, 2 pits, 1,000 feet west of Winfield shaft.

[1] Sample large enough for accurate beta count.

The content of radioactive material in these samples, in terms of percent equivalent uranium as determined by beta count, ranged from 0.021 percent in a concentrate as panned to 1.0 percent in a heavy-mineral fraction separated by the use of methylene iodine (sp g 3.3). The content in panned concentrates ranged from 0.021 percent equivalent uranium in a sample from Tuttle Creek to 0.215 percent in a sample from Quartz Creek. This may not show the actual difference in content because the relative cleanness of panning is not known, although it certainly was not uniform in all samples. Among the fractions separated by heavy liquids, the light fraction (sp. g. <2.8) in 2 samples contained 0.005 percent equivalent uranium. The intermediate fraction (sp. g. 2.8–3.3) in 4 samples contained from 0 to 0.202 percent equivalent uranium, or perhaps to 0.310 percent if the fraction of sample 616 was actually an intermediate gravity fraction. The heavy fraction (sp. g. >3.3) in 4 samples contained from 0.310 to 1.0 percent equivalent uranium. The equivalent uranium content of the heaviest fraction from different creeks was 0.310 and 0.370 in samples from Tuttle Creek, 0.520 percent from Eldorado Creek, and 1.000 percent from Pinnacle Creek. No heavy-liquid separation was made of the samples from Quartz Creek, and the panned sample containing 0.215 percent equivalent uranium is the most concentrated available for comparison. The radioactive minerals are concentrated for the most part in the heavy gravity fractions; no specific examination was made to determine whether the radioactivity of the lighter fractions is the result of poor separation by the heavy liquids or of incomplete disaggregation of the light and heavy mineral grains in the gravels.

FIELD PROCEDURE AND EQUIPMENT

The objectives of the field investigation were to sample the area extensively, obtain concentrates of sufficient volume for laboratory work, determine concentration ratios of samples with respect to the original gravels, seek areas of high concentration of radioactive minerals in the gravels, and locate the bedrock deposits which supplied these minerals to the gravels.

The field party was equipped with a portable Geiger counter designed by the Geological Survey. For quantitative determination of the equivalent uranium content of heavy-sand concentrates and of crushed samples of bedrock, a "standard" container of radioactive material was used for comparison of counts. The material of this standard contained 0.042 percent equivalent uranium and gave 45 to 65 counts per minute where background counts were 7 to 15 per minute. For direct comparison with the standard, samples were taken in sufficient volume to fill a container of the same shape and dimensions.

SURFACE RADIOACTIVITY

The initial field investigation involved rapid coverage of the area by traverses along which stops were made for a count of gamma-ray activity with the Geiger tube laid on the ground surface. The sites were selected to determine the variability in counts from different types of bedrock, either where bedrock was exposed or represented by frost-riven fragments of only one kind of bedrock, and from the gravels of the headwaters of the creeks. The counts at these sites were expected to reveal any local areas of high radioactivity and to give some concept of the extremes of variation in background count for which compensation would have to be made. However, only 200 surface counts were made, not a large enough number to give good coverage of the area, the cold wet windy weather of western Seward Peninsula limits the outdoor work that can be done with an instrument which must be kept dry. Almost all of the traverse work with the counter was done during the first 12 days of July. The counts determined at 168 of these stations are plotted on plate 11, because of the small scale of the map, the rest were omitted.

The range in average count per minute for 5- and 10-minute counting periods at the surface sites was 5 to 65 counts per minute. The lowest count in the area was 5 per minute on gravels at the junction of Kreuger and Eldorado Creeks, but 500 feet upstream on Kreuger Creek the count averaged 15½ per minute, and downstream at the junction of Kreuger and Short Creeks the count was 9 per minute. Elsewhere on Kreuger Creek counts ranged from 7 to 10.

Counts of 5 to 11 per minute, except for the one of 15½ per minute, were characteristic of the area underlain by limestone on the ridge at the head of Kreuger Creek and of the gravels on Kreuger Creek, Short Creek, and the extreme head of Crosby Creek. Three sites are within 2 miles north and east of the mountain.

In the mountain area, but outside the margin of the granite stock, the counts were slightly higher. On schistose limestone, counts ranged from 9 to 13 per minute. Slates which lie at the margin of the granite and form the crests of East and West Peaks and the spur northwest from Ears Peak gave counts of 10 to 19 per minute. Gabbro intruded in the slates at the crest of West Peak yielded a count of 9 per minute. Granitic dikes cutting the limestones and slates had counts of 11 to 19 per minute. Feldspathic veins and tourmalinized zones gave 13 counts per minute. A dike of quartz-augite porphyry which cuts across the contact of the granite and limestone showed 19 counts per minute.

Within the area of the granite stock all counts were between 17 and 60 per minute. Although an average count for the granite surface was not computed because the sites could not be suitably spaced, the count at the greater number of stations was 20 to 35 per minute. The higher counts appear to occur in restricted areas, but the stations were not near enough to each other to show how localized the high-count areas are, nor was the coverage of the granite area sufficiently detailed to show that these high-count areas are the only ones present. Three high-count bedrock areas were found: at the falls in the upper part of Pinnacle Creek, where the highest average count was 60 per minute and the average counts at 13 surrounding stations on a 10-foot grid pattern ranged from 38 to 54 per minute; an area on the lower flat shoulder of the northeast slope of Ears Peak, where a count of more than 50 per minute was obtained at 2 of 33 stations, and a site at the head of the south headwater gully of Eldorado Creek, where the count averages 53 per minute Talus at the head of the small north headwater gully of Eldorado Creek also gave counts as high as 53 per minute.

Counts on the gravels in the headwater gulches were low at a few sites but in general were similar to the higher count areas on the granite surface On granitic gravels of Pinnacle Creek the average count for the counting period at each of 12 sites ranged from a low of 32 to a high of 49 per minute, and high counts continued well downstream beyond the margin of the granite stock and mountain front. On Tuttle Creek the average counts at 18 stations ranged from 18 to 45 per minute; the low count of 18 per minute was at the second from the last station downstream, the next lowest count was 28 per minute, and 4 of the stations showed 43 to 45 counts per minute. Six stations on Tuttle Creek were on a line at right angles to the stream and showed an abrupt change to lower counts of 19 and 21 per minute where the flatter areas of gravel adjacent to the creek merged with the steeper slopes of the flanking hillsides On the westerly headwater branch of Pinnacle Creek 4 sites gave counts of 42 to 53 per minute, and 1 station in a minor gully farther north gave 46 per minute On Eldorado Creek counts ranged from 18 at the mountain front to 30 per minute at the headwater fork No surface counts were made on Quartz Creek, Step Gulch, Saddle Creek, or at the head of Middle Fork because it appeared that these would give counts similar to gravels already tested, depending on the proportion of granite and limestone debris, and that for reconnaissance purposes the collection of heavy-mineral concentrates would better serve the purpose of determining the content

It was feasible to determine the constancy or variation in count at any one site over a period of time for only a few sites At most sites the count for a 10-minute period, or less commonly a 5-minute period, was made only once, but among the stations that were reoccupied the following relations of counts were observed:

1. Identical readings were obtained a month apart at two stations, and no variation was detected on successive days at a third station

2 Both constant and inconstant counts for successive 10-minute periods were noted Average counts for successive 10-minute periods at 1 station were 29, 29 5, and 30 1 per minute, or an average of 29 5 for the continuous 30-minute period, but on another day counts for 10-minute periods at an interval of a few hours averaged 28 and 34 per minute Counts for successive 10-minute periods at another station averaged 30 and 33 counts per minute.

3 Reversed relations of counts at 2 stations 800 feet apart were noted after an interval of 5 days; the counts originally were 54 and 32 per minute, and the respective readings later were 36 and 51 per minute However, on 2 other days the count was nearly identical at both stations, 46 and 47 on 1 day, 57 and 54 on the other

4 Six stations, when rechecked at different times, showed a difference in count amounting to 8 counts at 2 stations (49 and 57 at 1 station on different days, and 7 to 15 at the other station for numerous counts during the season at base camp), 11 counts (23 to 34) for 8 recounts, 12 counts (33 and 45) at an interval of 5 weeks, 21 counts (36 to 57) for 4 readings in a 6-day period, and 22 counts (32 to 54) for 5 tests in 6 days

The departure of individual minute counts from the average for the 5- and 10-minute period of counting varied At one station the count was nearly constant for a 5-minute period—individual minute counts of 26 to 29 and an average of 27 per minute Four stations showed variations of 5 to 9 counts in successive minute periods of a 10-minute counting period 32 to 37 counts per minute (average 34), 35 to 42 per minute (average 38), 46 to 53 per minute (average 50), and 33 to 42 per minute (average 37) In the larger number of tests made, however, the variation between individual minute counts was 12 to 25 where average counts for the 5- and 10-minute periods ranged from 29 to 49 The maximum variation was 30 counts at a site where the individual minute count ranged from 53 to 83 and averaged 65 per minute for the 10-minute period

While the surface counting appeared to show variation in the relative radioactivity in various parts of the area, and not only confirmed the earlier supposition that the radioactive materials occurred either in or near the granite but actually showed restriction to the granite stock, no means was found for interpreting the specific high counts in terms of the content in percent equivalent uranium of the immediately adjacent bedrock or gravel or of deposits that might be nearby under a thin cover Much closer spacing of the counting sites might have given more precise delineation of at least some of the higher count areas, but a trial of this method involved too much time to justify the results obtained and had to be terminated Moreover, small veins might be present but not of such attitude as to be exposed at the station site, or they might be hidden by the overlying mantle of frost-riven debris At the time of the fieldwork, information was scant also concerning the effect on the instrument of material with very low radioactivity in such large volumes as are involved when the tube is laid against a gravel bed, a bedrock surface, or a surface mantled by frost-riven fragments

An attempt was made to determine the effect of using the Geiger tube in pits, in contrast to the surface counts In pits in the granitic gravels at the headwaters of Eldorado Creek the highest average count was 69 per minute at depths of 3 to 5 feet. In 1 pit, counts were made at each foot of depth in the gravel as the pit was dug, the increase was progressively higher to a depth of 3 feet but remained nearly constant through the next 2 feet. In this pitted area at the head of Eldorado Creek, surface readings for 10 sites varied between average counts of 24 and 65 per minute. The highest count obtained in the entire Ear Mountain area was 113 per minute in a trench across the bedrock lode that was subsequently found on the east side of Ears Peak. There was no surface count at this site for comparison, the spot was selected for trenching on the basis of testing loose fragments of rock only.

RADIOACTIVE MINERALS IN THE GRAVELS

CONCENTRATE SAMPLES

METHODS OF SAMPLING

Concentrates from 100 sites in the gravels were obtained during the 1945 field season, and the coverage was probably sufficient to have located any areas of higher placer concentration of radioactive minerals. The sites for sampling were selected to represent both average content of the gravels and pay-streak types of concentration. As no placer mining has been done, pay-streak types of concentration were sought in the stream banks or creek gravels either upstream or downstream from bedrock exposures in the creek beds. The amount of concentrate obtained was so small that it was obvious these gravels did not warrant close sampling as possible placer deposits of radioactive minerals, and more effort was made to investigate the gravels of the headwater gulches as a means of obtaining guides to possible differences in bedrock sources of the radioactive minerals. However, sampling was continued downstream on Crosby, Tuttle, and Eldorado Creeks to the areas of more extensive gravels, but the radioactivity and the amount of concentrate remained low. The radioactive minerals of the concentrates are finer in grain than most of the other heavy minerals, and small amounts probably have been carried far downstream, although the downstream limit was not determined. The sites at which 96 of the concentrates were obtained are plotted on plate 10. Four sites—1 on upper Kreuger Creek, 1 on Short Creek and 2 at the extreme head of Crosby Creek—are not marked on the map because they yielded no heavy concentrates. Four sites were so close to others that only one site number is plotted and reference to the individual concentrates in text and tables is made by appending A, B, or C to the site number. Likewise, the appended-letter system is used for samples at any site where several types of concentrates were taken to show the effect of partial panning, complete panning, or the variation in amount of concentrate with different volumes of gravel concentrated.

Data concerning the samples are given in table 2 for the 74 sites from which samples were subsequently tested in the laboratory for equivalent uranium content, and for 5 additional samples that are from 3 of the sites but represent a separate pit or a different method of concentration Samples 1178 to 1180 on Eldorado Creek are also included, in spite of the fact that no equivalent uranium determinations were made, because they were taken just upstream from one of the better samples from Eldorado Creek and yet have a relatively low heavy-minerals content, thus they are important from the viewpoint of distribution

The locations of 20 sample sites are shown on plate 10 only to indicate that these portions of the gravels were examined, but the data have been omitted from table 2 because no laboratory tests of equivalent uranium content were made Twelve of the 20 samples were not given further laboratory tests as only 1 or 2 small pans of gravels were sampled, and the amount of concentrate, 0 5 to 2 5 grams, was unsuitable for testing In eight samples from as many sites some doubt existed regarding the amount of gravel panned or as to whether some of the concentrate was lost during transport to the laboratory These 20 samples are from sites on Tuttle Creek (1158, 1160, 1167, and 1170), on Eldorado Creek (1187, 1189, 1193, 1194, and 1208), and on Pinnacle Creek (1223, 1231, 1234, and 1237) Sample 1177 from Eldorado Creek was from the dump of a pit on a mafic dike and is omitted from the tables because it is not gravel concentrate

With one exception, the amounts of gravel panned to obtain the concentrates ranged from 25 to 134½ pounds (⅕ to 1 cubic foot) from a depth of 18 to 30 inches in the gravels in place Sample 1184 was panned from 632 pounds of gravel on Eldorado Creek from a pit 5 feet in depth in order to obtain a well-panned concentrate that would fill an appreciable portion of the sample container that was being used for comparison with the radioactive standard.

Concentration of all gravels was necessary to get counts definitely recognizable above the background count Many of the initial samples were well panned in order to determine the amount of concentrate that would be obtained by sluicing methods, to examine the concentrates for possible variation in the minerals present, and to detect associations of minerals that might suggest differences in bedrock sources As the small volume of these concentrates prevented their comparison with the radioactive standard, other samples were only partially panned to either the volume or half the volume of the container. Generally the half-volume amounts were used, in order to reduce the weight of samples sent back to the laboratory for mineralogical determinations However, one sample panned to a clean heavy concentrate was taken at all sites where the partial concentrates were made. Many of the samples were further concentrated in the

TABLE 2.—*Amount and radioactivity of heavy-mineral concentrates from stream gravels, Ear Mountain, Alaska, 1945*

[Symbols: P, panned only; B, bromoform used to recover heavy minerals from partially panned samples; P–B, panned and further cleaned with bromoform]

Sample no. [1]	Weight of gravel panned (pounds)	Weight of concentrate (grams)	Method of concentration	Concentration ratio	Calculated concentrate per cubic yard (pounds)	Equivalent uranium (percent)		Remarks
						Concentrate	Gravels in place [2]	
				Tuttle Creek				
1152	111.5	16.5	B	3060	1.01	0.123	0.00004	
1153A	--------	7.7	P	--------	--------	.137	--------	In a rill between the headwater gullies.
1154	117.5	16.7	B	3180	1.0	.011	.000003	
1155	112.25	11.1	B	4600	.68	.094	.00002	In a rill.
1156	61.75	11.7	B	2560	--------	<.001	--------	Downslope from 1155 in same rill.
1157	66.25	30.9	B	970	3.1	.230	.00025	
1159B	97.75	50.7	B	874	3.5	.135	.00015	800 feet from fork.
1159C	120	72.5	P	750	4.1	.033	.00004	Few feet from 1159B.
1168	75.5	110.6	B	310	10	.009	.00003	
1169	51.25	65.4	B	356	9	.005	.00001	On tributary, 300 feet from Tuttle Creek.
1171	67.75	130.5	B	235	13	.006	.00002	
1172	58	82.1	B	320	10	.007	.00002	
1173	79	76.2	B	480	6.5	.015	.00003	
1174	123.5	73.9	B	414	7.5	.011	.00002	
1175	110	[3] 24.3	B	2050	1.5	.002	.000001	
1176	100	[3] 147.6	B	307	11.0	.009	.00002	
				Eldorado Creek				
1178	45	2.4	P	8500	--------	--------	--------	1,000 feet from fork, west side of creek.
1179	61	2.6	P	10640	--------	--------	--------	Near 1178, center of creek bed.
1180	25	1.1	P	4536	--------	--------	--------	Near 1179, east side of creek bed.
1181	110.5	17.1	P	3050	1.02	0.290	0.00009	350 feet from fork.
1182	80.5	20.3	P	1800	1.7	.160	.00009	100 feet from fork.
1183	102.5	56	P	830	3.75	.196	.00024	50 feet from fork, center of creek bed.
1184	632	201.8	P–B	1140	2.16	.170	.00012	50 feet from fork, east side of creek bed.
1185	62	12.1	P	2350	1.3	.137	.00006	East rill, same gully as 1184.
1186	68	9.3	B	3300	.94	.160	.00005	West rill, same gully as 1184.
1190	56	82.1	B	308	10	.111	.00035	Near 1184, same gully.
1192A	30	9.3	P	1510	2	.072	.00005	North side of creek, at fork.
1195	55	10	P	2500	1.2	.158	.00006	At mouth of second tributary downstream from fork.
1196B	40	--------	--------	--------	--------	.025	--------	Terrace, north bank of creek, midway between the two tributaries.
1197	48	18.1	B	1200	2.6	.085	.00007	Head of tributary.
1198	56.5	23.9	B	1070	3.4	.054	.00005	200 feet from 1195.
1199	56	71	B	358	8.7	.048	.0001	1,000 feet from 1195.
1200	63	74.1	B	387	8.0	.008	.00002	2,000 feet from 1195.
1202	45	210	B	97	32	.002	.00002	
1204	83.5	122.5	B	308	10	.017	.00006	On bedrock riffles.
1205A	68	158	B	195	16	.012	.00006	
1206	26	26.8	B	440	7	.003	.000007	
1207A	83.25	112	B	338	9	.003	.000009	500 feet from mouth.
1203	42	14.3	B	1330	2	.006	.000004	Gully with cabin.
1201	57	164.5	B	157	20	.010	.00006	Gully with Vatney shaft.
1209	20	53.1	B	170	--------	<.001	--------	
1210	20	21.5	B	422	7.3	.003	.0000007	
				Creeks east and north of mountain				
1211	--------	9	P	--------	--------	<0.001	--------	Kreuger Creek
1212	65.5	6.7	B	4430	0.7	.003	0.0000007	Tin Creek.
1213	54.5	31.8	B	777	--------	.001	.000001	First creek west of Tin Creek.
1214	33	8	B	1870	1.6	.033	.000001	Trout Creek.

See footnotes at end of table, p. 79.

TABLE 2.—*Amount and radioactivity of heavy-mineral concentrates from stream gravels, Ear Mountain, Alaska, 1945*—Continued

Sample no. [1]	Weight of gravel panned (pounds)	Weight of concentrate (grams)	Method of concentration	Concentration ratio	Calculated concentrate per cubic yard (pounds)	Equivalent uranium (percent)		Remarks
						Concentrate	Gravels in place [2]	
Quartz Creek								
1215	59.5	32.9	B	823	3.8	0.064	0.000078	
1216	54	36	B	680	4.6	.027	.000046	
1217	42	72	B	265	11	.006	.00002	
Step Gulch								
1218	61.5	69.2	B	410	7.6	0.014	0.00003	
1219	51.5	35	B	665	4.6	.070	.0001	
1220	66.5	69.1	B	437	7.1	.023	.00005	
Pinnacle Gulch and Pinnacle Creek								
1221	24	8.2	P	1330	2.3	0.039	0.00003	Head of east headwater gulch.
1222A	72(?)	18.2	P	1790	1.7	.070	.00004	
1224	40	12.7	P	1430	2.2	.078	.000055	Below bedrock falls.
1225A	23	8.2	P	1100	2.8	.180	.00017	At fork of headwater tributaries.
1225B	32	13.3	P	1090	3.5	.072	.00006	East side of creek bed
1225C	115.5	75.9	B	690	4.5	.080	.00011	Center of creek bed.
1226	23	19.3	P	540	5.75	.074	.00014	
1227A	10	3.8	P	1190	1.6	.050	.000026	
1227B	30	14.5	P	940	3.0	.081	.000079	Pit a few feet from 127A.
1227C	123	53.4	P	1040	3.3	.074	.00007	Same pit as 1227B but different method of concentration.
1228	30	11.2	P	1210	3.9	.047	.00004	
1229	118.5	184.4	B	292	10.6	.003	.00001	
1230	103.5	140	B	335	9	.043	.00013	Site of Coats' camp VI.
1232	32	15.6	P	970	3.2	.011	.00001	
1233	112.5	141.8	B	360	8.5	.030	.00008	
1235	97.5	92.9	B	478	6.5	.014	.000[3]	
1236	32	9.8	P	1480	2.1	.075	.00005	
1243	45.5	16.2	B	1270	2.4	.084	.00006	Head of west headwater branch.
1244	53.5	27	B	900	3.3	.052	.000057	1,500 feet from 1243, on south side of creek bed.
1245	60.5	18.1	B	1515	2.	.080	.00005	Near 1244 on north side of creek bed.
1246	58	20.8	B	1262	2.5	.130	.00010	Downstream from 1245.
1247	54.5	22.6	B	1090	2.8	.044	.00004	Minor gully west of east headwater branch.
Crosby Creek								
1238	134.5	117.3	B	520	6	0.007	0.000013	1,360 feet downstream from mouth of Pinnacle Creek.
1239	127.5	107	B	540	5.3	.017	.00003	
1240	60	51.2	B	535	5.7	.016	.00003	
1241	68	88	B	350	8.9	.015	.000048	
1242	57	75.2	B	344	9	.006	.000017	

[1] For explanation of letter suffix and missing sample numbers see page 76.
[2] Calculated.
[3] Total combined concentrate from 1175 and 1176 correct, but was some admixture of 1175 and 1176.

laboratory by the use of bromoform. No methylene iodide separations were submitted for beta count, and hence the determinations of percent equivalent uranium are not comparable with the high content of the iodide fractions tested in the winter of 1944–45 (table 1). The concentration ratios between the original gravels and the heavy concentrates ranged between 97 to 1 and 4,600 to 1.

EQUIVALENT URANIUM CONTENT

The highest concentration of radioactive material effected by panning, 0.290 percent equivalent uranium, was in sample 1181 from the south headwater gully of Eldorado Creek where only 1.02 pounds of heavy concentrate per cubic yard is recoverable. The maximum concentration effected by partial panning and subsequent recovery of the heavy minerals by bromoform separation was 0.230 percent equivalent uranium in sample 1157 from the west headwater branch of Tuttle Creek, where the recovery is 3.1 pounds of concentrate per cubic yard. However, a somewhat larger amount of radioactive material is present in a pay-streak type of deposit on Eldorado Creek where sample 1190 from the north headwater gully contains only 0.111 percent equivalent uranium in a bromoform fraction, but the yield is 10 pounds of concentrate per cubic yard. Although no beta counts were made on iodide fractions, calculation of the content of radioactive material in the iodide fraction of sample 1157, based on the relative weights of the bromoform and iodide fractions, apparently indicates a content of 0 365 percent equivalent uranium. The earlier work on Coats' collections in 1944–45 showed that the content of radioactive minerals in a concentrate from Pinnacle Creek could be brought as high as 1.0 percent equivalent uranium in the iodide fractions (table 1).

Of the 76 concentrates tested in the laboratory by beta count to obtain a more precise count than was possible by field gamma count, 73 showed a content between 0.001 and 0.290 percent equivalent uranium. The three containing $<0\ 001$ were from Kreuger Creek, the Middle Fork of Eldorado Creek, and a headwater sample from Tuttle Creek. Creeks that do not head in the granite—Tin, Trout, and an unnamed creek west of Tin Creek—were among those showing the lowest content. Also among the lowest content group were samples from Eldorado Creek downstream from Middle Fork, a sample from Pinnacle Creek near the mountain front, and a sample far downstream on Tuttle Creek. A content of more than 0 005 percent equivalent uranium was determined in 64 concentrates, and, with reference to a content of more than 0 01, 0 02, 0 05, and 0.10, the number of concentrates was 54, 42, 32 and 14 respectively. The average equivalent uranium content of all concentrates taken at Ear Mountain is 0.031

percent. The five best concentrates contain 0.290, 0.230, 0.196, 0.180, and 0.170 percent equivalent uranium. The beta count on all bromoform fractions was made on material which had been screened to minus 20-mesh to pass the separatory funnels; microscopic examination of plus 20-mesh material showed neither monazite nor zircon, which are believed to carry the radioactive elements.

The calculated total amount of radioactive minerals recoverable per cubic yard of gravel, in contrast to the maximum tenor effected in sample concentration, was highest in pay-streak sample 1190, taken from a 2½-foot depth in a pit on the east bank of the northerly headwater gully of Eldorado Creek. The calculated recovery from this material is 10 pounds of heavy concentrate per cubic yard containing 0.111 percent equivalent uranium. However, the calculated recovery from the entire 5-foot depth of sample 1184 was only 2.16 pounds of heavy minerals per cubic yard containing 0 170 percent equivalent uranium, or about a third the content of sample 1190. Nearby, in the center of this northerly headwater gully, sample 1183 shows the second highest recovery of any collected, indicating a yield of 3 75 pounds of concentrate per cubic yard containing 0.196 percent equivalent uranium, or about twice that of site 1183 and two-thirds that of 1190. Sample 1157, from the westerly headwater branch of Tuttle Creek, indicated 3 1 pounds of concentrate per cubic yard containing 0.230 percent equivalent uranium. Sample 1159B from the easterly headwater branch of Tuttle Creek and sample 1125A from the headwater fork of Pinnacle Creek have a content about two-thirds that of samples 1183 and 1157, and sample 1199 about 3,000 feet below the headwater fork of Eldorado Creek is only slightly lower in content. Samples 1146, from the westerly headwater branch of Pinnacle Creek, and 1219 from the middle portion of Step Gulch, have the next highest content, about half that of samples 1183 and 1157, or about the same content as that of 1184 from Eldorado Creek. Sample 1215 from upper Quartz Creek has about a third the content of samples 1183 and 1157. Thus, there is an indication of variation in the amount of radioactive minerals in the headwater portions of the different creeks, if it is assumed that the same minerals are responsible for the radioactivity in all samples, but too many factors remain unknown to interpret the variation in relation to the bedrock source as contrasted with effects involved during erosion and concentration. This variation persists, but is less marked, when the equivalent uranium content of all samples from a creek are averaged, as in table 3.

URANIUM CONTENT

Three samples of the concentrates were analyzed chemically for uranium. The difference between the percent equivalent uranium as determined by beta count, and the uranium content as determined chemically, is assumed to be due to the presence of thorium, although no specific determination of thorium has been made. Sample 1157 from Tuttle Creek, with 0.230 percent equivalent uranium, contains 0.070 percent uranium. Sample 1225A from Pinnacle Creek shows essentially the same ratio, 0 180 percent equivalent uranium and 0.065 percent uranium. Sample 1181 from Eldorado Creek shows a much higher thorium (?) to uranium ratio, 0.290 percent equivalent uranium and 0 02 percent uranium.

MINERALOGY

In a preliminary examination [6] of 8 concentrates from Quartz, Eldorado, Tuttle, and Pinnacle Creeks, 24 minerals were identified (see table 1). Black tourmaline was the most abundant mineral in all concentrates except sample 614 from Tuttle Creek, but probably only an iodide fraction of this sample was examined Monazite, zircon, and cassiterite constituted a considerable portion of all concentrates. Xenotime was identified in sample 612 from Quartz Creek and in the sample from Eldorado Creek Vesuvianite and garnet were absent only in sample 611 from Quartz Creek, upstream from the contact. Axinite was absent only in sample 611 from Quartz Creek and sample 614 from Tuttle Creek Diopside or hedenbergite were absent only in samples 610 and 612 from Pinnacle and Quartz Creeks, respectively. Hypersthene was identified in the sample from Eldorado Creek. Biotite was present in 2 of 3 samples from Quartz Creek and in sample 610 from Pinnacle Creek; these were panned samples that had not been separated into gravity fractions by heavy liquids. Tremolite was reported in the 2 samples from lower Quartz Creek and 1 from Tuttle Creek A small amount of apatite was recognized in sample 613 from Quartz Creek, in sample 616 from Tuttle Creek, and in the sample from Eldorado Creek. Scheelite was sparse in samples 614 and 616 from Tuttle Creek but abundant in the sample from Eldorado Creek. Minor amounts of fluorite and topaz were recognized in the sample from Eldorado Creek, magnetite in sample 614 from Tuttle Creek, brookite in 2 samples from Quartz Creek, olivine in samples 613 from Quartz Creek and 614 from Tuttle Creek, epidote in samples 616 from Tuttle Creek and 620 from Pinnacle Creek, danburite in sample 616 from Tuttle Creek, scapolite in sample 613 from Quartz Creek, and limonite pseudomorphous after pyrite in sample 612 from Quartz Creek

Mineralogical work on the concentrates taken during the 1945 radioactivity investigations was not completed. Small tabular crystals of

[6] Harder and Reed, op cit

a steel-gray to black mineral with metallic luster form a considerable portion of many of the concentrates; in at least some of the concentrates it is hematite. Black rhombs of hematite also have been identified in some of the concentrates A small amount of a milky white mineral of high refractive index, consistently present in iodode fractions of the concentrates, is tentatively identified as stokesite (a hydrous silicate of calcium and tin) although insufficient material has been isolated to prove this identification Cassiterite was found in all concentrates from the westerly headwater branch of Pinnacle Creek and in the lower parts of Step Gulch, a distribution not known at the time of tin investigations in the area.

The minerals common to all concentrates and probably responsible for the radioactivity are monazite and zircon. No alpha-ray plates have yet been used as a means of determining whether one or both of these minerals is radioactive.

AMOUNT OF HEAVY MINERALS

The amount of heavy-mineral concentrate per cubic yard that can be recovered, as calculated from the concentration ratios, ranges from 0 7 to 16 pounds except at 2 sites where the indicated recovery was 20 and 32 pounds per cubic yard (see table 2). The average content of heavy minerals in 64 samples is 6 pounds per cubic yard or a little less than 0 2 percent by weight The larger amounts of concentrate were obtained where streams that pass beyond the margin of the granite contain heavy metamorphic minerals in their gravels, although sample 1201 from the gully in which the Vatney shaft is located, on upper Eldorado Creek, was large because of an abnormally high content of biotite. Biotite is present in considerable amounts in most of the heavy-mineral concentrates that were prepared by bromoform separation of partially panned samples. This biotite is usually eliminated by complete panning; therefore, the amount of heavy concentrate recovered by panning or sluicing only would be considerably less than indicated in table 2 The panned sample from a pit at the headwater forks of Eldorado Creek that indicated 10 pounds of clean heavy concentrate per cubic yard is from a pay-streak phase of the gravels.

EQUIVALENT URANIUM CONTENT OF THE GRAVELS IN PLACE

The low, average, and high equivalent uranium content in the gravels in place on the different creeks, as calculated from the concentration ratios and percent equivalent uranium in the concentrates of 68 samples, are assembled in table 3

TABLE 3.—*Calculated equivalent uranium content of the gravels in place*

Location	Number of samples	Equivalent uranium (percent)		
		Low	Average	High
Eldorado Creek	21	0.0000007	0.00007	0.00035
Tuttle Creek	14	.000001	.000047	.00025
Pinnacle Creek	17	.00001	.000067	.00017
Pinnacle Gulch (westerly headwater branch)	5	.00004	.000061	.0001
Step Gulch	3	.00003	.000060	.0001
Quartz Creek	3	.00002	.000046	.000078
Crosby Creek	5	.000013	.000028	.00005
Weighted average			.000056	

VOLUME OF GRAVELS AND FACTORS AFFECTING HEAVY-MINERAL RECOVERY

Practically no information was available in 1945 concerning the depth of gravels in the creeks as no placer mining had been done in the area. Bedrock crops out in the headwater portions of Quartz, Pinnacle, and Tuttle Creeks; therefore the gravels are obviously shallow. Weathered bedrock was struck at a depth of 1½ to 2 feet only a few hundred feet from Tuttle Creek in gullies eroded by tributary streams. Pits 5 feet deep at the headwater fork of Eldorado Creek probably extended into disintegrated granite, for small black streaks in the bottom of one pit appear to be disintegrated tourmaline veins. Attempts to dig pits in the broad upper part of Tuttle Creek, back from the present water channels, were unsuccessful because of frozen ground a few feet below the surface. Some placer prospecting was done in 1940 on Tuttle Creek from the mountain front nearly to the mouth of Quartz Creek; the average depth of these holes was 5 feet, but apparently they reached only a clay hardpan, not bedrock. In 1953 drilling showed the gravels on Tuttle Creek upstream from the mouth of Quartz Creek, excluding the benches, to range from 1 to 15 feet in depth and average 5.6 feet, and on Eldorado Creek to range from 1 to 14 feet and average 8 feet in depth.

Most of the creeks have headwater gulches that extend into the mountain for about a mile. In these gulches the bottoms are only a few hundred feet wide, the gravels merge toward the sides with fragments brought down by hillside creep, and the floors are tundra covered except in the immediate water channel. The valleys are floored by wide areas of gravels only at a distance of several miles from the mountain front.

The computed volume of gravels, based on an assumed average thickness of 3 feet and an approximation of the probable margin along which the gravels and hillside wash merge, is 1,016,500 cubic yards (see table 4). This table has not been revised to conform to the higher average depths of gravel indicated by the 1953 drilling. The computations for Pinnacle, Crosby, Step, and Quartz Creeks would remain the same, but another half million yards may be involved on lower Eldorado and Tuttle Creeks.

TABLE 4.—*Estimated volume of gravels in Ear Mountain area*

Location	Dimensions (yards) [1]		Volume (cubic yards)	Remarks
	Length	Width		
Quartz Creek	500	80	40, 000	Upper fourth of headwater gulch.
Do	1, 500	15	22, 500	Rest of gulch to mountain front.
Step Gulch	1, 300	65	84, 500	From head of gulch to mountain front.
Pinnacle Gulch	1, 000	15	15, 000	Easterly headwater gulch.
Do	700	65	45, 500	Westerly headwater gulch.
Do	650	70	45, 500	From fork to mountain front.
Pinnacle Creek	3, 500	35	122, 500	Mountain front to Crosby Creek.
Eldorado Creek	2, 500	30	75, 000	From head of stream to mountain front.
Do	4, 000	35	140, 000	Mountain front to Kreuger Creek.
Tuttle Creek	1, 300	10	13, 000	Easterly headwater branch.
Do	700	15	10, 500	Westerly headwater branch.
Do	2, 000	35	70, 000	Fork of east and west head branches downstream to main bend.
Do	9, 500	35	332, 500	Bend to mouth of creek south of Quartz Creek.
Total			1, 016, 500	

[1] Assumed average thickness of 1 yard.

The gravels near the headwaters of all creeks contain an abundance of large boulders which have been uncovered as the finer material was washed downstream. The gravels away from the present channels probably contain a similar number of boulders but in lower proportion to fine material; some of these boulders are 6 to 8 feet in diameter and would be obstacles to mining. On Tuttle Creek, away from the present channel, there is nearly a foot of plastic clay just beneath the tundra cover, and clayey gravels were found elsewhere in the headwater parts of the creeks. This clay would be troublesome in ground-sluicing operations.

The creeks that head in Ear Mountain are very narrow, and the larger creeks are less than 50 feet wide even at distances of several miles from the mountain front. All are shallow. In 1945, snow and ice remained until August in the part of Tuttle Creek above the bend at the mountain front. On Eldorado Creek the water disappeared into the gravels beyond the mountain front and left the middle third of the length of the creek dry for a considerable part of the working season.

RADIOACTIVE MINERALS IN THE BEDROCK

ACCESSORY MINERALS IN THE GRANITE

Monazite and zircon, which are prominent in the heavy-mineral concentrates from the gravels, had been found as characteristic accessory constituents of the granite in thin sections prepared for microscopic study before the radioactivity of the concentrates was recognized.[7] The general distribution of these accessory minerals throughout the granite is confirmed by their presence in the concentrates from all creeks heading in the area underlain by granite. However, neither study of the granite nor study of the stream concentrates has been extensive enough to obtain evidence of the uniformity or variability of distribution of either of these minerals in the granite As indicated in the discussion of the mineralogy of the stream concentrates, monazite and zircon are believed to be the radioactive minerals, but no tests were made to determine whether one tends to be more radioactive than the other, nor to determine possible variability of radioactivity in one mineral species alone.

LOCALIZED AREAS OF HIGH SURFACE COUNT

Surface counting with the Geiger counter showed an increase in counts from the area of limestone bedrock and gravels at a distance of a mile or two east of the mountain, across the aureole surrounding the granite stock where metamorphosed limestones and slates are cut by dike and sill-like apophyses of the granite, to the granite stock. Therefore, some radioactive material may be present in the aureole surrounding the granite, although the bulk is within the margins of the granite. Moreover, within the margins the distribution apparently is variable for localized areas of the granite stock and of the headwater gravels of streams rising within the granite gave the highest counts. However, attempts to confirm the actual radioactive-minerals content by gamma count of crushed samples or chips of either the granite of the main stock or of the granitic dikes were not successful. Probably the amount of disseminated radioactive minerals in these samples of granite is so small that it does not appreciably raise the count above the background A low radioactive-minerals content of the granite would be expected from the small amount of these minerals in concentrates from the extreme headwater portions of the creeks which head entirely within the granite. Several samples of the granite did show 1 or 2 counts above background, and a few showed as many as 6 counts above background. These counts were so low, however, that they were considered as insignificant.

Because local high surface counts on the granite stock suggested a moderate amount of radioactive material which could not be confirmed

[7] Coats, op cit.

in samples of the granite in the vicinity, localization of radioactive material along fractures was considered possible. Surfaces mantled with broken rock are not favorable for finding small mineralized fractures, as some that lie just below the surface may affect the instrument but not appear in the surface float of the immediate vicinity.

Before preliminary reconnaissance surface counting of the area was complete, a change in weather ended outdoor use of the instrument; further examination of bedrock material required that the samples be caried by pack to the base camp for instrument counting. This placed such a limitation on the size of the samples, if a sufficient number were to be collected and crushed by hand, that many were not as large as the volume of the standard container Despite their small size and the fact that many were chips, rather than being crushed samples, it is believed that no samples having any appreciable radioactivity were overlooked All the rock types and vein materials that could be found in the surface mantle rock were tested. A number of rock samples appeared to act as a shield and gave counts below the background count.

FLOAT AND LODES

The type of bedrock that was found to be distinctly radioactive was limited to certain tourmaline and quartz vein fillings or replacements in the granite, particularly those which contain red hematite and are associated with tourmalinized mafic dikes or with fine-grained granitic dikes that cut the normal granite of the stock. In these the radioactive material possibly is a replacement along structural planes, for the dike rocks and the wall-rock granite in the immediate vicinity also are radioactive. However, the bulk of the numerous tourmaline and quartz veins that cut the granite show no radioactivity.

Some radioactive material probably is present also in a hematite-calcite vein, in some copper ore of the Winfield shaft, and in a fragment of yellow-stained coarse granite float, as samples of each consistently gave 3 to 6 counts above the background on successive readings. This increase in counts is relatively insignificant, but it furnishes guides that ought to be used in any subsequent prospecting in the area. The fragments of the hematite-calcite veinlet, probably from a vein only three-fourths of an inch in width, were on the dump of soft red weathered porphyry in Cabin Gully The weathered or decomposed porphyry itself has no noticeable radioactivity. Only one fragment of the black copper ore from the dump of the Winfield shaft showed a few counts above the background The float of the yellow-stained coarse granite was found 100 feet S 80° E of the pit in granite at the head of Shaft Gully

The bedrock material having the highest radioactivity determined in the Ear Mountain area was found by trenching an area of vein and dike float that extends across the granite mainly along the northeast slope of Ears Peak but that also crosses the spur to the south and reaches the southeast side of Sep Gulch. The total length of the line of float is more than 5,000 feet. Two trenches approximately 2,500 feet apart were dug across the lode one on the south side of the upper flat shoulder on the northeast slope of Ears Peak, and the other on the spur southeast from Ears Peak between the third and fourth granite pinnacles down from the Ears. The most conspicuous fragments in the float aside from granite are tourmaline and quartz vein material, red hematitic rock, and fragments of tourmalinized mafic dike rock The hematitic fragments are more difficult to trace in the float, for the dull red color is not as conspicuous in the granite debris as the black of the vein tourmaline and the mafic dike.

Information concerning the lode in place is somewhat limited, for the trenches were dug hastily a short time before the party was to leave the field and alternate snow and rain saturated loose surface material, which slumped frequently.

In the north and higher trench, radioactive material extends over a width of 8 feet that includes a central zone of about 4 feet of tourmalinized mafic dike rock flanked by a vein filling of quartz and tourmaline and by granite wall rock. The granite is locally disintegrated, partly decomposed to a clayey material, red stained, and cut by narrow tourmalinized seams. At the east side of the dike there is a zone of red rock 18 inches in width This red material appears to be an oxidized zone along closely spaced fractures, and both fissure filling and replacement of the dike rock, the tourmaline and quartz vein, and the adjacent granite may be involved The dike and vein are parallel and have a steep dip westward into the hill

The primary radioactive mineral has not been determined The material sampled is entirely in the oxidized zone, and the trenches were not sufficiently deep to reach unoxidized material In vugs in both the granite and the tourmaline and quartz vein, dull waxy light-green square to rectangular flakes and a few more massive pieces of a secondary radioactive mineral occur This was tentatively identified by the writers in 1945 as zeunerite, a hydrous copper uranium arsenate. Mineralogic studies in April 1949 by K Onda of the Trace Elements Laboratory, U. S. Geological Survey, show that this mineral contains both arsenic and phosphorus and is intermediate between metazeunerite and metatorbernite None of this green mineral was seen in the red material which is the most highly radioactive part of the deposit.

A channel sample taken across the zone in the north trench contains 0 016 percent equivalent uranium by beta count and 0 010 percent uranium by chemical analysis. A channel sample across the red zone contains 0 045 percent equivalent uranium by beta count and 0 035 percent uranium by chemical analysis. The ratio of uranium to thorium is considerably higher in this lode material than in the concentrates from the placers that have been analyzed for uranium. The 1 reading that could be made in this trench with the portable counter showed an average of 113 counts per minute.

Fragments from different parts of this lode show considerable variation in percent equivalent uranium as determined by gamma count in the field. The most highly radioactive piece of red ore, about 2 cubic inches in volume, contained 0.182 percent equivalent uranium; other fragments of similar rock contained 0.008 to 0 117 percent equivalent uranium. The counts for these small fragments ranged from 13 to 34 above the background count. Pieces of the black tourmaline and quartz vein material having earthy hematite in the vugs usually showed 0.005 to 0 008 percent equivalent uranium, but one piece contained 0 062 percent The radioactive mineral in this tourmaline rock is believed to be largely in the red material, for in crushing a sample of the richer ore most of the red material was lost as a powder and the content in the crushed sample was only 0 005 percent equivalent uranium. The equivalent uranium content of samples of the red-stained granite wall rock adjacent to the lode ranged from 0 008 to 0 085 percent, but other granite fragments contained only 0 002 percent. Fine-grained red rock, believed to be only partly altered dike rock, contained 0.013 and 0 02 percent equivalent uranium.

In the second trench, south from Ears Peak where the lode crosses the spur that lies between Pinnacle and Step Gulches, the radioactive zone is a 2½-foot wide blotchy replacement with considerable red ore. A sample taken across this zone contained 0 012 percent equivalent uranium as determined by gamma count in the field.

Only a rough estimate of the ore available in this lode can be made because of the difference in width at the two trenches; the material is evidently of replacement origin and may be spotty in distribution. In addition, only the oxidized ore has been sampled, and there is no information on the character of the fresh ore at depth. Computations for the 2,500 feet between the trenches, assuming an average width of 5 feet and a specific gravity of the rock of 2.7 or approximately 12 cubic feet to the ton, the reserves per foot of depth on the lode are about 960 tons of material containing 0 014 percent equivalent uranium. It is not possible to determine the reserves in the richer zone of red rock, which, over an 18-inch width in the upper trench, has an equivalent uranium content of 0 045 percent.

Although this lode was the only radioactive material located in place in bedrock, float of similar character but evidently from a lode of different trend was found a few hundred feet north of the pinnacles of Ears Peak The float trends south-southwestward into the head of Step Gulch, but attempts to locate the source of the float by trenching were not successful. Trenching of a third line of tourmalinized mafic-dike float near the northeast edge of the flat top of Ears Peak exposed a mafic dike that trends northward and is about 18 inches in width. This dike rock shows both patches and distinct veins of tourmaline, but no hematitic material was present, and no radioactivity could be detected in chip samples. A fourth line of mafic-dike float, which crosses the spur that extends north and west from Ears Peak, continues into Quartz Creek and contains some fragments with 0.002 to 0.006 percent equivalent uranium. This dike is considered to be the southwest extension of the mafic porphyry dike that is so prominent along the north side of upper Eldorado Creek. Other mafic dikes are indicated in the Ear Mountain area by float, and one of these was found in place by trenching at a distance of more than a mile from the mountain on the slope of the ridge north of the head of Kreuger Creek. The association of radioactive minerals with these mafic dikes and with patches of tourmalinization is probably due to accessible fracture systems rather than any genetic relation. The radioactive material associated with some of these mafic dikes was investigated hastily late in the season, and in any future prospecting a check should be made along all such dikes for possible additional sites of radioactive material that may have been overlooked in initial work in 1945.

Lower radioactivity was noticed in some float of tourmaline and quartz veins associated with fine-grained granites. A trench between the lower and upper flat shoulders on the northeast slope of Ears Peak, on the uppermost tourmaline float which had been traced from the lower shoulder, revealed a tourmaline and quartz vein and fine-grained granite in place in the coarse granite that is characteristic of the area. This locality showed the greatest amount of tourmaline float seen at Ear Mountain, yet it was untouched by the early prospectors, although many smaller masses had been pitted The trench is 35 feet long, essentially parallel to the contour of the hill, and nearly at right angles to the contact of the vein and fine-grained granite with the coarse granite. The shape of the tourmaline and fine-grained granite mass is uncertain for the contacts appear steep and suggest continuity uphill, yet the float disappears immediately uphill from the trench. Perhaps the body is a lens, but there was not sufficient time to test it The north end of the trench exposes, for the most part, a porous mass of tiny well-formed quartz crystals and blotchy patches of tourmaline prisms. To the south the quartz-crystal zone is succeeded by a zone of black, massive to vuggy, well-crystallized tourmaline. South of this predominantly tourmaline zone the trench cuts across fine-grained granite to its contact with coarse granite. Gamma counts in the field indicated a content of 0 012 to 0.027 percent equivalent uranium for some chip fragments of both the fine-grained granite and the porous tourmaline and quartz rock, but a crushed channel sample across the entire width of the trench failed to give any appreciable count above the background. The radioactive material may be spotty throughout the mass, and the content of the channel sample of the whole trench may be too diluted to affect the instrument.

At the head of the south headwater fork of Eldorado Creek a surface count of 53 per minute was found. Subsequent examination of the float showed that tourmaline and quartz vein material, which represents a vein at least 6 inches in width, gave a count of 3 to 5 above the background, and 1 fragment of fine-grained granite gave 14 counts above the background. Trenching failed to show the vein or the fine granite in place, and samples of the soil from the trenches contained no more than 0.005 percent equivalent uranium as indicated by a small count above the background count

CONCLUSIONS

The presence of uranium has been determined chemically in a lode deposit and in heavy-mineral concentrates from gravels of streams that head in Ear Mountain. Thorium is probably also present because the amount of equivalent uranium, as determined by beta and gamma counts, is higher than the amount of chemically determined uranium. The probable thorium content of the radioactive minerals in the placer concentrates is 3 to 10 times that of the uranium content, but in the lode the uranium content is about 2 to 3 times that of the possible thorium content.

The uranium and thorium in the placer concentrates is probably in monazite and perhaps also in zircon; both are accessory constituents of the granite The primary radioactive mineral in the lode has not been identified but is neither monazite nor zircon. A secondary green tabular mineral in the oxidized portion of the lode is identified as intermediate between metazeunerite and metatorbernite. However, this green mineral is not conspicuous in the red zone of the oxidized portion of the deposit, and another secondary mineral may be present there. A few grains of red ore similar to the oxidized material of the lode have been found in the concentrates of the west headwater tributary of Pinnacle Creek and of Step Gulch.

The occurrence of two radioactive minerals in the area, which differ in the ratio of uranium to thorium and in time of formation, suggests that thorium was largely concentrated in the early accessory minerals of the granite and uranium in the final products of differentiation.

The low radioactive-minerals content of the gravels and the low tonnage of lode material indicate that the Ear Mountain area does not warrant further investigation as a source of radioactive minerals However, stripping of the overburden by bulldozers might prove that the lode is more extensive than indicated in the field by the present investigation.

This discovery of a radioactive lode at Ear Mountain in 1945 was the first verified bedrock deposit of radioactive minerals in Alaska, although vague reports existed of discoveries years ago at three widely separated localities. This bedrock deposit, and field evidence obtained in the same year by another Geological Survey party indicating that an even more highly radioactive mineral in stream concentrates in the southeastern part of the peninsula was derived from the debris of a syenite stock, suggested that bedrock deposits might occur in other stocks of the peninsula. Lode deposits were subsequently found in the Serpentine-Kougarok area in 1946 (Moxham and West, 1953) and at Brooks Mountain in 1950 (West and White, 1952); others were indicated in the eastern part of the peninsula (Gault, Killeen, West, and others, 1953; West 1953).

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