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GEOLOGICAL SURVEY CIRCULAR 250

RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN THE NORTHEASTERN PART OF THE SEWARD PENINSULA ALASKA, 1945–47 and 1951

By H. R. Gault, P. L. Killeen, W. S. West, and others

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

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RECONNAISSANCE FOR RADIOACTIVE DEPOSITS IN THE NORTHEASTERN PART OF THE SEWARD PENINSULA, ALASKA, 1945–47 and 1951

CHAPTER A.--SWEEPSTAKES CREEK AREA, 1945

By H. R. Gault, R. F. Black, and J. B. Lyons

ABSTRACT

A significant content of radioactive material was recognized in a few placer concentrates from Sweepstakes and Rube Creeks in the northeastern part of the Seward Peninsula, Alaska, when old collections were scanned for radioactivity in the spring of 1945. Subsequent field investigations with a Geiger-Mueller counter were made of the creek gravels and the placer-gold paystreak on the bench ground of Sweepstakes Creek and its tributaries, the syenite stock of Granite Mountain to the north of Sweepstakes Creek, and the creek gravels of Rube and Anzac Creeks which are tributaries of the Peace River east of the syenite stock.

The content of radioactive minerals in the gravels and in the placer-gold "paystreak" was found to be disappointingly low. Where concentration ratios were between 45 and 169 to 1, the content of concentrates from the creek gravels was only 0.001 to 0.016 percent equivalent uranium. The average content of the creek gravels in place is computed as 0.0001 percent equivalent uranium. The placer-gold paystreak was not accessible in place, but the content was computed as 0.0003 percent equivalent uranium from the sluice-box concentrates and tailings at Winder's open-cut, the only active Placer mine in the area in 1945. The radioactive minerals are relatively abundant in such gravity concentrates as the sluice-box concentrates, and are particularly abundant in certain size-fractions of these sluice concentrates. Thus the concentrates from the sluice-box, after screening through 20-mesh, showed 0.04 percent equivalent uranium. An even greater concentration of radioactive minerals is obtained in the "blowings," which represent a further cleaning of the sluice-box concentrates, one sample showing 14.20 percent equivalent uranium.

The field investigations indicate that syenite is the only bedrock which has noticeable radioactivity, and stream concentrates that were radioactive were obtained only from creeks containing syenite in the gravels or flowing in areas underlain in part at least by the syenite. Crushed syenite samples from 14 localities show a content of radioactive material ranging from 0.001 to 0.013 percent equivalent uranium. The most radioactive unconcentrated material found is a 1-inch pegmatite dike cutting the syenite. The syenite stock is pre-Cretaceous and intrudes andesitic tuffs and flows that form the bedrock over much of the area.

Two radioactive minerals have been recognized from the photographic effects obtained on alpha-ray plates, and are tentatively identified as uraninite-thorianite and hydrothorite. Almost all of the radioactive grains are uraninite-thorianite and only a few grains of hydrothorite were identified. Chemical analysis of a concentrate collected in 1917 from Sweepstakes Creek shows approximately equal amounts of uranium and thorium, and together they form more than 80 percent by weight of the sample. Chemical analyses of 5 of the samples collected in 1945 indicate a uranium content of 0.008 to 2.17 percent. In the sample which has 2.17 percent uranium, beta counts show 14.20 percent equivalent uranium and the difference is believed to be thorium.

The content of radioactive minerals in the placer deposits is believed to be too low for them to be significant as sources of uranium.

INTRODUCTION

A significant content of radioactive minerals was recognized in placer concentrates from Sweepstakes and Rube Creeks in the northeastern part of the Seward Peninsula, Alaska, when collections of the Alaskan Branch of the Geological Survey were scanned for radioactivity in the spring of 1945 (Harder and Reed, 1945, p. 5 and appendix 1)[1]. The location of the area is shown on figure 1. Only two samples from Sweepstakes Creek and one from Rube Creek were available. A sluice-box concentrate from the Circle claim on Sweepstakes Creek showed by chemical analysis more than 80 percent combined uranium and thorium with the two elements in approximately equal amounts.

Between June 28 and September 1945 a Geological Survey field party determined the amount and distribution of the radioactive minerals in the creek gravels of Sweepstakes Creek and its tributaries, in the placer deposits at the two inactive and one active site of gold mining in gravels on the left-limit bench of Sweepstakes Creek, and in the intrusive syenite stock that is north of Sweepstakes Creek and apparently is the bedrock source of these minerals. A few samples were also obtained on Anzac and Rube Creeks, tributaries of the Peace River, on the eastern side of the syenite stock.

H. R. Gault and R. F. Black, geologists, and D. R. Loftus, camphand, comprised the field party. R. F. Black was relieved from duty on August 10 because of an injury and was subsequently assigned to another project. The preparation of the report and a portion of the laboratory work were done by H. R. Gault. Mineral identifications and the exposures of some alpha-ray plates were made by J. B. Lyons. The work has been done as part of the trace elements program of the Geological Survey.

[1] See list of references, p. 31.

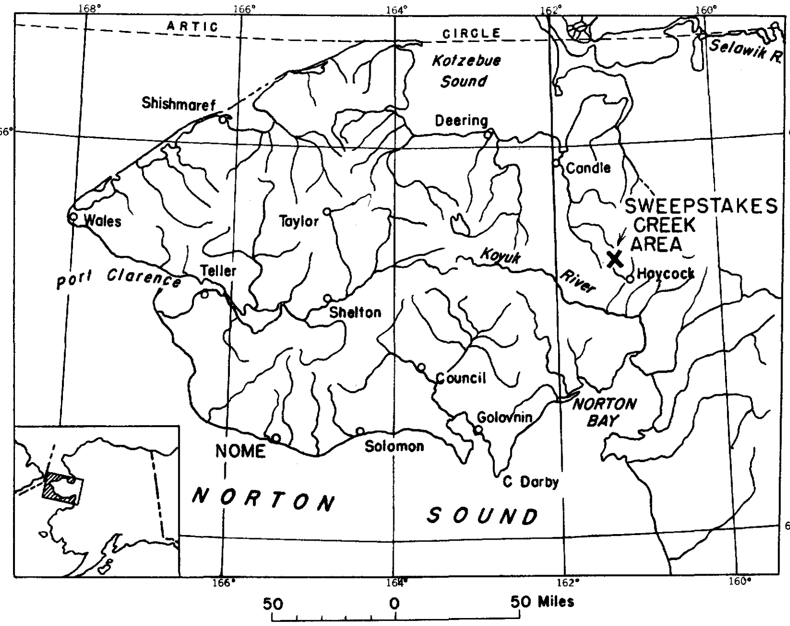

Figure 1. --Index map of the Seward Peninsula, Alaska, showing location of the Sweepstakes Creek area.

Acknowledgment is gratefully made to Messrs. John Winder, William Porter, and Carl Rylander of Haycock, and to Arthur Johnson of Fairbanks, for their assistance and friendly cooperation in the field.

Location and geography

The Sweepstakes Creek area is about 135 miles east-northeast of Nome. Sweepstakes Creek (pl. 1) is a southward-flowing tributary of the Peace River which in turn is a tributary of the Koyuk River. The main creek and some of its upper tributaries head against the Granite Mountain portion of the divide between the Koyuk basin, which drains southward to Norton Sound, and Kiwalik basin, which drains northward to Kotzebue Sound. The headwater forks of Sweepstakes Creek are designated Right Fork and Left Fork as seen when looking upstream. Granite and Spring Creeks are the principal left-limit tributaries and a few minor streams from the north enter below Spring Creek. Bear Gulch is the largest right-limit tributary although several minor ones from the south join lower Sweepstakes Creek. The main creek is 12 miles long and the mouth is about 5 miles north of the village of Haycock. Rube Creek, of which Farmer Creek is a tributary, and Anzac Creek are small tributaries of the Peace River upstream from the mouth of Sweepstakes Creek.

Haycock is the only settlement in the vicinity and consists of a few houses, an Eskimo school, a post office, and a landing field. A small placer gold mine was operating between the landing field and the settlement in 1945. Mail, radio, and plane connections are maintained with Nome, and during the summer months there is also mailboat service from Golovnin and Nome on the Bering Sea.

Tundra covers most of the area except the higher mountains which are covered with talus and frost-heaved blocks. Bedrock exposures are scarce and are principally in bluffs along the streams. Much of Sweepstakes Creek is between 200 and 500 feet above sea level. The heads of the main creek and the tributaries are at altitudes about 1,000 feet, and Granite Mountain to the north is more than 2,000 feet above sea level.

From October to June the streams and the upper foot or two of the tundra are frozen while below that depth the muck and underlying gravels are generally permanently frozen. The placer-mining season, except for underground work, is limited to the summer months.

Transportation of supplies and equipment is difficult at any time but particularly in the summer when the surface is thawed. The inhabitants of the region depend principally upon fully tracked vehicles in the summer and winter for hauling fuel and supplies. The natives use dog sleds in the winter.

Temperatures are mild during the day in July and August. Frost can be expected in any month. The precipitation is about 20 inches a year but in the late spring and late summer rain falls on more than half the days. The creeks fluctuate rapidly and high water often adds to the difficulty of travel.

GEOLOGY

The general geology of the Sweepstakes Creek area and vicinity has been described by Harrington (1919). Three types of bedrock are distinguished in the vicinity of Sweepstakes Creek: Tertiary and Recent vesicular basaltic lavas, a pre-Cretaceous syenite stock, and still older andesitic tuffs and flows with minor interbedded water-laid sediments (pl. 1). Cretaceous and metamorphosed Paleozoic sedimentary rocks are present farther south around Dime Creek. Over most of the area the bedrock is covered by frost-heaved blocks and finer disintegrated residual material. The valley fill consists of unconsolidated sediments of Quaternary age.

Types of bedrock

The bedrock of Sweepstakes Creek, except near the mouth of Granite Creek, of the lower part of Spring Creek and most of the lower part of Granite Creek, and of all but one of the small right-limit tributaries of lower Sweepstakes Creek is the andesitic tuffs and flows. These rocks are dark gray or green on freshly broken surfaces, but the weathered rock is dark brown and is broken into small angular pieces. Locally the rock is sheared and the small shear fractures are filled by calcite veins. The structure of the tuffs and flows is indistinct and the dip and strike cound not be determined. At a few places cleavage is faintly developed. Harrington noted graywacke and conglomerate along Sweepstakes Creek but stated that these sedimentary beds are not greatly different from the effusive rocks (Harrington, 1919, p. 373). Similar conglomerate-like rocks were observed in the andesite at several places during the present investigations.

Hills and ridges on the south side of lower Sweepstakes Creek near its junction with the Peace River are capped by Tertiary and Recent basaltic lavas. The lowest right-limit tributary of Sweepstakes Creek heads in this basalt.

A large body of syenite, intrusive into the surrounding andesite, forms the bedrock east of the Right Fork of Sweepstakes Creek in the upper portions of Granite and Spring Creeks. Practically all of Granite Mountain above an altitude of 1,600 feet is covered with talus and frost-heaved blocks of syenite. A few small masses of syenite beyond the margin of the main mass are probably responsible for large boulders in the creeks and on the tundra. Such Boulders are present near the mouth of Granite Creek and at the head of Farmer Creek. The syenite is gray, coarse-grained, and in many places contains large phenocrysts of feldspar. Feldspar, hornblende, and biotite are the essential minerals. Accessory minerals include Sphene, zircon, apatite, and probably very small amounts of one of the uranium minerals as indicated by the consistent though slight radioactivity of the crushed samples. Many of the frost-heaved syenite blocks, particularly of the porphyritic facies and the marginal portions, have a well-developed planar structure.

Placer-gold deposits

The stream and bench gravels in the valleys of Sweepstakes, Rube, Quartz, Bear, and Dime Creeks have been prospected or mined for placer-gold (pl. 1). The mining sites on Quartz and Bear Creeks were not examined and available information is not sufficiently up to date to permit plotting these sites on the map. The sites of the old placer workings on Rube Creek could not be recognized in 1945.

The history of the early development of placer-gold deposits in the Sweepstakes Creek area is given by Harrington (1919, pp. 387-395). Although placer mining has been carried on since 1910 on Sweepstakes Creek, only a small amount of ground in a limited area has been mined. On Rube Creek little mining has been done since the early days when the area was the scene of a stampede.

Placer-mining operations have been carried on at three places along Sweepstakes Creek in the bench deposits on the left-limit. The valley of Sweepstakes creek is asymmetric with the creek flowing close to its southwest side, or right-limit, and with a very gentle slope on the left limit. The upper site is on the Right Fork (pl. 2) and was worked intermittently by Tom Moon and associates from 1910 to 1914. Another site near the junction of the Right and Left Forks was worked by Arthur Johnson of Haycock and Fairbanks about 20 years ago. The third mining site is opposite the mouth of Bear Gulch on the Circle claim where John Winder's open-cut was the sole active operation in 1945 on Sweepstakes Creek. The old open-cut 2,400 feet below Winder's site was only a prospect and no productive mining was done there. Some gold is said to have been taken out in the past on Spring Creek, about a mile below the hot springs (pl. 1), and on Bear Gulch, in the vicinity of the forks.

Creek and bench claims have been staked along the entire length of Sweepstakes Creek and along parts of Granite Creek, Bear Gulch, and Spring Creek. Only the ground along the main creek above Spring Creek is reported to be held now. In upstream order these claims are: the Eagle claim upstream from the mouth of Spring Creek, the Circle claim about opposite Bear Gulch, the Rampart and Fairbanks claims, one unnamed claim between these and the No. 1 claim at Johnson's open-cut, some claims between No. 1 and No. 9 that are reported held by Wallace Porter of Haycock, Moon's workings on claims 9 and 10, and claims said to have been staked to the head of the Right Fork. The discovery claim was at the junction of the Right and Left Forks just below the site of Johnson's placer. The Eagle, Circle, Rampart, and Faribanks claims are said to be association claims and, with the unnamed claim above, constitute the holdings of John Winder. According to Mr. Johnson the No. 1 claim is not a full claim.

Much of the information which follows on the depth of the valley fill over bedrock, width of the paystreak, and gold recovery was obtained from John Winder and Arthur Johnson. No records are available of the results of the churn drilling that was done in the creek gravels and bench deposits of the Right Fork in the late 1930's.

The gravel in the creek bed ranges from 6 to 14 feet in depth upstream from Moon's open-cut, 9 to 12 feet between Moon's and Johnson's open-cuts, 7 feet between the mouth of Granite Creek and Winder's open-cut, 10 feet at the mouth of Spring Creek, 12 feet on Spring Creek, and 6 feet at the first left-limit tributary below Spring Creek. On Granite Creek, 2,000 feet above the mouth, clay is present beneath $2\frac{1}{2}$ feet of gravel, and elsewhere bedrock crops out in the stream.

In bench ground between Moon's and Winder's open-cuts there is 2 to 6 feet of muck and vegetation above 3 to 6 feet of gravel. Thus at Moon's site 2 feet of overburden covers 4 feet of gravel; at Johnson's open-cut 6 feet overburden overlies 3 to 4 feet of gravel, and at Winder's workings there are 6 feet each of overburden and gravel. About 1,200 feet below Winder's site at the rim of the bench the overburden and gravel are 7 feet thick, but 100 feet back from the rim the thickness is 10 to 12 feet, and farther up the slope the unconsolidated material thins and bedrock approaches the surface. The old prospect cut 2,400 feet below Winder's workings shows 8 feet of muck overlying 12 feet of gravel. On the third-tier, left-limit bench, 2 miles below Spring Creek, there is 18 feet each of overburden and gravel. A prospect pit on the left limit of lower Sweepstakes Creek, 3/4 mile from the creek and 1/2 mile west of the right limit of the Peace River, also shows 35 feet combined overburden and gravel. The bench ground along Spring Creek is probably no deeper than along Sweepstakes Creek, at a point 200 feet upstream from the mouth of Snow Gulch (pl. 2) the depth to bedrock is 12 feet.

The gravels of Sweepstakes Creek have been mined primarily for gold, although a little platinum has been recovered from Bear Gulch and the upper end of the Circle claim. No platinum has been reported in Sweepstakes Creek above that area. Moon's placer site on claims no. 9 and no. 10 on the Right Fork is reported to have been the richest ground and to have yielded the coarsest gold. The pay is said to have been better on claim 10 than on claim 11 just above. Some pay gravel is reported on claims 6, 7, and 9 between Moon's and Johnson's placer sites. The paystreak mined at Winder's workings in 1945 yielded an average of $0.25 per square foot. "Colors" or small particles of gold are reported from prospect pits scattered along Sweepstakes Creek and pay gravel has been found in a few holes. During the Geological Survey investigations in 1945, colors were seen only in the creek gravels on a bar in Sweepstakes Creek sample Ga 25, (pl. 1). A few small colors were generally found in pan samples taken from the edges of old cuts.

The width of the paystreak on the left limit of Sweepstakes Creek that could be profitably handled under the general mining costs at the time of operations or with available water pressure, is indicated by the width of the open-cuts. Johnson reports that the paystreak at his site is 150 feet wide and that poorer pay continues upstream for 400 feet, followed by a barren zone for 200 feet, and then by a zone several hundred feet in length in which colors are present. The data obtained for the first open-cut on the Circle claim in 1945 are given below:

Area of cut: 1,500 square feet.
Gold recovered: 9 ounces at $28.50 per ounce
  or $0.17 per square foot of bedrock.
Overburden: tundra 6 feet.
  gravel 6 feet.
Paystreak: gravel 0.5 foot.
  bedrock 1.0 foot.

Approximate volume of paystreak handled:
  83 cubic yards.
Number of sluice boxes: 1 (iron).
Number of riffles: 8½.
Dimensions of sluice box: 10 feet x 1 foot x
  1.3 feet.

RADIOACTIVE MINERAL INVESTIGATIONS

Field methods

Portable survey meter. --In the field, radioactivity determinations were made with a portable survey meter designed by the Geological Survey. Only a minor amount of time was given to outcrop readings where the counter tube is laid directly against an outcrop or boulder of bedrock, or on the gravels. Most of the work involved panning concentrates from gravels or crushing chips of bedrock for determination of the equivalent uranium content by comparison with a previously prepared standard. Gamma counts were made for 5-minute periods in the sequence: background, sample, standard, sample and background.

Concentrates from gravels. --The creek gravels were sampled by panning from 2/3 to 1 1/3 cubic feet of gravel to a concentrate of heavy sand. This concentrate was dried, usually sieved through a 20-mesh screen, and the minus 20-mesh material, approximately 25 cubic inches by volume, was tested by the probe in a container of the same size as the standard. At the few sites where placer deposits were accessible, samples were taken from the old tailings of former operations, from tailings at the sluice box of the operating mine from concentrates in the sluice box at the time of a clean-up, from fine concentrates caught in the cracks of old sluice boxes, and from the paystreak where exposed at both old and new placer-mining sites. Some of these samples were further concentrated by careful panning.

Bedrock samples. --Crushed samples of the syenite bedrock were generally prepared from a composite of small chips taken from 25 to 30 boulders within an area of several hundred square feet. The samples from Spring Creek (see table 1) represent fragments collected at relatively close intervals on two 1/4-mile traverses along the creek. The chips were crushed to pass an 8-mesh screen.

Laboratory study

Splits of most of the concentrates and of the crushed bedrock were brought back to the laboratory for possible checking of the gamma counts, mineralogical study, and chemical analysis.

Only a few of the concentrates have been rechecked by gamma counts because of the generally low radioactivity of the samples and the fact that the field and laboratory counts are in close agreement. Beta counts were used to determine the radioactivity of some heavy fractions, magnetic subfractions, and samples too small to handle on a gamma counter.

Gravity and magnetic fractions were separated from representative samples of the creek gravels, sluice-box concentrates, and crushed bedrock aid in the identification of the minerals and to obtain data on the amount of heavy minerals in the concentrates. Three gravity fractions were prepared by the use of bromoform and methylene iodide: light fraction, specific gravity less than 2.8; bromoform fraction, specific gravity greater than 2.8 and less than 3.1; and methylene-iodide fraction, specific gravity greater than 3.1. The bromoform and methylene-iodide fractions were further separated into magnetic and non-magnetic subfractions.

Alpha-ray photographs were used in recognizing the radioactive minerals. For this purpose the fractions are mounted in bakelite varnish on glass slides, polished, and exposed to a photographic plate coated with an emulsion sensitive only to alpha-rays. As these rays have a short depth of penetration, only those radioactive grains in actual contact with the emulsion produce photographic effects. The slides were prepared on standard glass 1.75-inches by 1-inch and contain an average of about 500 grains. Marked photographic effects were obtained only from slides of the nonmagnetic methylene-iodide subfractions. Slides prepared from samples showing less than 0.1 percent equivalent uranium showed only a few radioactive grains.

RADIOACTIVE MINERAL DEPOSITS

Gravel deposits

The field sampling showed a persistent trace of radioactive minerals in the creek gravels of Sweepstakes Creek and its tributaries and in the bench ground along Sweepstakes Creek. A similar small content was obtained in sampling the creek gravels of Rube and Anzac Creeks, and of Farmer Creek, headwater tributary of Rube Creek. The location, concentration ratio, and content of radioactive minerals in percent of equivalent uranium of the concentrates from these gravels are plotted on plates 1 and 2 and additional data are recorded in table 1.

Generally samples with concentration ratios between 45 and 169 to 1 contain only 0.001 to 0.016 percent equivalent uranium, but the sample from Anzac Creek, with a concentration ratio of 90 to 1, contains 0.033 percent equivalent uranium. Concentrates from sluice boxes, with concentration ratios around 6,000 to 1, or larger, contain 0.02 to 0.095 percent equivalent uranium. The highest content of radioactive minerals expressed in terms of equivalent uranium is obtained in samples of blowings which are those parts of the sluice concentrates that have been further cleaned by panning and then have been removed from the associated gold by gentle blowing. The sample of these blowings from the first clean-up at Winder's placer workings in 1945 has a content of 14.20 percent equivalent uranium but the concentration ratio is computed as 900,000 to 1. The old sample from the Circle claim that yielded such a high content of uranium and thorium during preliminary scanning of the Alaskan Branch collection in 1945 was probably from blowings rather than a sluice-box concentrate.

The natural concentrations in the gravels just above bedrock contain radioactive minerals in amounts comparable to the normal creek gravels. The content of equivalent uranium of panned concentrates corrected for the concentration ratio of normal creek gravels is 0.0001 percent and of natural placers 0.0003 percent.

Bedrock source

The source of the radioactive minerals in the gravels appears to be the syenite mass of Granite Mountain and smaller bodies of syenite in the vicinity. Shortly after field work was begun, the andesite bedrock was found to have no noticeable effect on the portable survey meter whereas syenite bedrock, syenite boulders, and crushed samples of syenite gave counts noticeably above background readings. Likewise, stream concentrates that show radioactivity were obtained only from those creeks which contain syenite in the gravels or flow in areas underlain at least in part by syenite. The increase in counts on syenite samples is greater than could be attributed to the influence of potassium if all of the potassium was radioactive.

In 14 samples of the crushed syenite the content of radioactive material ranges from 0.001 to 0.013 percent equivalent uranium. The sample containing 0.013 percent equivalent uranium when analyzed chemically showed 0.008 percent uranium and the remainder is presumably thorium if the field gamma count was accurate.

Minerals in the concentrates

The creek gravels, natural placers, sluice-box concentrates, and tailings contain the same minerals although in different proportions, and reflect the mineralogy of the andesite and syenite bedrock from which they were derived. The minerals that have been identified are grouped below according to their source and in their relative order of abundance. As the samples are concentrates, the percentage of heavy minerals is much greater than in the original gravels.

Common minerals

From syenite	From andesite tuffs and flows
oligoclase	oligoclase
orthoclase	andesine
sodium-rich pyroxene	
augite	augite
dark green hornblende	light green hornblende
sphene	
magnetite	magnetite
melanite	
zircon	pyrite

Minor minerals

From syenite	Source unknown	From andesite tuffs and flows
quartz	gold	calcite
biotite		picotite
apatite		ilmenite
uraninite(?)		platinum
hydrothorite(?)		

Radioactive minerals

Two minerals in the concentrates have been recognized as radioactive from the photographic effects obtained on plates sensitive to alpha-rays. These radioactive minerals are tentatively identified as uraninite-thoranite (UO_2, THO_2) and hydrothorite ($ThSiO_4 \cdot 4H_2O$). The uraninite-thorianite constitutes nearly all of the radioactive minerals whereas only a few grains of hydrothorite were recognized. The uraninite-thorianite crystals are small black cubes, metamict in structure. Penetration twins on the (111) face are fairly common. The index of refraction is 2.12 and the specific gravity, according to correspondence with J. O. Harder, 1945, is about 9.2 as determined by Larsen. Hydrothorite is a white fibrous aggregate that is faintly birefringent. Both minerals show a stronger photographic effect on alpha-ray plates than carnotite and samarskite and are therefore probably more radioactive than those minerals.

Chemical determinations of uranium and thorium content

Analyses of the two samples collected in 1917 from the Circle claim on Sweepstakes Creek yielded respectively 42.0 and 3.8 percent uranium and 42.03 and 4.7 percent thorium. Five additional analyses, given below, of the 1945 samples were made for uranium only. The difference between the content in percent of equivalent uranium, as determined by gamma counts, and the chemically determined uranium is believed to represent the thorium content.

Sample	Description	Equivalent uranium (percent)	Chemically determined uranium (percent)
45A-Ga24e	Blowings, Circle claim, 1945------------------------------	14.20	2.17
45A-Ga24dcc	Methyleen-iodide fraction of sluice-box concentrates first open-cut, Circle claim, 1945.	.227	.16
45A-Ga67	Sweepings, old sluice-box Moon's open-cut, Right Fork------	.095	.17
45A-Ga86	Anzac Creek, tributary of Peace River; concentration ratio 90:1.	.033	.016
45A-Ga66	Crushed syenite, Granite Mountain-------------------------	.013	.008

Concentration of radioactive minerals in grain-size fractions

The distribution of radioactive minerals was determined in grain-size fractions of concentrate from the first two riffles of the sluice box at Winder's placer. The sample, Ga88, contained about $20.00 in gold, showed 0.009 percent of equivalent uranium, and represented the concentrate from about 135 square feet of paystreak. The concentrate was fractioned by sieving. Most of the radioactive mineral is in the fraction between minus 6-mesh and plus 100-mesh, and there is a notable concentration between minus 20-mesh and plus 60-mesh as seen in the tabulation below:

Sieve opening	Weight of sample fraction in pounds	Equivalent uranium (percent)	Sieve opening	Weight of sample fraction in pounds	Equivalent uranium (percent)
>0.742 inch--------	4.37	0.000	20- to 45-mesh------	5.00	0.025
.742 to .525 inch---	3.81	.000	45- to 60-mesh------	1.50	.030
.525 in. to 3-mesh--	7.37	.003	60- to 80-mesh------	.62	.015
3- to 6-mesh--------	7.13	.002	80- to 100-mesh-----	.28	.012
6- to 10-mesh-------	6.25	.011	< 100 mesh----------	.81	.007
10- to 20-mesh------	5.00	.015			

The weighted average grade of the entire sample is nearly 0.009 percent; of the minus 6-mesh fraction, 0.017 percent; and of the minus 20-mesh, 0.04 percent equivalent uranium. Another minus 20-mesh sample of the concentrate from 1,500 square feet of paystreak or 83 cubic yards also showed 0.04 percent equivalent uranium.

Gravity and magnetic separations of the concentrates

The percentage, by weight, of mineral fractions obtained by gravity and magnetic separations was determined for the samples shown below. The amount of the light fraction shows the relative effectiveness of concentrating heavy minerals by panning and by sluicing. The bulk of the two heavy fractions is magnetic.

Sample description and concentration ratio (volume)	Percent weight of concentrate Gravity fractions[1]		
	Light	Bromoform	Iodide
Ga24dc. Sluice-box concentrate; minus 20-mesh; Circle claim, 1945. 42,000:1. Repanned.	28.3	9.9 (M) .9 (N)	55.1 (M) 5.7 (N)
Ga16. Sluice-box tailings; minus 20-mesh; Circle claim, 1945. 95:1.	50.0	12.5 (M) .5 (N)	33.4 (M) 3.6 (N)
Ga67. Sweepings, old sluice-box; minus 20-mesh; Moon's placer mine. Conc. ratio large.	7.5 (M) 48.5 (N)	14.5 (M) 7.3 (N)	19.0 (M) 3.2 (N)
Ga75. Sweepings, old sluice-box; minus 20-mesh Johnson's placer mine. Conc. ratio large.	7.5 (M) 16.2 (N)	19.5 (M) 2.1 (N)	47.8 (M) 7.0 (N)
Ga86. Creek gravel, Anzac Creek; minus 20-mesh. 90:1---------------	1.9 (M) 23.1 (N)	16.4 (M) 1.8 (N)	54.8 (M) 2.0 (N)

[1] (M) is magnetic subfraction and (N) is nonmagnetic subfraction.

Gravity concentration of radioactive minerals

The radioactive minerals can be concentrated in a nonmagnetic, methylene-iodide subfraction as might be inferred from the specific gravities and compositions of the minerals. Gravity separation of sample Ga24dc, a sluice-box concentrate from Winder's placer on the Circle claim, segregated a large percentage of the equivalent uranium in the iodide fraction. Magnetic separation of this methylene-iodide fraction yielded a magnetic subfraction of large bulk that contained relatively little of the equivalent uranium. The nonmagnetic subfraction, therefore, contained the remainder of the radioactive material, although the quantity of the subfraction was too small for determination of the percentage of equivalent uranium by beta-ray count. Results of the separation of sample Ga24dc are shown below:

Fractions	Equivalent uranium (percent)
Original concentrate--	0.170
Light fraction, 28 percent of original concentrate by weight---------	.002
Bromoform fraction, approximately 11 percent of original concentrate by weight---	.002
Magnetic subfraction, 9.9 percent by weight---------------------	less than .001
Nonmagnetic subfraction, 0.9 percent by weight, sample too small for analysis--	----
Iodide fraction, about 60.8 percent of original concentrate by weight---	.227 (beta count)
Magnetic subfraction, about 55 percent of original concentrate by weight--	.011
Nonmagnetic subfraction, 5.7 percent by weight of original concentrate, sample too small for analysis-------------------	----

Recoverability of radioactive minerals

The content in percent of equivalent uranium, the concentration ratio, and other data concerning the samples are given on the maps (pls. 1 and 2) and in table 1.

The average content of the creek gravels in place, computed from the percent of equivalent uranium in the concentrate recovered (not to be confused with a clean, heavy-mineral concentrate) in 50 samples is of the order of 0.0001 percent equivalent uranium. Excluded in calculating this average were samples from areas where the gravels are andesitic and show essentially no radioactivity: Bear Gulch, the Left Fork of Sweepstakes Creek, two unnamed right-limit tributaries of lower Sweepstakes Creek, and one locality in Sweepstakes Creek below Spring Creek.

Average pounds of concentrate per cubic yard---------------	41.3
Average concentration ratio (volume)----------------------	71.7:1
Average percent of equivalent uranium in the concentrates--	.006
Average grade in percent of equivalent uranium of gravels in place-------------	.0001

The average tenor of the paystreak in place is probably 0.0003 percent equivalent uranium as computed from the amount and tenor of the sluice-box concentrate and tailings from the first open-cut made in 1945 on the Circle claim. At this mine 83 cubic yards of gravel was run through the sluice-box from an open-cut area of 1,500 square feet in which the paystreak comprised 1/2 foot of gravel and 1 foot of the underlying bedrock. The equivalent uranium in the concentrate from this 83 cubic yards of paystreak gravel, assuming that a cubic foot of the gravel weighs 115 pounds, was only 0.8 pound. A sample of the tailings from the sluice-box, screened to minus 20-mesh, shows nearly 0.0002 percent equivalent uranium. A larger proportion of the radioactive mineral might be recovered in the sluice-box concentrate by more careful sluicing but the amount would still be small and the tenor, probably lower for lighter-weight minerals, would also remain in the boxes. Size fractions of the concentrate vary in content of equivalent uranium and screening affords a means of increasing the tenor of part of the concentrate to as much as 0.041 percent. Panning and "blowing" of the sluice-box concentrate brought the content of one sample to 14.2 percent of equivalent uranium. No information is available on the beneficiation of the sample, collected in 1917, which contained more than 80 percent of uranium and thorium as determined chemically.

The average content of equivalent uranium in 14 samples of the crushed syenite is 0.005 percent (table 1). The smaller percentage of equivalent uranium in the creek gravels is believed to have resulted from dilution of the syenite disintegration products by andesitic material, to the change in bulk volume, and possibly to removal of some of the radioactive material through leaching by surface waters.

Uranium-thorium ratio.--Chemical analysis showed 42 percent uranium and 42.03 percent thorium in the concentrate collected in 1917 from the Circle claim. The sample of blowings from the 1945 clean-up on the Circle claim yields only 2.17 percent uranium by chemical analysis, whereas the beta-count showed 14.20 percent equivalent uranium. The remainder of the equivalent uranium is probably thorium. The radioactive mineral is the same in both samples and no explanation is offered as yet for the difference in the uranium-thorium ratio in the two samples.

Other deposits in the vicinity

Only Sweepstakes Creek and its major tributaries were examined in detail; but the data from the Rube Creek and Anzac Creek area, and the general geology of the district, suggest that the gravels along other creeks draining areas underlain by syenite and the rock of other syenite stocks north of the Sweepstakes Creek (Harrington, 1919, pl. 10) may contain similar percentages of equivalent uranium.

Table 1.--Data on samples from Sweepstakes Creek area, 1945
(for location of samples see plates 1 and 2)

Sample	Size-fraction mesh	Equivalent uranium (percent)[1]	Conc. ratio (volume)	Lbs. conc. per cu. yd.	Remarks
			Creek gravels		
Sweepstakes Creek (in downstream order)					
Ga 53	-20	0.002	88:1	31.8	Hole 4, line 1.
54	---	.003	73:1	65.0	Hole 5, line II.
55	-20	.005	81:1	34.0	Hole 4, line IV.
56	-20	.005	85:1	33.6	Between lines V & VI.
68	-20	.004	64:1	82.0	Hole IV, line VII.
69	-20	.007	63:1	30.0	Hole 3, line VIII.
70	-20	.007	60:1	51.2	50 feet below line IX.
71	-20	.008	67:1	43.6	Right-limit line X.
72	-20	.004	60:1	43.0	Between lines XIII & XIII.
51	-20	.003	83:1	31.5	Right Fork, in creek below line XIV.
50	---	.005	47:1	67.6	Right Fork, prospect pit.
49	---	.004	67:1	40.0	Right Fork, gravel bar.
52	-20	.000	69:1	39.1	Left Fork, andesite gravels only.
48	---	.002	79:1	39.4	Gravel bar.
47	-20	.003	67:1	40.0	Gravel bar.
22	-20	.000	63:1	42.6	Gravel bar, mostly andesite fragments.
21	-20	.009	75:1	29.5	Gravel bar.
Bl 24	-20	.006	80:1	33.4	Gravel bar, below Granite Creek.
29	-20	.004	94:1	29.6	Gravel bar.
23	-20	.002	112:1	24.5	Gravel bar.
10	-20	.007	49:1	56.8	Gravel bar, below Bear Gulch.
9	-20	.003	34:1	75.8	Gravel bar.
7	-20	.005	56:1	46.0	Gravel bar.
6	-20	.003	28:1	113.0	Gravel bar.
5	-20	.005	54:1	49.1	Gravel bar.
4	-20	.007	45:1	53.7	Gravel bar, mouth Spring Creek.
32	-20	.008	112:1	26.2	Gravel bar.
40	-20	.016	135:1	22.8	Below Spring Creek (pl. 2).
33	-20	.012	48:1	64.0	Right-limit tributary, syenite gravels.
Ga 43	-20	.000	104:1	22.4	Right-limit tributary andesite gravels only.
Bl 34	-20	.008	161:1	18.2	(Pl. 2.)
Bl 35	-20	.005	150:1	19.2	(Pl. 2.)
Ga 25	-20	.010	143:1	20.5	Gravel bar, few colors.
Bl 36	-20	.012	156:1	22.4	(Pl. 1.)
Ga 44	-20	.012	124:1	23.6	Gravel bar.
45	---	.001	52:1	50.2	Andesite bedrock, right-limit tributary.
Bl 37	-20	.006	169:1	17.0	(Pl. 1.)
Spring Creek (in upstream order)					
Ga 6	-20	.007	56:1	----	Base of cut bank (pl. 2).
Bl 22	-20	.002	2:1	----	Gravel bar, Snow Gulch.
Bl 3	-20	.005	63:1	41.7	Gravel bar.
Bl 18	-20	.008	67:1	37.9	Do.
Bl 20	-20	.006	45:1	54.2	Do.
Bear Gulch (in upstream order)					
Bl 11	-20	.001	41:1	----	Gravel bar (pl. 2).
Bl 30	-20	.001	80:1	----	Right-limit tributary (pl. 1).
Ba 20	-20	.000	91:1	29.5	Bedrock in creek (pl. 2).

See footnotes at the end of table, p. 10.

Table 1.--Data on samples from Sweepstakes Creek area, 1945 (for location of samples see plates 1 and 2)--Continued

Sample	Size-fraction mesh	Equivalent uranium (percent)[1]	Conc. ratio (volume)	Lbs. conc. per cu. yd.	Remarks
Creek gravels (continued)					
Granite Creek (in upstream order)					
Bl 25	-20	0.004	88:1	29.3	Gravel bar.
Bl 26	-20	.005	81:1	33.4	Do.
Bl 27	-20	.003	84:1	31.6	Do.
Ba 77	---	.003	57:1	----	Do.
Peace River					
Ga 46	-20	.005	56:1	54.5	Gravel bar.
Rube Creek (in upstream order)					
Ga 85	-20	.003	117:1	26.2	Gravel bar.
Ga 84	-20	.001	90:1	35.3	Stream bed.
Ga 83	-20	.002	79:1	36.4	Do.
Farmer Creek					
Ga 82	-20	.007	43:1	77.0	Stream bed.
Anzac Creek					
Ga 86	-20	.033	90:1	45.2	Gravel bar.
Bench Ground					
Sweepstakes Creek (in downstream order)					
Ga 73	-20	.004	36:1	83.3	Right Fork, drill cuttings.
Bl 15	-20	.010	133:1	18.4	Gravel above paystreak, Winder's placer pit.
Bl 16	-20	.007	90:1	29.6	Gravel above paystreak. Edge old cut, Circle claim.
Bl 8	-20	.001	40:1	62.3	Prospect pit, 2400 feet below Winder's pit.
Placer deposits					
Sweepstakes Creek (in upstream order)					
Ga 13	-20	.005	74:1	----	Paystreak, margin of old cut, Circle claim.
Ga 16	-20	.017	95:1	28.0	Tailings, Winder's sluice box, Circle claim, 1945.
Ga 24b	+11½	.007	4150:1 } estimated	----	Concentrate from first placer cut on Circle claim, 1945.
Ga 24c	-11½+20	.022	4750:1 } estimated	----	
Ga 24d	-20	.041	8300:1 } estimated	----	
Ga 24e	---	14.20[2]	900,000:1	----	inBlowings, Circle claim, 1945 sweepings, old sluice box, Johnson's placer mine.
Ga 75	-20	0.013	large	----	Sweepings, old sluice box, Johnson's placer mine.
Ga 76	-20	.013	112:1	----	Edge of paystreak, Johnson's placer mine.
Ga 67	-20	.095[2]	large	----	Sweepings, old sluice box, Moon's placer mine.
Crushed syenite samples					
Ga 57	---	.005	----	----	Granite Mountain.
Ga 58	---	.003	----	----	Do.
Ga 60	---	.002	----	----	Do.
Ga 61	---	.007	----	----	Do.

See footnotes at the end of table, p. 10.

Table 1.--Data on samples from Sweepstakes Creek area, 1945 (for location of samples see plates 1 and 2)--Continued

Sample	Size-fraction mesh	Equivalent uranium (percent)[1]	Conc. ratio (volume)	Lbs. conc. per cu. yd.	Remarks
Crushed syenite samples--Continued					
Ga 62	---	0.005	----	----	Granite Mountain.
Ga 63	---	.003	----	----	Do.
Ga 64	---	.009	----	----	Do.
Ga 65	---	<.001	----	----	Divide between Granite and Sweepstakes Creeks.
Ga 66	---	.013[3]	----	----	1-inch pegmatite vein in boulder, vicinity Ga 65.
Ga 78 (Bl 42)	---	.008 (Bl 42 0.009)	----	----	Granite Creek.
Ga 79	---	.009	----	----	Do.
Ga 87	---	.006	----	----	Head of Farmer Creek.
Bl 19	---	.003	----	----	Spring Creek traverse.
Bl 21	---	.003	----	----	Do.

[1] Determined in field with portable survey meter
[2] Beta count, Washington laboratory.
[3] 0.020 percent equivalent uranium in laboratory determination.

CHAPTER B.--CANDLE CREEK AREA, 1945

By H. R. Gault

ABSTRACT

A black cubic mineral, questionably identified as uraninite, is abundant in one of two significantly radioactive placer samples obtained prior to 1945 from the Candle Creek area on the Seward Peninsula. Only 4 of the 16 concentrate samples collected during the field season of 1945 from this area contain more than 0.01 percent equivalent uranium. Although mineralogical study of the samples collected in 1945 failed to isolate the radioactive mineral grains, additional search of the Candle Creek area for the uraninite may be warranted.

INTRODUCTION

Preliminary radioactivity tests were made in the spring of 1945 on a small collection of placer samples obtained from the Candle Creek area, Seward Peninsula, Alaska, during earlier Geological Survey investigations. One sample contained more than 5 percent equivalent uranium and a second sample contained 0.049 percent equivalent uranium (Harder and Reed, 1945, p. 14, tables 1 and 2, appendix). On the basis of these results, the writer spent the last week of July 1945 in the Candle Creek area collecting a representative group of samples from the placer workings along Candle Creek and its principal tributaries for the purpose of determining the advisability of a more detailed search for radioactive mineral deposits in the area.

The Candle Creek area is a part of the Fairhaven district in the northeastern corner of the Seward Peninsula (fig. 2). Candle Creek flows northeast and joins the Kiwalik River at the site of the town of Candle. The Kiwalik River continues north beyond Candle for 6 miles to the head of Kiwalik Bay, an inlet of Kotzebue Sound which in turn opens into the Arctic Ocean.

Candle is the chief settlement and source of supply for the placer mines in this area. It is about 140 airline miles northeast of Nome. The population is small and consists mainly of Eskimos, some white Government workers, and employees of the Arctic Circle Exploration Company. The latter company is the main placer-mining outfit in the area and has been operating since 1935. The town possesses two small landing fields, and many supplies are brought in by plane from Fairbanks. Small boats bring in supplies through Kotzebue Sound during the months of July and August.

A road leads up Candle Creek for a distance of about 5 miles from the town.

GEOLOGY AND PLACER MINING

The general geology of the Fairhaven district has been described by Moffit (1905). Along Candle Creek the bedrock is predominantly a mica schist cut by small quartz stringers. Small dikes and sills of rhyolite also cut the schist, and a few are exposed in the placer workings on the bench ground. A gneissic intrusive is mapped near the head of Potato Creek.

Placer mining in the Candle Creek area has been carried on since 1901, when a stampede followed the discovery of placer gold on Jump Creek and the rich spots along Candle Creek were worked by rocker. Gold-bearing gravels have been mined or are known along the lower 5 miles of Candle Creek; along Jump and Patterson Creeks, tributaries to Candle Creek from the west (fig. 1); and in the Kiwalik River flats north of the town of Candle. Both creek and bench deposits occur along Candle Creek and its tributaries. The creek gravels are worked by dredge, and the bench ground is sluiced with hydraulic giants. The creek gravels are 12 to 18 feet thick and are covered by 10 to 20 feet of tundra. The bench gravels are 4 to 10 feet thick and are overlain by 5 to 10 feet of tundra. All of the ground is permanently frozen a few feet below the surface.

RADIOACTIVITY TESTS

Samples obtained prior to 1945 field investigation

Seven of the samples in the Alaskan concentrate collection that were tested for radioactivity in the winter of 1944-45 are from the Candle Creek area (Harder and Reed, 1945). One sample in that collection, no. 327, was not listed by Harder and Reed. Some doubt exists that sample no. 377 is actually from the Candle Creek area, as a Windy Creek is not shown on any of the maps of the area. The exact locations from which samples 208 and 209 were obtained are uncertain, although both are from the Candle Creek area. The majority of these samples were obtained from placer mines operating in 1917 by G. L. Harrington (1919) of the Geological Survey while he was engaged in investigations farther south. The data on these samples are given in table 2.

Samples obtained in 1945

Data on the 16 samples collected in the Candle Creek area in 1945 are presented in table 3. The sampling was designed to include:

1. All types of deposits over as wide an area as possible.

2. The various stages in the different recovery methods used in the placer-mining operations.

Of the 16 samples, 10 are from the main valley of Candle Creek, 3 are from the Kiwalik River flats below Candle, and 3 are from tributaries of Candle Creek

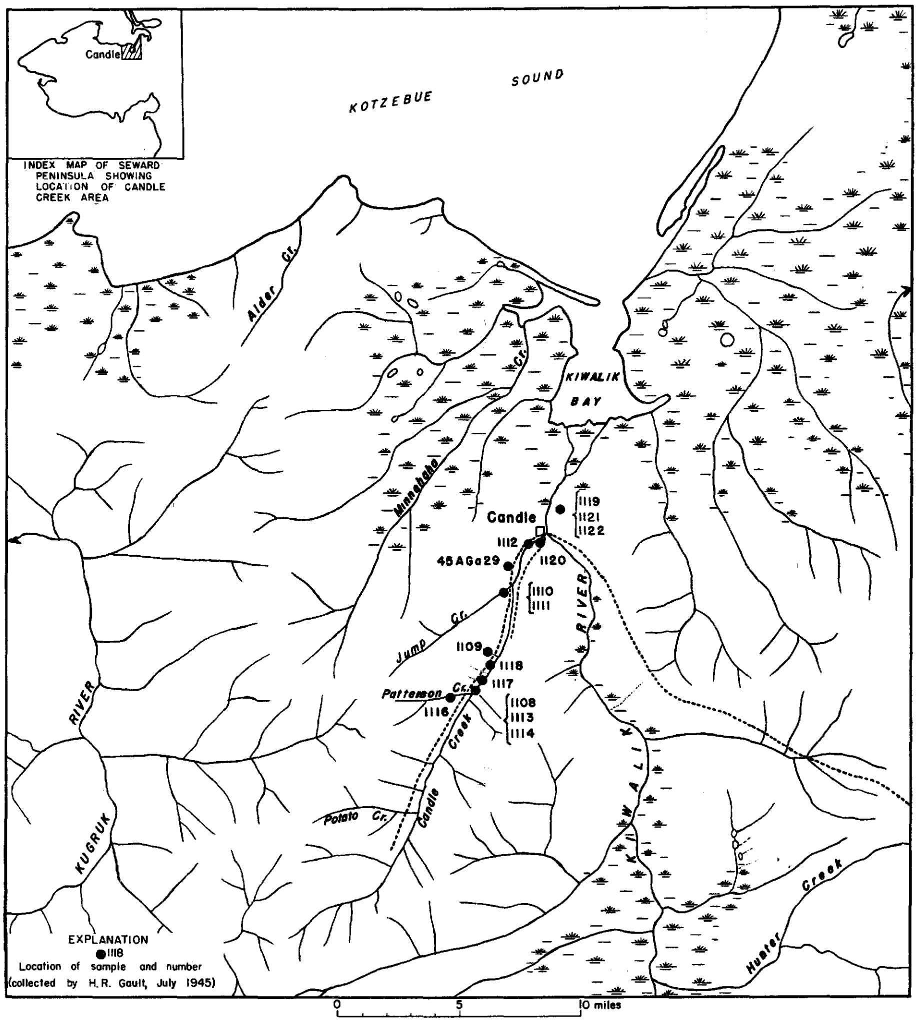

Figure 2.--Sketch map of the Candle Creek area, Seward Peninsula, Alaska

(fig. 2). The 10 samples from Candle Creek were collected from various claims beginning at claim 6-Below, and ending at claim 19-Above at the mouth of Patterson Creek. The location of the dredge concentrate sample (no. 1115), which is a composite of concentrates from claims 13- to 18-Above, is not plotted on the map. The dredge operating in 1945 was just below the mouth of Patterson Creek and was working upstream.

SUMMARY OF RESULTS AND CONCLUSIONS

The equivalent uranium content of the samples collected in 1945 ranges from 0.001 to 0.025 percent. Radioactivity exceeds 0.01 percent equivalent uranium in only four samples. The minimum concentration ratios for these four samples with respect to the original gravels range between 7,500 and 25,000 to 1 by volume. The best recovery per cubic yard obtained in sampling was approximately three-fifths of a pound of concentrate containing 0.025 percent equivalent uranium.

Heavy-mineral studies of several samples collected in 1945 failed to isolate the radioactive grains, and the identification of the mineral or minerals containing the radioactive elements is still uncertain. Nevertheless, mineralogical examination of sample 371 made by Larsen (Harder and Reed, appendix) showed that a highly radioactive, black cubic mineral, questionably identified as uraninite, makes up the larger part of the radioactive portion of the concentrate. Zircon and sphene, both of which may contain radioactive elements, are also present. The black cubic mineral also occurs in samples from the Sweepstakes Creek area of the Koyuk basin about 30 miles south of Candle, where it was tentatively identified as uraninite-thorianite (see chapter A). Field work subsequent to the 1945 investigations has indicated that this mineral is widely distributed in the northeastern part of the Seward Peninsula (see chapters C, D, and E).

No evidence of the bedrock source of the radioactive materials present in the Candle Creek placer concentrates was obtained during the brief field investigation.

The sampling in the Candle Creek area, although not extensive, included all of the mining operations active at the time. A small area of schistose or gneissic rock mapped near the head of Potato Creek, believed to be an altered acidic intrusive rock, may be the source of the radioactive minerals in the Candle Creek concentrates. However, no samples from Potato Creek are available to support this hypothesis.

Table 2.--Data on samples obtained prior to 1945 field investigation, Candle Creek area, Seward Peninsula

Alaskan Concentrate File no.	Collector's field no.	Equivalent uranium content (percent)	Location and description
371	17AHa 51a	>5.0	Candle Creek, claim 19-Above; mainly magnetite, ilmenite(?), zircon, garnet, hematite, uraninite-thorianite(?), and sphene.
22	52	.049	Candle Creek, claim 12-Above; donated by Ed. Hanson; contains magnetite, ilmenite, zircon, garnet, and rutile.
271	51	.006	Candle Creek, claim 19-Above; mainly galena (coated with cerussite), chalcopyrite, arsenopyrite, ilmenite, magnetite, rutile, garnet, limonite, hematite, pyrite, and zircon.
208	54b	.003	Candle Creek or vicinity; contains galena, rutile, garnet, titanite or zircon(?), magnetite, pyrite, little arsenopyrite, and very little ilmenite.
209	54a	.001	Candle Creek; contains hematite, limonite, magnetite, pyrite, arsenopyrite, galena, zircon, garnet (wine-colored), and very little ilmenite and rutile.
377	---	.003	Windy Creek(?) near Candle(?); donated in 1918 by L. A. Sundquist accompanied by letter of 3/9/18; contains ilmenite, limonite, garnet, and stibnite(?).
327	---	.000	Kiwalik Flats, about half a mile below mouth of Candle Creek; donated in 1907 by John Griffin; minerals not identified.

Table 3.--Data on samples obtained in 1945, Candle Creek area, Seward Peninsula, Alaska

Alaskan Concentrate File no.	Collector's field no.	E. U. content (in percent)	Mesh size	Concentration[1] ratio	Location and description
1119	45AGa 38	0.001	-20	> 10,000:1	Kiwalik River flats; reject from first jigging of dredge concentrates.
1121	40	.002	-20	> 75:1	Kiwalik River flats; panned concentrate of sand from blue mud brought up by dredge.
1122	41	.001	-20	> 10:1	Kiwalik River flats; panned concentrate of sand from tundra uncovered by drag-line.
1120	39	.002	---	112:1	Candle Creek, claim 6-Below; panned concentrate of pay streak on bench.
1112	30	.004	-20	100:1	Candle Creek, claim 2-Below; panned concentrate of pay streak on bench.
---	29	.003	-20	117:1	Candle Creek below Jump Creek; panned concentrate of pay streak on bench.
1109	26	.001	---	103:1	Candle Creek, claim 13-Above; panned concentrate of pay streak on bench.
1118	37	.006	-20	> 1,000:1	Candle Creek, claim 15-Above; cleaned hydraulic concentrate from bench ground.
1115	33	.007	---	> 10,000:1	Candle Creek, claims 13- to 18-Above, sample is composite from all claims; concentrate from first jigging of dredge concentrate, gold removed.
1117	35	.003	---	27:1	Candle Creek, claim 18-Above; panned concentrate from dredge tailings.

See footnote at the end of table, p. 14.

Table 3.--Data on samples obtained in 1945, Candle Creek area, Seward Peninsula, Alaska--Continued

Alaskan Concentrate File no.	Collector's field no.	E. U. content (in percent)	Mesh size	Concentration[1] ratio	Location and description
1113	45AGa 31	0.018	-20	> 14,000:1	Candle Creek, claim 19-Above; reject from first jigging of dredge concentrate.
1114	32	.025	---	> 15,000:1	Candle Creek, claim 19-Above; final cleaned dredge concentrate from second jigging.
1108	92	.013	Very fine--	> 25,000:1	Candle Creek, claim 19-Above; blowings from final dredge concentrate.
1110	27	.019	Very fine--	> 7,500:1	Jump Creek near Candle Creek, Wm. French workings; blowings from hydraulics sluice-box concentrate.
1111	28	.001	-20	> 5,000:1	Jump Creek near Candle Creek, Wm. French workings; hydraulic sluice-box concentrate.
1116	34	.002	-20	112:1	Patterson Creek near Candle Creek; panned concentrate from old tailings and creek gravels.

[1] Concentration ratio of original gravels to concentrate by volume.

CHAPTER C.--SOUTH FORK OF QUARTZ CREEK, 1946

By P. L. Killeen and M. G. White

ABSTRACT

Two uranium-bearing minerals, uranothorianite and thorite(?), were found in the stream gravels of the main branch of the South Fork of Quartz Creek, a tributary of the Kiwalik River. Although the bedrock source of the minerals was not located, the radioactive material was traced in slope wash well above the stream gravel. A detailed investigation of the area with more sensitive portable survey meters might reveal the source of the minerals and localities where the minerals are sufficiently concentrated to be minable.

INTRODUCTION

Purpose and scope of investigation

In January 1945, the United States Geological Survey made a rapid survey (Harder and Reed, 1945) of some placer samples to determine areas for preliminary radioactivity investigations in Alaska. The most radioactive sample was no. 342, a heavy-mineral concentrate from the Circle claim on Sweepstakes Creek, a tributary of the Peace River, south of Granite Mountain in the northeastern Seward Peninsula (inset, fig. 3). Chemical analysis of this sample indicated the presence of approximately 42 percent uranium and 43 percent thorium. In the summer of 1945 a Geological Survey party (see chapter A) visited the Sweepstakes Creek area to study the extent and possible source of the radioactive elements. The party failed to find a major deposit of the principal radioactive mineral in question, which they tentatively called uraninite-thorianite, or discover any conclusive evidence of its source. However, tests on all of the bedrock types in the area showed that the radioactive material was confined to the syenite of Granite Mountain.

Upon completion of the 1945 work in the Sweepstakes Creek area, it was decided to conduct a reconnaissance investigation on the north side of Granite Mountain in the headwaters of the South Fork of Quartz Creek, a tributary of the Kiwalik River, to determine the possible northward extension of the radioactive mineralization. Results of such an investigation by P. L. Killeen and M. G. White in July 1946 are given in this report. The area to the north of Granite Mountain has even more uranothorianite (uraninite-thorianite of Gault, Black, and Lyons, 1946; and Frondel and Fleischer, 1950, p. 7) than the Sweepstakes Creek area and in addition carries uranium-bearing thorite(?). During the 1947 season, investigations (see chapter D) were extended to the syenite masses north of the Granite Mountain mass to determine the possible northward extent of these radioactive minerals.

Location of area

The locality examined is on the headwaters of the main branch of the South Fork of Quartz Creek, a westward-flowing tributary of the Kiwalik River, in the northeastern part of the Seward Peninsula. The headwaters of the branch are in the syenite mass of Granite Mountain. The creek gravels were formerly mined for placer gold. There is a short airstrip on the creek, and the area is most easily accessible by plane from Haycock, 25 miles to the south, and from Nome, 160 miles to the southwest.

GEOLOGY

The geology of the area has been described briefly by Moffit (1905, p. 29) in connection with his reconnaissance of the northeastern part of the Seward Peninsula and by Harrington (1919, pp. 371, 372, 374) in connection with studies of the gold and platinum placer deposits in the nearby Sweepstakes Creek area.

The bedrock of the headwaters area of the South Fork of Quartz Creek consists of syenite, the Granite Mountain stock, intruded into a complex of andesitic flows and intrusives (see fig. 3). The syenite is generally light in color, and its texture ranges from even and fine-grained to porphyritic and coarse-grained. The porphyritic facies contains feldspar crystals almost an inch long with a roughly parallel orientation. The darker and coarser syenite forms the border facies of the stock. Veins and dikes are rare in the syenite. Fragments of narrow quartz veins and pegmatite dikes were found in the float, but none of them is highly mineralized. One boulder of pegmatite found at the top of the north peak of Granite Mountain contains the heavy minerals magnetite, biotite, sphene, zircon, fluorite, and allanite (sample 46AWe90, table 4 and fig. 3).

The andesite is green to dark green on fresh surfaces and weathers yellow to dark brown. No mineralized zones were found in this rock, and there is virtually no quartz. At the outset of field investigations, the andesite was discovered to be nonradioactive, so work was restricted to the syenite mass, the apparent source of radioactivity in the area.

Except for a few scattered pinnacles, no outcrops of bedrock were found, but large masses of talus cover the hill slopes. The syenite shatters into rather large boulders, many of them 2 or 3 feet in diameter. The andesite usually breaks into relatively small angular pieces.

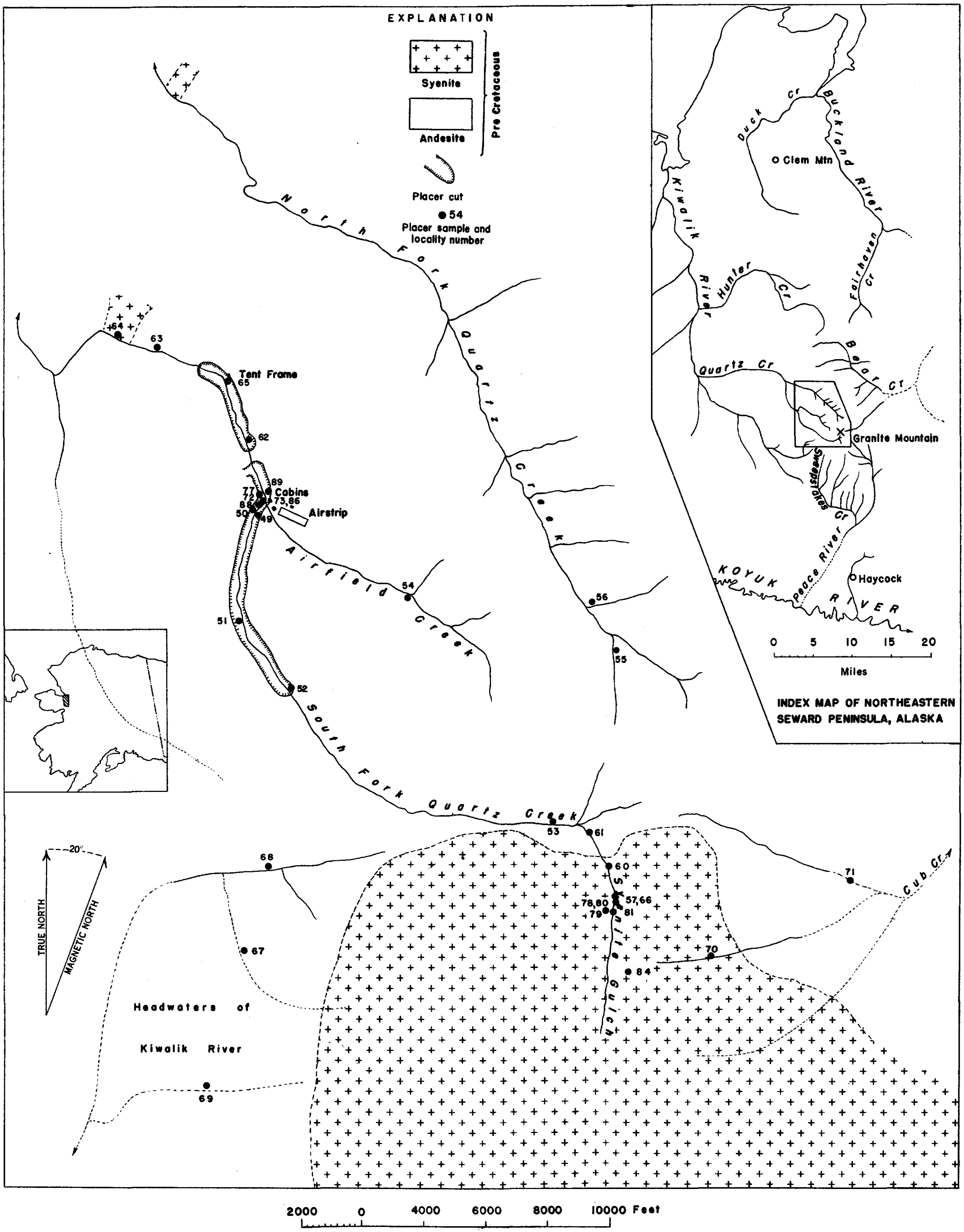

Figure 3.--Geologic sketch map of the upper portion of Quartz Creek, northeastern Seward Peninsula.

RADIOACTIVITY INVESTIGATIONS

Field investigations

Bedrock

A portable survey meter was used for radioactivity determinations in the field. On all traverses, readings were taken at every opportunity on talus, isolated boulders, or outcrops of bedrock; with the probe lying on and covered by fresh surfaces of rock. No bedrock was crushed and tested in the field because it was decided that covering the tube with bedrock fragments was sufficient test of the rocks' radioactivity. For these field readings, rocks were chosen that appeared to be representative of the type or types of rock in a talus or outcrop of a particular locality. Different types of rock at any locality were tested separately.

Readings on the syenite mass are consistently higher than those on any of the surrounding rocks. Within the syenite the background count is from two to four times greater than the background count on any of the surrounding rocks. This indicates that the radioactive minerals may be disseminated in the syenite rock, possibly in facies of small extent or in inclusions in the syenite. A more detailed study might reveal that the highly radioactive minerals occur in pegmatite dikes or in veins cutting the syenite. However, dikes and veins are uncommon on the north side of Granite Mountain (none were found in place), and those fragments that were tested in the field were not generally as radioactive as the syenite itself. Zircon and sphene, common accessory minerals, are radioactive but do not seem to account for the amount of radioactivity of the syenite.

Stream gravels

The stream gravels and gravels in placer cuts were panned to recover semiconcentrates of the heavy minerals for testing. A rock mixture of known radioactivity, in a sealed container, was used in the field as a standard to estimate relative amounts of radioactivity in the semiconcentrates. The portable survey meter indicated 8 to 10 counts per minute for average background.

Stream gravels that originate entirely in the andesitic rocks are essentially nonradioactive. Only the gravels of that part of the South Fork of Quartz Creek that heads in the syenite mass of Granite Mountain showed any appreciable radioactive content. Therefore activity was directed toward locating the source of the radioactive gravels of this stream with the field counter. Radioactivity was traced into "Syenite Gulch," so named for convenience of this report, a southern headwaters fork of the South Fork of Quartz Creek (see fig. 3). About half a mile from the mouth of the creek both uranothorianite and thorite(?) occur in the surface wash on the east bank of the gulch. The minerals are more concentrated at the surface and decrease markedly in abundance with depth into the gravels. Two localities about 50 feet apart have a relatively high concentration of the two radioactive minerals. Two samples, 57 and 80, collected from prospect pits at these locations, represent approximately the top foot of material. The heavy-mineral fraction of sample 57 contains 0.06 percent equivalent uranium and that of sample 80, 0.088 percent equivalent uranium.

Two other samples were collected from the same pits at greater depth. Sample 66, a concentrate taken at the site of sample 57 at a 3½-foot depth, contains 0.049 percent equivalent uranium in the heavy-mineral fraction. Sample 78, from a 2-foot depth at the site of sample 80, contains only 0.002 percent equivalent uranium in the heavy-mineral fraction. Search for the source of the radioactive minerals on all hill slopes above the sides and head of Syenite Gulch revealed a few patches of slope wash where readings on the counter were higher than average but none that approached the intensity of that in samples 57 and 80.

Laboratory investigations

In table 4 at the end of this report are listed all pertinent data on samples.

Concentrates of crushed bedrock

Four bedrock samples that gave fairly high counts in field readings were crushed and brought back for laboratory study. The highest equivalent uranium value obtained by laboratory test is 0.064 percent, which was from sample 90, a pegmatite from the top of Granite Mountain. The radioactivity is probably in the zircon and allanite which are abundant in the pegmatite. The three other samples, 58, 59, and 87, are of syenite. Sample 87 is the most radioactive of the three and contains a large amount of zircon. Samples 58 and 59 are low in radioactivity and contain only small amounts of zircon. All three samples are very rich in sphene, which forms as much as 50 percent of the heavy-mineral fraction. Possibly fragments of the uranium minerals are present in these concentrates. No significantly radioactive vein material was found.

Stream concentrates

Twenty-one semiconcentrate samples were collected from the stream gravels of the South Fork of Quartz Creek. The concentrates include heavy minerals which originate in both the syenite mass and the andesite; and they are indicative of the amounts of those heavy minerals present in about the upper 2 feet of the stream and placer gravels of the creek (table 4). The samples were fractionated in bromoform or methylene iodide, and all computations and determinations were made on the heavy fractions of the concentrates. The average concentration ratio of the samples from the South Fork of Quartz Creek is 192 to 1; the average recovery of heavy minerals of less than 20-mesh grain size per cubic yard of gravel is 35 pounds; the average percentage of equivalent uranium in the heavy-mineral fraction is 0.026 percent; and the average grade of equivalent uranium in the gravels in place is 0.00014 percent.

Zircon and sphene, which are major constituents of the heavy-mineral fractions, are the source of some, but as yet undetermined amount, of the radioactivity. Most of the radioactivity of the gravels, however, is due to uranothorianite and thorite(?). Very minor amounts of these minerals are present in all heavy-mineral fractions examined. The thorite(?) is apparently somewhat more common than the uranothorianite. More detailed studies may, however, prove the reverse to be true, as the uranothorianite has a tendency to shatter into fine silt-size particles that are easily detected only after magnetic concentration.

None of the samples taken during this reconnaissance from the gravels of the Kiwalik River tributaries heading in the syenite (sample localities 67, 68, and 69, fig. 5) contain a significant amount of radioactive material. On the other hand, a sample from the headwater fork of Cub Creek heading in the syenite (sample locality 70, fig. 3) contains 0.022 percent equivalent uranium, a value of significance in determining possible variation in the distribution of radioactive material in this acid intrusive.

MINERALOGY

The semiconcentrates from stream gravels were treated with bromoform to separate the minerals with specific gravity greater than 2.8. The relative order of abundance of the minerals with a specific gravity greater than 2.8 in the two principal types of source rock is listed below:

Syenite	Andesite
sphene[1]	hornblende light green
melanite	magnetite
magnetite	ilmenite
hornblende dark green, black	spinel
zircon[1]	hematite
apatite	
thorite(?)[1]	
uranothorianite[1]	

[1] Mineral contains radioactive material as determined by radiometric and chemical tests.

The black cubic uranium-bearing mineral listed above as uranothorianite is so named (Frondel and Fleischer, 1950, p. 7) until more information is available as to whether there is variability in the uranium-thorium content of the mineral not only in the Quartz Creek gravels but in other localities where the mineral has been found in the eastern Seward Peninsula (see chapter D of this report).

No trace was discovered of the mineral found by Gault (see chapter A) in the Sweepstakes Creek area and tentatively identified by him as hydrothorite.

CONCLUSIONS

The reconnaissance in 1946 extended the area known to contain uranothorianite to the north side of Granite Mountain, where the mineral was found in stream gravels and slope wash derived from syenite, but did not define the mode of occurrence.

The irregularity of the concentration of the uranothorianite in slope wash and gravel appears to indicate that this mineral may be concentrated in facies or veins in the syenite, although no facies or veins of this type could be found because of the heavy cover of talus and tundra. On the other hand, the uranothorianite may be rather evenly disseminated in the syenite, and the differences in surficial concentration may account for the irregular distribution of the uranothorianite in slope wash and gravel derived from the syenite.

A detailed examination of the syenite of Granite Mountain by traversing with more sensitive portable survey meters and by trenching with a bulldozer would be necessary to find the facies or veins in the syenite with concentrations of uranothorianite as postulated above and to determine if sufficient radioactive material is present to be of interest as a primary source of uranium.

Table 4.--Data on placer and rock samples from the area of the South Fork of Quartz Creek, Seward Peninsula, 1946

Field no.	Alaska placer file no.	Location	Concentration ratio	Pounds concentrate per cubic yard	Percent equivalent uranium in bromoform or methylene-iodide (I) fraction	Percent equivalent uranium in gravels or rocks in place
46AWe 49	1633	South Fk. Quartz Cr., just above Jack cabin---	210:1	14	0.011	0.000052
50	1634	South Fk. Quartz Cr., gravel from sluice box, Jack mine.	111:1	27	.020	.00018
51	1635	South Fk. Quartz Cr., 4000 feet S. of Jack mine.	58:1	52	.020	.00034
52	1636	South Fk. Quartz Cr., at head of placer workings on creek.	65:1	46	.013	.0002
53	1637	South Fk. Quartz Cr., 800 feet below mouth of Syenite Gulch	93:1	32	.005	.000053
54	1632	Airfield Cr., 1 mile above junction with South Fork Quartz Cr.	694:1	4.3	.001	.0000014
55	1656	North Fk. Quartz Cr., S. headwaters fork------	254:1	11	< .001	< .000004
56	1657	North Fk. Quartz Cr., N. headwaters fork------	222:1	13	< .001	.0000057
57	1640	Syenite Gulch, Cairn no. 1, 400 feet vertically above mouth.	50:1	59	.06 .115 (I)	.0012
58	1642-L	Syenite Gulch, dark syenite from talus--------	3:1	1008	.015	.005
59	1643-L	Syenite Gulch, syenite with dark bands from talus.	2:1	1512	.006	.003
60	1639	Syenite Gulch, 200 feet vertically above mouth of gulch.	94:1	32	.015	.00015
61	1638	Syenite Gulch, gravel bar at foot of gulch----	51:1	59	.011	.0002
62	1624	South Fk. Quartz Cr., base of tailings 2500 feet below Jack cabin.	137:1	22	.010	.00007
63	1623	South Fk. Quartz Cr., 3400 feet below tent frame.	153:1	19	.005	.000032
64	1622	South Fork Quartz Cr., 4000 feet below tent frame.	90:1	33	.007	.000077
65	1625	South Fk. Quartz Cr., at tent frame-----------	---	---	.039	----
66	1641	Syenite Gulch, Cairn no. 1 at 3½-foot depth---	92:1	32	.049	.00053
67	1650	Headwaters tributary Kiwalik River------------	50:1	60	.006	.00012
68	1651	Headwaters tributary Kiwalik River------------	58:1	52	.007	.00012
69	1652	Headwaters tributary Kiwalik River------------	48:1	63	.004	.000083
70	1653	Cub Cr., middle meadwaters fork at head-------	131:1	23	.022	.00017
71	1654	Cub Cr., N. headwaters fork-------------------	109:1	27	.002	.000018
72	1629	South Fk. Quartz Cr., Jack mine---------------	1884:1	1.6	.019 (I) .024	.000013
73	1630	South Fk. Quartz Cr., Jack mine, probably blowings.	Very large	---	Too high for determination.	----
74	1658	North Fk. Quartz Cr., 1¼ miles above junction with South Fk.	173:1	17	.001	.0000057
75	1620	Quartz Cr., 400 feet below junction of North and South Forks.	143:1	21	.019	.00013

Table 4.--Data on placer and rock samples from the area of the South Fork of Quartz Creek, Seward Peninsula, 1946.--Continued

Field no.	Alaska placer file no.	Location	Concentration ratio	Pounds concentrate per cubic yard	Percent equivalent uranium in Bromoform or methylene-iodide(l) fraction	Percent equivalent uranium in gravels or rocks in place
46AWe 76	1621	South Fk. Quartz Cr., 4000 feet above junction with North Fork	145:1	20	0.005	0.000034
77	1628	South Fk. Quartz Cr., Jack mine--------------	371:1	8.2	.010	.000026
78	1645	Syenite Gulch, Cairn no. 2 at 2-foot depth---	31:1	97	.002	.000064
79	1646	Syenite Gulch, at top of grassy bank above Cairn no. 2.	83:1	36	.071	.00085
80	1644	Syenite Gulch, Cairn no. 2, 15 feet vertically above Cairn no. 1 at surface.	51:1	59	.088 .27(I)	.0017 ----
81	1647	Syenite Gulch, 20 feet above Cairn no. 2-----	72:1	42	.068	.00094
84	1648	Syenite Gulch, 200 feet E. of head of Gulch.	50:1	60	.046	.00092
86	1631	South Fk. Quartz Cr., Jack mine, probably blowings.	Very large.	---	Too high for determination.	----
87	1649-L	Syenite Gulch, dark syenite from talus-------	Not known.	---	.058 (estimate)	----
88	1626	South Fork Quartz Cr., just S. of Jack mine.	Not known.	---	.113 (estimate)	----
89	1627	South Fork Quartz Cr., Jack mine-------------	Not known.	---	.045	----
90	1655-L	Granite Mtn., pegmatite from syenite at Cairn, N. peak.	55:1	54	.064	.0011

CHAPTER D.--BUCKLAND-KIWALIK DISTRICT, 1947

By W. S. West and J. J. Matzko

ABSTRACT

Radioactive minerals are widely distributed in the Buckland-Kiwalik district of the Seward Peninsula, Alaska. Localized concentrations of uranothorianite, the most important uranium mineral found, occur in the headwaters of Peace River, Quartz Creek, and Sweepstakes Creek on the slopes of Granite Mountain; in the Hunter Creek-Connolly Creek area, and on the south slope of Clem Mountain. Although the source of the uranothorianite and the other radioactive minerals has not yet been discovered because of tundra cover and heavy talus deposits, these minerals probably occur as accessories in granitic rocks.

The concentration of uranothorianite in placers at the head of the Peace River is believed to be the only lead to a possible high-grade uranium deposit. At this locality uranothorianite and its alteration product gummite, associated with hematite, limonite, powellite, pyrite, chalcopyrite, bornite, molybdenite, gold, silver, and bismuth, occur in the gravels of a restricted drainage basin near a syenite-andesite contact. A low-grade copper sulfide lode was previously reported in granite near the location of these placers. Concentrates from these placers contain from about 0.2 to about 0.8 percent equivalent uranium or about ten times the equivalent uranium content of the average uranothorianite-bearing concentrates from other localities in the eastern Seward Peninsula.

INTRODUCTION

Location of area

The Buckland-Kiwalik district is bounded on the east and west by the Buckland and Kiwalik Rivers respectively, which flow north into the Arctic Ocean and drain the northeastern part of the Seward Peninsula (inset map of Alaska, pl. 3). The area investigated in 1947 includes the divide between these rivers, from Granite Mountain on the south to Clem Mountain on the north, approximately 15 miles from the north shore of the Seward Peninsula (pl. 3).

The area is accessible from Nome, approximately 160 air-line miles to the southwest, by small airplane to two short airstrips, one located in the headwaters of Quartz Creek, and the other on Bear Creek (pl. 3). Haycock, the nearest settlement to the area, is located about 25 miles south of the Bear Creek airstrip. As no roads have yet been built in the area, transportation of supplies to and within the area must be done by tractor and sled or trailer.

The Buckland-Kiwalik divide area is a high elongated partially dissected ridge of marked relief, approximately 50 miles long (north-south), and from 6 to 20 miles wide. Striking topographic features of this divide area are the terraced character of many of the hills and mountains, the steep-sided flat-topped mountains, the conical-shaped hills, and the deeply entrenched valleys. The highest elevation of this watershed is only 2,600 feet, but the abrupt rise from the swampy lowlands of the Buckland and Kiwalik Rivers gives an appearance of great relief.

Purpose and scope of investigation

Radiometric examination in 1944 and 1945 (Harder and Reed, 1945) of a collection of Alaskan placer samples discovered several highly radioactive samples from Sweepstakes and Rube Creeks, south and southeast of Granite Mountain and the headwaters of the Kiwalik and Buckland Rivers (pl. 3). According to Larsen (Harder and Reed, 1945, appendix 1), the radioactivity of two of the Sweepstakes Creek samples is due mainly to a heavy black, opaque, mineral with a cubic habit or form which was thought at the time to be uraninite(?). Larsen later tentatively identified it, in correspondence with J. O. Harder, 1945, as uraninite-thorianite or a solid mixture of both.

In 1945 a Geological Survey field party made a reconnaissance investigation (see chapter A) of the Sweepstakes Creek area (pl. 3). Although no large deposit nor the source of the black radioactive mineral was located, it was found that the mineral has wide distribution in placers derived from the syenite on the south side of Granite Mountain. Traces of hydrothorite also were reported in some of the samples.

In 1946 reconnaissance investigation was extended to the north side of Granite Mountain (see chapter C) in the headwaters area of Quartz Creek, a tributary of the Kiwalik River (pl. 3). The black mineral (tentatively called uranothorianite by Killeen and White, see chapter C) was found to be more abundant in placers of this area than in the Sweepstakes Creek area, and, in addition, uranium-bearing thorite(?) was found. Again, however, the bedrock source of the radioactive minerals was not located, although the investigation suggested that the minerals might be disseminated accessory minerals in the syenite underlying the drainage area.

The reconnaissance investigation reported here occupied the entire summer field season of 1947. Its purpose was to extend the 1945-46 investigations to the granitic masses mainly to the north. More than 400 square miles of the Buckland-Kiwalik district was examined by W. S. West and J. J. Matzko, geologists, and A. E. Nessett, J. J. Otoyuk, and J. E. Komak, camp assistants. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOLOGY

Prior to the recent reconnaissance investigations for uranium (see Introduction), the Geological Survey had conducted only two other investigations in the northeastern part of the Seward Peninsula. In 1903 Moffit (1905) mapped the geology of the northeastern part of the Seward Peninsula on an exploration-reconnaissance scale. In 1917 Harrington (1919) visited portions of the area in connection with his investigations of the gold and platinum placers of the eastern part of the Seward Peninsula.

The general distribution of the various rock formations found in the area are shown on plate 3. Because of tundra cover and scarceness of bedrock outcrops, the mapped portion of all rock-formation boundaries is only approximate.

Undivided mafic igneous rocks

The oldest rocks in the Buckland-Kiwalik district are mafic igneous rocks of pre-Cretaceous age consisting mainly of andesitic tuffs and flows but also including some basalt, porphyritic basalt, diabase, and gabbro. Some of these rocks have been altered in varying amounts of weathering, and stresses and heat produced chiefly by later granitic intrusions. Many of the mafic rocks are cut by calcite veins as much as 10 inches in width and scattered quartz veins, but as a whole neither type of vein was found to contain sulfides. Disseminated pyrite and pyritiferous veins, however, occur in andesitic rock in the headwaters of Peace River. Concentrates from stream gravels, in which the recovered minerals originally were derived only from mafic igneous rocks, are not radioactive.

Phyllite

A small outcrop of phyllite near the headwater of the first left tributary to the West Fork of the Buckland River, south of Bear Creek, is probably an outlier of Cretaceous(?) rocks of the same type that crop out more widely 4 miles to the east, beyond the area covered by this report.

Undivided granitic rocks

Granitic rocks including syenite, syenite porphyry, granite, granite porphyry, monzonite, and monzonite porphyry were intruded in the area probably during Early Tertiary time. Field evidence indicates that all of these felsic igneous rocks are phases of one batholithic mass and may therefore be regarded as differentiates of a magma which was syenitic at an early stage. Several types of felsic dikes and a few small pegmatite dikes, genetically related to the main bodies of granitic rocks, were injected into the already cooled periphery of this batholith and into the undivided mafic igneous rocks.

Throughout the Buckland-Kiwalik district and especially in the Hunter Creek area (pl. 3), the granitic rocks range from very light to quite dark in appearance and from a very fine, even grain to a coarse porphyritic texture with phenocrysts of feldspar as much as 2 inches long. Most of the granitic rock, however, is light-colored. As a whole this mass is not highly mineralized although in localized areas it contains an abundance of disseminated pyrite. Magnetite, galena, fluorite, ilmenite, rutile, and scheelite are also present, but less common. Quartz veins cut the granitic rocks in only small numbers.

In the course of this investigation earlier geologic mapping was corrected insofar as possible, as it was found that the areal distribution of the granitic rocks is much more extensive than that indicated on previously published reconnaissance maps (Moffit, 1905; Harrington, 1919).

As the granitic rocks are the apparent source of the radioactive minerals, this investigation was largely confined to the granitic areas.

Basalt

Extensive remnants of vesicular basalt flows signify that most of the Buckland-Kiwalik district was once covered by lava possibly during Tertiary or early Quaternary time.

Unconsolidated sediments

Quaternary deposits of sands, gravels, cobbles, and boulders occur along all of present stream courses as well as in the form of disintegrated rock and talus blocks which are found on the tops of the mountains, hills, and some of the more gentle slopes.

MINERAL DEPOSITS

Stream and bench gravels in the valleys of Sweepstakes, Rube, Boulder, Rock, Quartz, Bear, Cub, Hunter, Spruce, Fairhaven, Sugar Loaf, Scotch, and Meinzer Creeks have been prospected or mined for placer gold.

During 1947 the only active placer mining in the area was on Bear Creek, where minor amounts of platinum were recovered with the gold. In addition, one man was prospecting on the Right Fork of Hunter Creek.

The only known gold lode in the area is an auriferous quartz vein on a hillside between Split and Polar Creeks, tributaries to Bear Creek. The Beltz prospect on Split Creek is on a copper lode consisting of chalcopyrite with some copper carbonate stain in a quartz vein cutting andesite (Harrington, 1919, p. 399). Smith and Eakin (1911, p. 135) report copper sulfides in a pink granite at the head of Peace River.

RADIOACTIVITY INVESTIGATIONS

Field methods

Traverses with a portable survey meter, mounted on a packboard or carried by hand, were made in the Bear Creek and Granite Mountain areas at the start of the season. Results of these traverses were unsatisfactory, however, due to the low sensitivity of the instrument; no well-defined areas having significant radioactivity anomalies could be detected by this method. Consequently, the much slower method of recording individual counts with the probe in direct contact with surfaces (freshly broken wherever practicable) of bedrock outcrops, talus blocks, disintegrated rock fragments, and stream gravels was employed in spite of the fact that this meant a sacrifice in total coverage and the possibility of not detecting more highly radioactive areas.

As counters available at the time of this investigation were not adequate for a rapid survey of bedrock sources in an area such as the Buckland-Kiwalik district, much of the field work was devoted to the sampling of stream gravels in an attempt to get maximum coverage within this region in the time available. Accordingly, a total of 356 semiconcentrates was collected from stream gravels, not necessarily because of the chance of finding recoverable quantities of uranium minerals in placer deposits, but because of the possibility that the occurrence of radioactive minerals in placers might lead to the discovery of minable lodes which could be studied in detail at a later date. Wherever possible each semiconcentrate was panned from approximately 50 pounds of sand and gravel taken at a depth of from 1 to 3 feet below gravel-bar or stream-bed level, in a selected location where natural concentration of heavy minerals would occur. Thus, with the exception of three sluice-box concentrates, all of these samples represent only the surficial stream gravels and sands. Each semiconcentrate was dried and tested with the counter in the field to determine whether or not further sampling should be done on any given stream.

Seventeen slopewash samples were also collected at various localities where highly weathered rock was exposed. Each slopewash semiconcentrate was panned from about 100 pounds of disintegrated rock material.

The location of the creek gravel and slopewash samples are shown on plate 3.

Laboratory methods

The semiconcentrates mentioned above were concentrated further in the laboratory by floating off the light-weight minerals and rock fragments with bromoform (specific gravity 2.8). The equivalent uranium content of the heavier-than-bromoform fractions (hereinafter referred to as the heavy-mineral fraction) thus obtained were then determined radiometrically. Selected heavy mineral fractions were then studied to determine the radioactive minerals and their associates. The equivalent uranium determinations were made by members of the Geological Survey's Alaskan Trace Elements Unit; the mineralogic studies were made by personnel of the Trace Elements Section Washington Laboratory.

Radioactive minerals

Uranium and thorium minerals identified in samples from the Buckland-Kiwalik district are uranothorianite, thorite, gummite, orangite, and hydrothorite. Allanite, sphene, and zircon and in some samples hematite, garnet, apatite, augite, and altered hypersthene were found to contain minor amounts of uranium and to contribute to the total radioactivity of the samples in which they are found. Detailed descriptions of the more important radioactive minerals are given below.

Uranothorianite.—Uranothorianite is cubical or, in some grains, octahedral in form. Penetration twinning has been noted. The mineral is black with a submetallic luster, an uneven to subconchoidal fracture, and a specific gravity of 9.2. The X-ray diffraction pattern lies between thorianite and uraninite but fits more closely the pattern of thorianite. A spectrographic analysis of uranothorianite from Quartz Creek shows uranium and thorium about equal in amount with no other elements detected. It is possible that this mineral may be uranoan thorianite (Palache, Berman, and Frondel, 1944, p. 621), but until further studies can be made the name uranothorianite (Frondel and Fleischer, 1950, p. 7) will be used. Uranothorianite is the source of most of the radioactivity in the most highly radioactive samples.

Thorite.—Thorite is similar to zircon in form and is lustrous gray. It is isotropic with an index of refraction of about 1.86. X-ray information confirmed the identity of this mineral. A spectrographic analysis of thorite from Quartz Creek showed thorium to be the dominant element with approximately 10 percent uranium and silicon and less than 1 percent iron, lead, zirconium, copper, manganese, and yttrium.

Gummite.—Gummite forms rounded and flattened fragments having a conchoidal fracture. It is brownish yellow and has a dull greasy luster. The mineral probably represents the final stages of oxidation and hydration of uranothorianite although no actual evidence of this has been found in samples from the area. Elsewhere gummite is known to be an alteration product of uraninite or pitchblende.

Orangite.—Orangite is similar to thorite except for its orange-yellow color. It is believed to be an alteration product of thorite.

Hydrothorite.—Hydrothorite forms white opaque fibrous aggregates and is strongly radioactive. This mineral is generally considered to be an alteration product of mackintoshite, but the latter mineral has not been identified in any sample from this area.

Allanite.—Allanite forms black tabular crystals. The radioactivity of this mineral is due mainly to its thorium content although the presence of uranium was detected by sodium fluoride flux tests.

Sphene.—Sphene, which comprises approximately one-third of the volume of many samples, is found in brown wedge-shaped fragments with a resinous luster. In many samples the sphene gives a positive fluorimetric test for uranium.

Zircon.—Zircon forms square prisms and irregular-shaped fragments. Much of the zircon is colorless but pale, yellowish and grayish varieties are abundant in some samples. A large percentage of the zircon contains inclusions, some of which appear to be uranothorianite.

Distribution of radioactive minerals

Laboratory radiometric studies of the heavy mineral fractions of the concentrates from the Buckland-

Kiwalik district found that the heavy fractions of 225 of the 356 concentrates taken contain 0.01 or more percent equivalent uranium. Only 67 of these 225 heavy fractions, however, contain 0.025 percent or more equivalent uranium. Mineralogic studies of selected heavy mineral fractions reveal that minerals containing uranium as an impurity or as inclusions of uraniferous material are more numerous and have a more general occurrence than those minerals which contain uranium as a major constituent. Thus the samples collected within or near the limits of the granitic rock areas show a marked variation in their radioactivity depending on the presence or absence of more than just trace amounts of the uranium minerals, particularly uranothorianite.

Data on the 67 heavy mineral fractions containing 0.025 or more percent equivalent uranium are given in table 5. On plate 3 symbols distinguish the locations of the heavy mineral fractions containing 0.025 or more percent equivalent uranium from those containing less. The data strongly suggest that the major radioactive minerals, especially uranothorianite, are concentrated segregations of accessory minerals from differentiate phases of certain types of the granitic rocks. Whether the so-called radioactive accessories are all primary or in part of late stage or later hydrothermal origin is still a matter of conjecture, although the presence of various metallic sulfides, fluorite, bismuth, and silver in some of the concentrates indicates that some of the uranium may have been introduced after the emplacement of the granitic rocks. Proof of this through observation of actual sites of mineralization, however, has been hampered by the scarcity of bedrock exposures.

The most important localized placer concentrations of the uranothorianite occur in the following areas: the Granite Mountain intrusive; the belt between Connolly Creek and Hunter Creek; and the area south of Clem Mountain. These areas are described below:

Granite Mountain area

Headwaters of the Peace River.—The most promising locality for the occurrence of high-grade uranium ore in the entire Buckland-Kiwalik district is situated along a headwater branch of Peace River in the Granite Mountain intrusive area (pl. 3). The mineralogy and equivalent uranium content of the heavy mineral fractions of three placer samples from this locality are shown in table 6.

Samples 2470 and 2469 were collected in a small right tributary near the head of the left headwater branch of Peace River; sample 2468 was taken a short distance below the mouth of this right tributary in the left headwater branch (pl. 3). The stream from which samples 2470 and 2469 were taken does not exceed 400 yards in length and flows throughout most of its course over tundra and muck. Sample 2470 was panned in the course of this stream at the first place where gravel appears below the divide. The heavy minerals in this concentrate (table 6), as well as in the other samples, indicates that a highly mineralized zone may occur in syenite at or near a syenite-andesite contact, and the mineralized zone, if present, must of necessity be relatively close to the sample location. The presence of gummite, which is somewhat water-soluble, further bears out the belief that the minerals could not have traveled far from their bedrock source. The stream gravels just below sample 2470 were estimated to consist of 60 percent syenite and 40 percent andesite. Although no outcrops are found within this area, the sampling of the placers indicates that the highly mineralized zone is probably confined to an area with a maximum size of about half a square mile. As surface cover does not appear to be deep in this vicinity and the terrain is gently rolling, it is believed that bedrock could be exposed for detailed study by trenching with a bulldozer.

Quartz Creek.—Concentrates ranging from 0.01 to 0.102 percent equivalent uranium were obtained on the northwest slope of Granite Mountain above the headwaters of Quartz Creek and the Kiwalik River (table 5). The occurrence of uranothorianite was traced higher up the mountain slope than had been done in 1946 by Killeen and White (see chapter C). The occurrence of thorite in the Buckland-Kiwalik district appears to be confined largely to this area. No bedrock is exposed in the general vicinity of the sites sampled.

Other localities.—Other localities in the Granite Mountain intrusive area where uranothorianite is present in the placer concentrates collected during the 1947 investigation are as follows:

1. Anzac Creek, a right tributary to Peace River.

2. Boulder Creek, a right tributary to Peace River.

3. Rock Creek, a right tributary to Peace River.

4. The headwater area of the first left tributary to the West Fork of the Buckland River above Bear Creek.

5. The area on the left side of Cub Creek a short distance below the junction of the headwater branches.

6. The northeastern side of Granite Mountain near the head of the middle branch of Cub Creek.

7. The eastern side of Granite Mountain in the vicinity of the right headwater branch of Cub Creek.

8. The south slope of Granite Mountain above the headwaters of Spring Creek.

The last area named produced the only sample (no. 2563) in the Buckland-Kiwalik district which was found to contain hydrothorite. Hydrothorite had been discovered at lower elevation in this same area in 1945 (see chapter A).

Connolly Creek-Hunter Creek area

Samples 2644 and 2645, which contain 0.125 percent and 0.16 percent equivalent uranium respectively, were panned in Muck Creek, a left tributary to Hunter Creek, and show the highest radioactivity of any concentrates taken in the belt between Connolly Creek and Hunter Creek. The minerals with a specific gravity

Table 5.--Data on heavy-mineral fractions[1] of creek placer concentrates containing 0.025 percent or more equivalent uranium from the Buckland-Kiwalik district, Seward Peninsula, 1947

Sample no.	Location	Concentration ratio	eU[2] (percent)
	Granite Mountain area		
2448	Anzac Creek, tributary to Peace River	250:1	0.045
2449	----------do	---	.029
2452	Anzac Creek, left limit-sw[3]	---	.031
2463	Peace River, just below headwater branches	500:1	.025
2464	Peace River, left headwater branch	---	.076
2465	----------do	---	.060
2466	Peace River, left tributary to left headwater branch	---	.044
2467	Peace River, right limit, left headwater branch-sw	---	.061
2468	Peace River, left headwater branch	850:1	.242
2469	Peace River, right tributary to left headwater branch	1,500:1	.76
2470	----------do	750:1	.73
2471	Peace River, left headwater branch	---	.053
2472	----------do	750:1	.026
2482	West Fork, Buckland River, left tributary	700:1	.048
2483	----------do	---	.030
2518	Cub Creek	475:1	.026
2523	Cub Creek, left tributary	---	.031
2524	Cub Creek, left limit-sw	---	.064
2533	Cub Creek, high on slope of Granite Mountain	---	.042
2534	----------do	---	.034
2536	----------do	325:1	.035
2538	Cub Creek, middle branch	---	.032
2539	----------do	775:1	.057
2541	----------do	---	.056
2542	----------do	---	.065
2543	----------do	---	.038
2544	Cub Creek, high on slope of Granite Mountain	375:1	.043
2545	----------do	---	.045
2546	----------do	---	.028
2548	Cub Creek, right tributary, below middle branch	---	.027
2549	Cub Creek, right branch	925:1	.031
2552	----------do	800:1	.041
2553	----------do	---	.036
2560	----------do	425:1	.028
2562	Spring Creek, high on slope of Granite Mountain	---	.033
2570	Kiwalik River, high on slope of Granite Mountain	---	.058
2571	----------do	200:1	.096
2572	----------do	225:1	.102
2574	Quartz Creek, high on slope of Granite Mountain	275:1	.065
2575	----------do	---	.028
2576	----------do	150:1	.097
2577	----------do	200:1	.076
2578	----------do	250:1	.063
	Connolly Creek-Hunter Creek area		
2607	Buck Creek, right tributary	800:1	.025
2631	Connolly Creek, right tributary	1,175:1	.028
2632	----------do	800:1	.040
2633	----------do	1,050:1	.066
2634	----------do	1,675:1	.040
2639	Linda Creek	275:1	.040
2644	Muck Creek	300:1	.125
2645	----------do	350:1	.160
2659	Hunter Creek, Right Fork, right tributary	2,875:1	.027
2677	Hunter Creek, Left Fork, left tributary	---	.048
2683	Spruce Creek	---	.027
2685	----------do	325:1	.033

See footnotes at the end of table, p. 26

Table 5.--Data on heavy mineral fractions[1] of creek placer concentrates containing 0.025 percent or more equivalent uranium from the Buckland-Kiwalik district, Seward Peninsula, 1947--Con.

Sample no.	Location	Concentration ratio	eU[2] (percent)
	Clem Mountain area		
2728	West Clem Creek	---	0.106
2730	Duck Creek, right tributary	325:1	.056
2731	do	---	.034
2732	do	900:1	.030
2750	East Clem Creek	1,125:1	.040
2752	do	2,400:1	.030
2753	do	800:1	.045
2755	Buckland River, left tributary	3,425:1	.037
2756	do	1,900:1	.027
	Fairhaven Creek area		
2800	Sugar Loaf Creek, left limit-sw	6,875:1	.050
2801	Sugar Loaf Creek	2,525:1	.026
2805	do	2,000:1	.025
2806	do	1,275:1	.025
2815	Fairhaven Creek, left tributary	---	.026
2819	Scotch Creek	---	.030

[1] Greater than 2.8 specific gravity.
[2] Equivalent uranium.
[3] sw indicates concentrate was obtained from slopewash rather than creek gravels.

Table 6.--Mineralogy and equivalent uranium content of three concentrate samples from gravels in the headwaters of the Peace River, Seward Peninsula, 1947

Minerals	Estimated volume percent of minerals present		
	Sample 2470 (eU 0.73)[1]	Sample 2469 (eU 0.76)[1]	Sample 2468 (eU 0.242)[1]
Garnet	40	X[2]	50
Hornblende	20	X	1
Augite	10	-	tr
Sphene	13	X	7
Zircon	6	X	4
Thorite	tr[3]	-	-
Wollastonite	tr	-	-
Epidote	-	X	tr
Hypersthene	-	X	-
Apatite	-	-	1
Powellite	-	-	tr
Spinel	-	X	-
Picotite	1	-	tr
Ilmenite	1	-	-
Hematite	1	X	tr
Limonite	-	-	tr
Magnetite	-	-	12
Chromite	tr	-	-
Corundum	-	X	-
Uranothorianite	2	X	tr
Gummite	tr	-	-
Pyrite	3	X	25
Chalcopyrite	1	X	-
Bornite	tr	-	-
Molybdenite	-	-	tr
Gold	tr	X	-
Silver	tr	-	-
Bismuth	tr	-	-

[1] Equivalent uranium content in percent.
[2] X indicates presence of mineral in sample, amount not determined.
[3] tr - trace.

greater than 2.8 in these two samples are listed below in order of decreasing abundance.

Garnet	Powellite
Hornblende	Ilmenite
Augite	Hematite
Sphene	Limonite
Zircon	Magnetite
Epidote	Uranothorianite
Apatite	Pyrite
Scheelite	

The uranothorianite in the above list contains most of the radioactive elements in the two samples. Uranothorianite was also found in samples 2633 (0.066 percent equivalent uranium) and 2634 (0.040 percent equivalent uranium) in the headwater area of the first right tributary to Connolly Creek above the latter's mouth at Hunter Creek; and both uranothorianite and gummite were identified in sample 2865 (0.033 percent equivalent uranium) in the headwaters of Spruce Creek, a left tributary to the Left Fork of Hunter Creek. No bedrock outcrops were found in the vicinity of any of these samples.

Clem Mountain area

Sample 2728 (0.106 percent equivalent uranium) is the most radioactive sample from the area immediately south of Clem Mountain (pl. 3). It was taken at shallow depths near the head of West Clem Creek, a right tributary to Duck Creek. Other than sphene and zircon, uranothorianite is the only radioactive mineral in this sample. Sample 2730 (0.056 percent equivalent uranium), taken on the second right tributary to Duck Creek above West Clem Creek, and samples 2752 (0.030 percent equivalent uranium), 2753 (0.045 percent equivalent uranium), and 2754 (0.019 percent equivalent uranium) collected in the headwaters of East Clem Creek, a tributary to the Buckland River, were the only other samples in this area in which uranothorianite was identified. A trace of thorite was found also in sample 2752. Because of the depth of snow cover and the arrival of the freeze-up, field work had to be terminated in this area south of Clem Mountain before this phase of the investigation could be completed.

Other areas

The only other known occurrence of uranothorianite in the Buckland-Kiwalik district outside of the general boundaries of the three major areas discussed above is in sample 2788 (0.014 percent equivalent uranium) which was collected in the headwater of Meinzer Creek, a left tributary to Fairhaven Creek. In the same general area a trace of orangite was identified in sample 2801 (0.026 percent equivalent uranium) which was panned in Sugar Loaf Creek, a left tributary to Fairhaven Creek, and thorite was found in sample 2802 (0.023 percent equivalent uranium) from the same stream.

CONCLUSIONS

Although radioactive minerals are widely distributed in the Buckland-Kiwalik district, the more important of these minerals, such as uranothorianite and thorite, occur for the most part in rather well defined placer zones within the granitic rock areas. It is believed, therefore, that these latter minerals are segregated accessories in differentiate phases of the granitic rocks. However, the presence of various metallic sulfides, fluorite, bismuth, and silver along with the uranothorianite in a number of the concentrates suggests that some of the uranium may have been introduced after the emplacement of the granitic rocks during a period of hydrothermal alteration.

The local concentration of uranothorianite in the placers at the head of Peace River is believed to be the best lead to a possible high-grade uranium lode deposit on the basis of equivalent uranium content and mineral association.

CHAPTER E.--HEADWATERS OF THE PEACE RIVER, 1951

By W. S. West

ABSTRACT

Reconnaissance in 1947 found uranothorianite and gummite associated with copper sulfides, iron oxides, molybdenite, gold, silver, bismuth, and thorite in placers of a headwater tributary of the Peace River in the eastern part of the Seward Peninsula, Alaska. The concentrates from these placers contain as much as about 0. 8 percent equivalent uranium, or about ten times the equivalent uranium content of the average uranothorianite-bearing concentrates from other placers in the eastern Seward Peninsula.

Brief radiometric reconnaissance early in the summer of 1952 failed to locate the bedrock source of the radioactive minerals at the head of the Peace River, primarily because of the shielding-effect of widespread tundra cover. The samples obtained in 1952 indicate the presence of galena, sphalerite, pyrrhotite, covellite, and fluorite in addition to the minerals reported in the results of the 1947 reconnaissance. In these samples the intimate association of pyrite, sphalerite, chalcopyrite, and galena in discrete grains in the placers, but not in the granite country rock, indicates a possible lode source for the sulfides. Gummite, believed to be a decomposition product of the uranothorianite, occurs in mineral grains with tetradymite, galena, and pyrite; this also suggests that the uranium minerals occur along with the sulfides in a lode deposit, possibly a vein, which is located somewhere in an area of about one-half square mile lying upstream from the topographically highest placer sample.

INTRODUCTION

Reconnaissance for radioactive deposits in the Buckland-Kiwalik district (pl. 3) of the Seward Peninsula, Alaska, in 1947 (see chapter D) found significant amounts of uranothorianite in concentrates from placers in the headwaters of the Peace River (pl. 3 and fig. 4). These concentrates contain from about 0. 2 to about 0. 8 percent equivalent uranium or about 10 times the equivalent uranium content of the average uranothorianite-bearing concentrates obtained at other localities in the eastern part of the Seward Peninsula. In addition to uranothorianite these concentrates contain gummite, thorite, hematite, limonite, powellite, pyrite, chalcopyrite, bornite, molybdenite, gold, silver, bismuth, and other heavy minerals—the last, for the most part, are common accessory minerals of granitic rock (see chapter D). The gummite is probably an alteration product of the uranothorianite. The placers from which these concentrates were obtained lie near a granite-andesite contact in a restricted drainage basin. The locations of the samples were such as to limit the source area of the radioactive minerals to a maximum size of about one-half square mile. The presence of gummite, which is somewhat water soluble, further bears out the belief that the heavy minerals in these placers could not have traveled far from their bedrock source. A low-grade copper sulfide lode has been reported (Smith and Eakin, 1911, p. 135) in granite also in the headwaters of the Peace River.

For about one week early in the summer of 1952 Walter S. West, geologist, and Arthur E. Nessett, camp assistant, conducted a brief reconnaissance in the headwaters of the Peace River in an attempt to discover the bedrock source of the uranothorianite and associated sulfide minerals. Radiometric traverses in the area were made with a 2- by 20-inch gamma tube attached to a commercial model of a portable survey meter. Trenches and test pits were dug by hand to expose bedrock for further radiometric tests and collection of samples. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOLOGIC SETTING

The bedrock in the headwaters of the Peace River consists of andesitic rocks of pre-Cretaceous age, and granitic rocks and dikes of Early Tertiary age (fig. 4). The formation contacts shown on figure 4 are only tentative as much of the area is covered by tundra. It is evident that the Peace River tributary, which contains the more radioactive placers, flows across or near an andesite-granite contact, because both rock types occur in about equal amounts in the creek gravels (see chapter D).

Much of the headwaters area of the Peace River is covered by tundra. Because heavy mechanical trenching equipment was not available during the period of this reconnaissance in 1951, a total of 16 test pits or trenches, ranging in depth from $1\frac{1}{2}$ to $8\frac{1}{2}$ feet were dug by hand in an effort to expose bedrock for examination. Bedrock was reached in only four of the pits; in the remainder, excessive flow of ground water or frozen ground prevented the exposure of bedrock.

The granite exposed in the four pits is highly weathered. Networks of heavily iron-stained veins with a maximum width of 3/4 inch are prominent in the granite of two of the pits.

RADIOMETRIC AND MINERALOGIC STUDIES

Radiometric traversing in the headwaters of the Peace River was found to be impractical because the rather widespread tundra cover effectively shields any possible radiation from underlying rocks. The description and radioactivity of the samples taken from the testpits mentioned above are presented in table 7; the locations of these samples are indicated on figure 4. The mineralogic composition of the samples is given in table 8. The radioactive minerals in

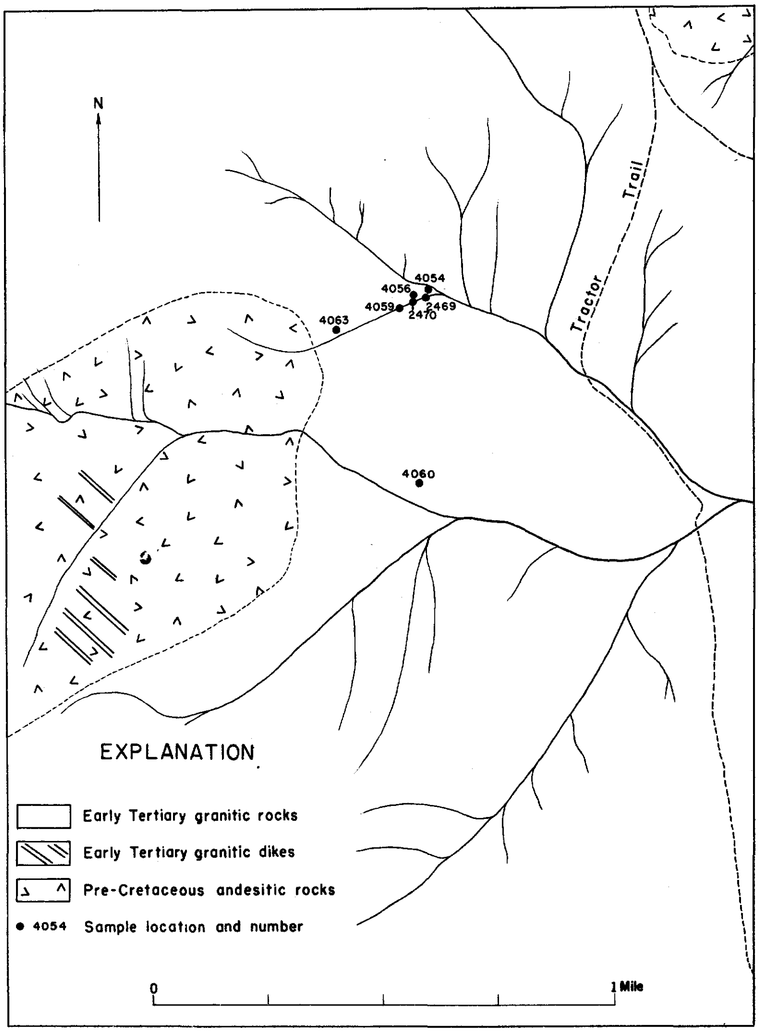

Figure 4.--Sketch map of the headwaters of the Peace River, Seward Peninsula, Alaska

the concentrates from the creek gravels (samples 2469, 2470, and 4059) are uranothorianite, gummite, thorite, sphene, and zircon.

In sample 4059 some of the sulfide mineral grains are intergrowths of galena, sphalerite, chalcopyrite, and pyrite. In a few grains gummite appears to be intergrown with either tetradymite, or pyrite, or galena.

CONCLUSIONS

The brief reconnaissance in 1952 failed to find the source of the uranothorianite and associated sulfide minerals which occur in the placers of one of the headwater tributaries of the Peace River. However, the additional mineralogic data obtained support an hypothesis that the major radioactive minerals in these placers, namely uranothorianite and gummite, have their ultimate source in a lode within a restricted drainage basin above the highest point of the placers sampled. The mineralogic data, and the conclusions drawn therefrom, in support of the lode hypothesis are as follows:

1. The occurrence of sphene and zircon, but <u>not</u> uranothorianite, gummite, and thorite, in the heavy mineral suites of the granite samples; this tends to deemphasize the theory that the uranothorianite is an accessory mineral in granite, at least in the vicinity of the headwaters of the Peace River.

2. The presence of intergrowths of galena, sphalerite, chalcopyrite, and pyrite as discrete mineral grains in the placers, but not in the granite country rock, suggests a vein source for these minerals.

3. The intimate relationship of gummite with such minerals as pyrite, galena, and tetradymite leads to the belief that the uranothorianite, from which the gummite was probably derived, occurs in a lode deposit, possibly a vein, in association with the various sulfide minerals. However, the possibility exists that other primary uranium oxide minerals may occur in the area, as gummite is known elsewhere as an alteration product of uraninite or pitchblende.

Table 7.--Description and equivalent uranium content of samples taken in the vicinity of the headwaters of the Peace River, Seward Peninsula

Sample no.	Description	eU[1] content (percent)
2469	Concentrate from stream gravel (obtained by panning and further concentrated in laboratory with bromoform--sp gr 2.8).	0.76
2470	-----------do-----------	.73
4054	Weathered iron-rich vein material with some granitic wall rock, weathered-----	.004
4056	-----------do-----------	.005
4059	Concentrate from stream gravel (obtained by panning)-----------	.25
4060	Granite, weathered-----------	.006
4063	-----------do-----------	.003

[1]eU-equivalent uranium; analyses of samples made by members of the Alaskan Geology Branch, Trace Elements Unit.

Table 8.--Mineral composition of heavy-mineral fractions of samples taken in the vicinity of the headwaters of the Peace River, Seward Peninsula.

[Heavy-mineral fractions of samples 2469 and 2470 are greater than 2.8 sp gr; those of samples 4054, 4056, 4059, 4060, and 4063 are greater than 3.3 sp gr. Analyses of samples 2469 and 2470 previously reported (in chapter D); other analyses by the author]

Minerals	Sample 2469	Sample 2470	Sample 4054	Sample 4056	Sample 4059	Sample 4060	Sample 4063
	Estimated volume percent of minerals present						
Augite----------------	--	10	--	--	--	--	--
Biotite---------------	--	--	--	--	--	--	tr
Bismuth---------------	--	tr	--	--	--	--	--
Bornite---------------	--	tr	--	--	--	--	--
Chalcopyrite----------	X[1]	1	--	--	1	--	--
Chromite--------------	--	tr	--	--	--	--	--
Covellite-------------	--	--	--	--	tr	--	--
Epidote---------------	X	--	--	--	2	--	--
Fluorite--------------	--	--	--	--	--	tr	--
Galena----------------	--	--	tr	2	tr	--	--
Garnet----------------	X	40	--	--	30	--	6
Gold------------------	X	tr	--	--	tr	--	--
Gummite---------------	--	tr	--	--	tr	--	--
Hematite--------------	X	1	2	--	tr	tr	--
Hornblende------------	X	20	--	--	--	--	--
Hypersthene-----------	X	--	--	--	--	--	--
Ilmenite--------------	--	1	--	--	tr	--	--
Limonite--------------	--	--	5	tr	tr	--	--
Magnetite-------------	--	--	60	45	15	45	60
Olivene---------------	--	--	--	--	2	--	--
Picotite--------------	--	1	--	--	--	--	--
Powellite-------------	--	--	--	--	1	--	--
Pyrite----------------	X	3	20	50	4	tr	tr
Pyrrhotite------------	--	--	--	--	1	--	3
Rock minerals[2]--------	--	--	10	--	15	30	10
Scheelite-------------	--	--	1	1	--	tr	2
Silver----------------	--	tr	--	--	--	--	--
Sphalerite------------	--	--	--	--	tr	--	--
Sphene----------------	X	13	2	2	15	20	20
Spinel----------------	X	--	--	--	2	--	--
Tetradymite-----------	--	--	tr	--	tr	tr	tr
Thorite---------------	--	tr	--	--	tr	--	--
Uranothorianite-------	X	2	--	--	1	--	--
Wollastonite----------	--	tr	--	--	--	--	--
Zircon----------------	X	6	tr	tr	.11	5	--

[1]X indicates mineral present, amount not determined.
[2]Mostly augite and hornblende, may include some hypersthene.

4. The known occurrence of metalliferous lodes (see chapter D) both near the head of the Peace River and in the valley of Bear Creek, a few miles to the north, indicates that lode concentrations of ore minerals other than those with uranium and thorium have formed in the area and that it is conceivable the uranothorianite and gummite are associated in a lode deposit with the copper and other sulfides at the head of the Peace River.

RECOMMENDATIONS FOR PROSPECTING

To prospect further for a possible lode source of the radioactive minerals found in placers near the head of the Peace River in the eastern part of the Seward Peninsula, the following steps are suggested:

A series of short bulldozer trenches should be cut across the main drainage line of the right tributary of the left headwater branch of the Peace River. The trenches should be cut into bedrock at right-angles to the streamflow and spaced at intervals of about 500 feet upstream beginning at the location of sample 4059 (fig. 4). Similar concentrates should be taken from the gravels directly overlying the bedrock, that is, the same volume of gravels should be concentrated to equivalent smaller volumes. These concentrates should then be examined both radiometrically and mineralogically, in order to determine between which two 500-foot trenches the source of the uranothorianite, gummite, and sulfide minerals occurs. The bedrock in each of the trenches should also be checked for radioactivity to determine whether a trench has exposed, by coincidence, the possible lode source.

If the source of the radioactive minerals can be narrowed down to the 500-foot interval between two trenches, the trenching plan to be followed would be such as to narrow down the location still further, possibly by additional short trenches perpendicular to the streamflow or by cutting one long trench along the creek bed parallel to the streamflow, beginning at the downstream end of the 500-foot interval. Should a lode source of the radioactive minerals be located, and should its size and grade at the surface be of such to warrant additional investigation, underground exploration, such as diamond drilling or exposing by shaft-sinking, would of course be necessary.

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