UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

GEOLOGICAL SURVEY CIRCULAR 195

RADIOACTIVITY OF SELECTED ROCKS AND PLACER CONCENTRATES FROM NORTHEASTERN ALASKA

By Max G. White

This report concerns work done on behalf of the U. S. Atomic Energy Commission and is published with the permission of the Commission.

Washington, D. C., 1952

Free on application to the Geological Survey, Washington 25, D. C.

RADIOACTIVITY OF SELECTED ROCKS AND PLACER CONCENTRATES FROM NORTHEASTERN ALASKA

CONTENTS

ILLUSTRATIONS

TABLES

PART 1.--RADIOACTIVITY IN GNEISSIC GRANITE OF THE MOUNT MICHELSON AREA, NORTHEASTERN ALASKA

ABSTRACT

Radiometric examination of 13 samples collected in the Mount Michelson area, northeastern Alaska, in 1948, shows that four samples of gneissic granite contain an average of 0.007 percent equivalent uranium. The heavy-mineral fractions from three of these four samples contain an average 0.052 percent equivalent uranium and 0.03 percent uranium. The heavy-mineral fractions of panned concentrates from gravels of streams draining relatively large areas of granitic rock, contain an average of 0.028 percent equivalent uranium, whereas similar heavy fractions of panned concentrates from streams that drain areas other than those largely underlain by granitic rock contain an average of only 0.005 percent equivalent uranium.

Mineralogic study of all heavy-mineral fractions having more than 0.01 percent equivalent uranium indicates that the radioactive material apparently is confined to biotite, which in one sample contains 1.19 percent uranium. Fluorite, hematite, zircon, sphene, galena, and molybdenite, commonly associated elsewhere with uranium, apparently are disseminated in the granite with the biotite.

The presence of uranium in the biotite of the granite and, of other minerals associated with uranium elsewhere, suggests that this area should be considered in relation to others in Alaska as a possible locality to search for high-grade uranium deposits.

INTRODUCTION

On the latest geologic map of Alaska, compiled by Smith (1939, pl. 1),[1] three areas of intrusive rocks are shown in northeastern Alaska on the north flank of the Brooks Range. These areas are as follows:

1) On the international boundary about 30 miles south of the Arctic coast (fig. 1).

[1] See references cited.

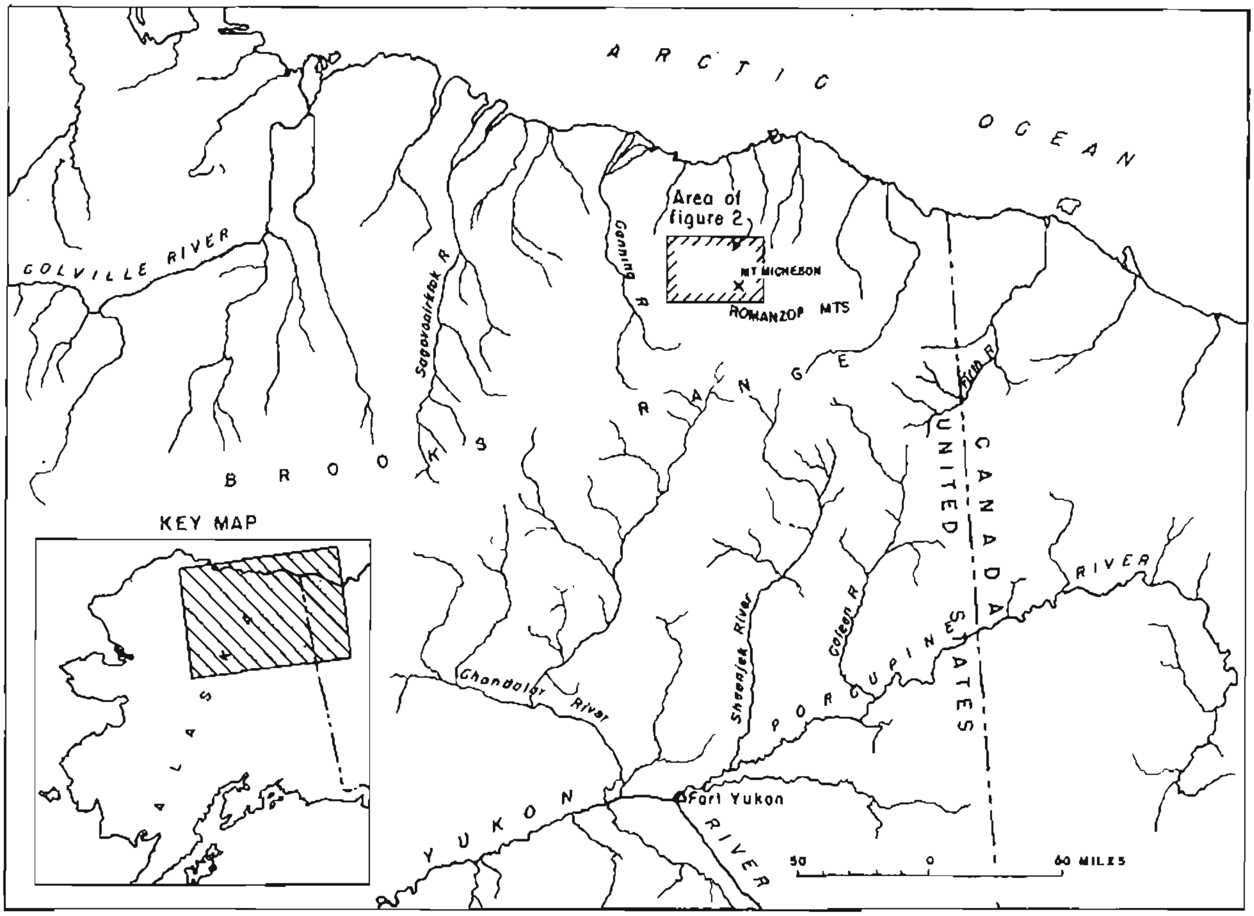


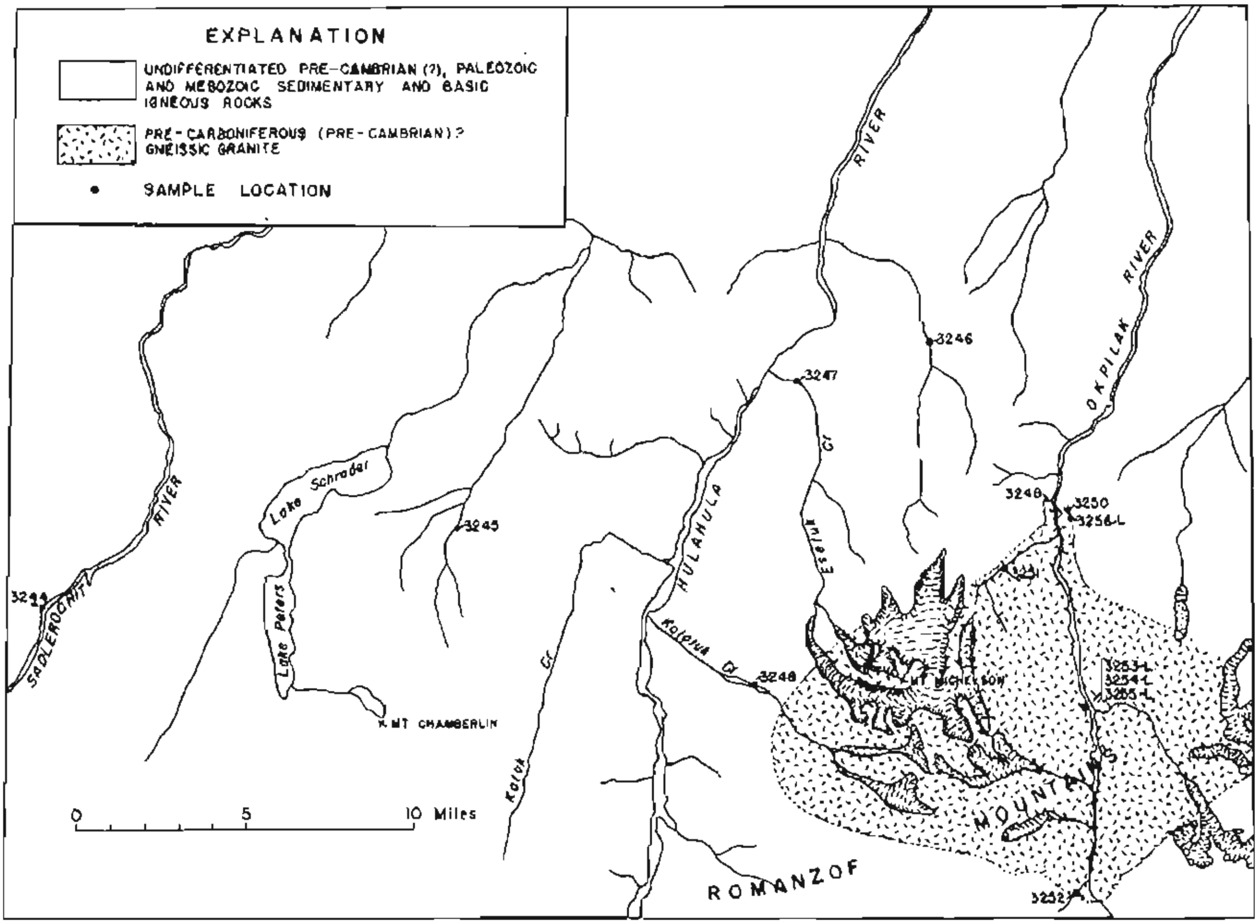
Figure 1.--Map of northeastern Alaska showing location of the Mount Michelson area.

2) In the vicinity of Mount Michelson about 80 miles west of the international boundary (figs. 1, 2).

3) In the vicinity of Mount Chamberlain about 15 miles west of Mount Michelson (fig. 2).

The presence of granite in areas (1) and (3) listed above is uncertain. Its presence has been confirmed by recent field investigations only in the vicinity of Mount Michelson, area (2), (Whittington and Sable, 1948, unpublished report, pp. 14-16, and fig. 1; Payne and others, 1951) . A. G. Maddren, the only Survey geologist to work along the northern part of the international boundary, indicates in his unpublished notes and maps that the rocks in area (1) are tuffs and agglomerates. The area around Mount Chamberlain (fig. 2), originally mapped by Leffingwell (1919, pl. 2) as granite(?), was found by Whittington and Sable (1948, fig. 1) to consist instead of pre-Cambrian(?) schists of the Neruokpuk formation. In the Mount Michelson area, however, the work by Whittington and Sable corroborated the occurrence of intrusive rock as mapped by Leffingwell (1919, pp. 126-128, and pl. 2). It is thus the only verified occurrence of intrusive rock in northeastern Alaska on the north flank of the Brooks Range.

Following the field season of 1948, Whittington turned over to the author a collection of 13 samples from the Mount Michelson area (fig. 2). The purpose of this report is to present the results of the radiometric and mineralogic studies of these samples. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.



Geology and base from maps by U.S. Geological Survey Navy Oil Unit

Figure 2.--Sketch map of the Mount Michelson area, northeastern Alaska.

GEOLOGY

The gneissic granite at Mount Michelson is commonly gray and coarse-grained. According to Whittington and Sable (1948, unpublished report, pp. 14-15) the granite

> "seems to be made up of several different granites. The granite which is apparently most common is gray in color. In general the granites are composed of quartz, white feldspars, and minor amounts of dark minerals. Quartz probably averages 25 percent with feldspars contributing the bulk of the remainder. The feldspars are mostly white in color, but pink feldspar was seen in float. In a number of hand specimens two different white feldspars were tentatively differentiated. Although the dark minerals are generally a minor constituent, in a few cases they were found to comprise a considerable percentage, 30 to 50 percent, of the rock. The dark mineral or minerals have been mostly altered to chlorite. In a few cases biotite was found with a chlorite outline. Feldspar phenocrysts are present in some of the rock. Outcrops of granite containing phenocrysts were found near the north edge of the mass. Erratics bearing phenocrysts are common, and many of them have come from other parts of the mass. In general, the phenocrysts are one to one and one-half inches long, but some have been seen up to six inches in length. The phenocrysts are usually fractured, often showing two sets of fractures approximately at right angles.
>
> "Inclusions and segregations were seen only in outcrops along a creek which flows from the west into the Okpilak River near

the north edge of the granite mass. The inclusions are generally angular, but the corners are rounded and the edges minutely scalloped, suggesting absorption of some of the rock by the including magma. Both light and dark colored inclusions were found. They are generally finer-grained than the including rock and are thought to be entirely igneous. One dark colored inclusion contained a light colored inclusion. Another dark inclusion contained feldspar phenocrysts. Segregations seen apparently consist of small masses of biotite which have been concentrated into layers."

In places the granite grades into the schist and phyllite of the Neruokpuk formation of pre-Cambrian(?) age (Payne and others, 1951). A gneissic structure is characteristic of the granite, but is not universally present and varies considerably in degree of development. Where the granite grades into the schist, the gneissic structure becomes more intense and passes into the foliation of the Neruokpuk formation. On the basis of the gneissic structure, the apparent lateral gradation into schist, and the unmetamorphosed condition of adjacent Carboniferous limestone, the granite of the Mount Michelson area is considered to be at least pre-Carboniferous(?) (Payne and others, 1951). If this granite is as old as pre-Cambrian, it may be related to the Pelly gneiss of the Yukon-Tanana region (Mertie, 1937, pp. 201-203).

RADIOACTIVITY AND MINERALOGY

The 13 samples from the Mount Michelson area consisted of four specimens of the granite bedrock along the Okpilak River, seven panned concentrates from gravels of streams in the immediate vicinity of Mount Michelson, and two panned concentrates from stream gravels of the Sadlerochit River and one of its tributaries west of Mount Michelson (fig. 2). The four rock samples were crushed to minus-20 mesh and analyzed radiometrically. They were then fractionated with bromoform (sp gr 2.8). The nine panned concentrates from stream gravel also were sized to minus-20 mesh and fractionated with bromoform. The bromoform-heavy fractions of both the crushed rock samples and panned concentrates were then analyzed radiometrically. The bromoform-heavy fractions of three of the rock samples were analyzed for uranium fluorometrically. Table 1 gives the data on the 13 samples. Mineralogic studies were made of all the heavy-mineral fractions containing more than 0.01 percent equivalent uranium (eU). Table 2 shows the mineral composition of these radioactive heavy-mineral fractions.

The four samples of gneissic granite bedrock contain an average of 0.007 percent equivalent uranium. The heavy-mineral fractions of three of these four samples contain an average of 0.052 percent equivalent uranium and 0.03 percent uranium. Thus by concentrating the heavy minerals of the granite by a ratio of about 30:1 approximately a seven-fold increase in the equivalent uranium content is obtained, of which about 60 percent is uranium.

On the basis of the radiometric data on the panned-concentrate samples, it appears obvious that the radioactive material comes from the granite, as all samples from gravels of the streams draining large sectors of the granitic area have a relatively large equivalent uranium content (samples 3248, 3249, and 3251, fig. 2 and table 1). The equivalent uranium content decreases considerably in other sectors even where the watershed of the stream contains a small amount of granitic rock.

The radioactivity of all the samples investigated mineralogically appears to be entirely in the biotite. X-ray studies of selected grains of this mineral from sample 3253-L show a mixed pattern with major biotite-phlogopite(?) lines. Spectrographic analysis of the biotite indicates the presence of silicon, calcium, iron, aluminum, magnesium, lanthanum, zirconium, and rare earths. A fluorimetric test shows that the biotite from sample 3253-L contains 1.19 percent uranium. Minerals such as fluorite, hematite, molybdenite, galena, zircon, and sphene (table 2), commonly associated with radioactive materials elsewhere, apparently are disseminated in the gneissic granite with the biotite, although the fluorite and molybdenite suggest either pegmatitic or hydrothermal conditions.

CONCLUSIONS

Radiometric and mineralogic study of four bedrock samples and nine panned-concentrate samples from the Mount Michelson area of northeastern Alaska shows that uranium is associated with biotite in the pre-Carboniferous(?) gneissic granite of the area. Fluorite, hematite, molybdenite, galena, and other minerals, associated with uranium elsewhere, also occur in the granite. These occurrences suggest that this area should be considered in relation to others in Alaska as a possible source of high-grade deposits of uranium.

REFERENCES CITED

Leffingwell, E. de K., 1919, The Canning River region, northern Alaska: U. S. Geol. Survey Prof. Paper 109.

Mertie, J. B., Jr., 1937, The Yukon-Tanana region, Alaska: U. S. Geol. Survey Bull. 872.

Payne, T. G., and others, 1951, Geology of the Arctic Slope of Alaska: U. S. Geol. Survey Oil and Gas Investigations, Map OM 126.

Smith, P. S., 1939, Areal geology of Alaska: U. S. Geol. Survey Prof. Paper 192.

Whittington, C. L. and Sable E. G., 1948, Preliminary report on the geology of the Sadlerochit River area [Alaska]: U. S. Geol. Survey Geological Investigations, Naval Petroleum Reserve no. 4, Alaska, (report in files of U. S. Geol. Survey).

Table 1.--Data on samples from the Mount Michelson area, northeastern Alaska

Sample no.	Location (see fig. 2)	Crushed bedrock eU (percent)	Heavy-mineral fraction[1]		Concentration ratio[2]
			eU (percent)	U (percent)	
	Bedrock samples				
3253-L	Left limit of Okpilak River about midway between northern and southern edges of intrusive mass.	0.007	0.080	0.033	40:1
3254-L	-do-	.007	.034	.010	18:1
3255-L	-do-	.008	.043	.046	36:1
3256-L	Right limit of Okpilak River at northern edge of intrusive mass.	.005	.008	--	10:1
	Panned-concentrate sample				
3244	Sadlerochit River about 7 miles southwest of Lake Schrader.	--	.006	--	2,600:1
3245	Tributary of Sadlerochit River about 3 miles southeast of Lake Schrader.	--	.004	--	5,100:1
3246	East tributary of Hulahula River about 5 miles upstream from junction with Hulahula River and about 10 miles north of Mount Michelson.	--	.002	--	4,400:1
3247	Esetuk Creek about 1 mile upstream from junction with Hulahula River and about 8 miles downstream from granite contact.	--	.013	--	4,000:1
3248	Kolotuk Creek about 4 miles upstream from junction with Hulahula River and about 1 mile downstream from granite contact.	--	.030	--	5,300:1
3249	Small tributary on west side of Okpilak River just downstream from north edge of granite.	--	.030	--	7,500:1
3250	Small tributary on east side of Okpilak River at contact of granite and limestone.	--	.005	--	10,000:1

Table 1.--Data on samples from the Mount Michelson area, northeastern Alaska--Continued

Sample no.	Location (see fig. 2)	Crushed bedrock eU (percent)	Heavy-mineral fraction		Concentration ratio[2]
			eU (percent)	U (percent)[1]	
Panned-concentrate sample--Continued					
3251	West tributary of Okpilak River, about 2 miles upstream from junction with Okpilak River; near north edge of granite.	--	.040	--	10,000:1
3252	West fork of Okpilak River, about 3/4 mile upstream from junction of forks; near south edge of granite where it is in contact with the Neruokpuk formation.	--	.007	--	2,500:1

[1]Determined fluorometrically by the Geological Survey Laboratory.

[2]Concentration ratio is ratio between original material and heavy-mineral fraction.

Table 2.--Mineral composition[1] of heavy-mineral fractions containing more than 0.01 percent equivalent uranium, Mount Michelson area, northeastern Alaska

[Minerals are listed in order of decreasing abundance. Asterisk(*) indicates trace only]

3247	3248	3249	3251	3253-L	3254-L	3255-L
Biotite	Biotite	Biotite	Biotite	Biotite	Biotite	Fragments of quartz with biotite, muscovite, pyrite, and magnetite.
Chlorite	Chlorite	Hematite	Garnet	Muscovite	Muscovite	Muscovite
Muscovite	Muscovite	Pyrite	Muscovite	Pyrite (with hematite coating)	Yttrocerite(?)	Biotite
Epidote	Yttrocerite(?)	Ilmenite	Chlorite	Yttrocerite(?)	Fluorite	Pyrite (with hematite coating)
*Fluorite	Fluorite	Zircon	Tourmaline	Fluorite	Chlorite	Magnetite
*Zircon	Magnetite	*Zoisite	Yttrocerite(?)	*Garnet	Magnetite	
*Hematite		*Magnetite	Fluorite	*Chlorite		
		*Sphene	Pyrite	*Magnetite		
		*Brookite	*Zircon	*Molybdenite		
		*Scheelite	*Hematite			
			*Galena			

[1]Analyses by K. Onada, Geological Survey Laboratory.

PART 2.--RADIOACTIVITY AND MINERALOGY OF PLACER CONCENTRATES FROM THE WISEMAN AND CHANDALAR DISTRICTS

ABSTRACT

Radiometric and mineralogic study of 19 placer concentrates revealed the presence of monazite on Rye Creek in the Wiseman district and on several creeks northeast of Chandalar Lake in the Chandalar district, upper Yukon region, northeastern Alaska. Uranium-bearing thorianite(?) occurs on the South Fork of the Koyukuk River at Gold Bench and vicinity in the Wiseman district.

The radioactive minerals are almost always associated in the placers with hematite and several of the metallic sulfides. Such association may indicate the possible occurrence of primary uranium ores with hematitic alteration within the drainage basins of the streams where the radioactive minerals are found. Selected areas in the vicinity of the radioactive mineral occurrences in the Wiseman and Chandalar districts might contain primary uraniferous deposits.

INTRODUCTION

The Wiseman and Chandalar districts, upper Yukon region, are located in northeastern Alaska north of the Yukon River and south of the Brooks Range (fig. 3). The Wiseman district includes all the headwater drainage of the Koyukuk River from a point about 25 miles downstream from Bettles at the confluence of the North and South Forks. The Chandalar district includes all the drainage of the Chandalar River from a point about 50 miles above its junction with the Yukon River (fig. 3).

The purpose of this report is to present the results of the radiometric and mineralogic study of 19 samples from the Wiseman and Chandalar districts which are available in the Geological Survey's Alaskan collection. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

DISCUSSION OF DATA

Wiseman district

Only generalized information is available on the geology of the Wiseman district (fig. 4), the best and most recent being that obtained by Maddren (1913). Maddren's report is accompanied by a topographic and geologic map on a scale of 1:500,000. Placer-gold mining has been conducted in many areas within this district since the early part of the century. The ten samples available from the Wiseman district are from several localities within some of the mining areas of the district. The data on the samples from the Wiseman district are summarized in table 3.

Only three samples from the Wiseman district show a significant amount of radioactivity. The radioactivity of the sample from Rye Creek (no. 1358, table 3 and fig. 4) is attributed to a trace of monazite which was not found in the other sample from the same creek (no. 1359, table 3 and fig. 4). Traces of pyrite, chalcopyrite, galena, scheelite, and gold are significant associates of the monazite.

The radioactivity of the samples from Gold Bench and vicinity on the South Fork of the Koyukuk River (nos. 1151 and 1648, table 3 and fig. 4) is ascribed to traces of uranium-bearing thorianite(?) which occurs as minute cubes and fragments in the minus 100-mesh portion of the nonmagnetic fraction of the concentrate. Hematite and traces of bismuthinite(?), chalcopyrite, cinnabar, galena, cassiterite, and scheelite are associated with the uranium-bearing thorianite(?).

Gold Bench, according to Maddren (1913, pp. 105-107), is a deposit of high-stream gravels situated on the northeast side of the South Fork of the Koyukuk River with the gold-bearing gravels lying on top of thick unconsolidated wash deposits. Ironside Bar, possibly the source of sample 1151, is similar to Gold Bench but lies on the south side of the Fork about a mile above Gold Bench. Gold Bench is about 30 miles south of the settlement of Wiseman (fig. 4).

Chandalar district

The geology of the Chandalar district has been discussed briefly by Maddren (1913) and in some detail by Mertie (1925). The placer-mining operations in the district are located largely on creeks a short distance northeast of Chandalar Lake (fig. 5). Of the nine samples available from the Chandalar district for study only two (nos. 2253 and 2254, table 4 and fig. 5) are probably representative of the heavy sands in the placers. The others appear to be splits from the heavy sands and carry a concentration of only one or two minerals in an amount that is probably not representative of the minerals as they occur in the placers. The data on the samples from the Chandalar district are summarized in table 4.

Monazite is probably the main radioactive mineral in the samples from the Chandalar district (table 4). Hematite, scheelite, gold, and a trace of galena are associated with the monazite on Tobin Creek. On Big Creek these same minerals and arsenopyrite and chalcopyrite are associated with the monazite. Mertie (1925, p. 282) reports the occurrence of arsenopyrite, pyrite, stibnite, galena, sphalerite, and siderite in gold-quartz veins in a mineralized area at the head of Little Squaw, Boulder, Tobin, and Big Creeks (fig. 5).

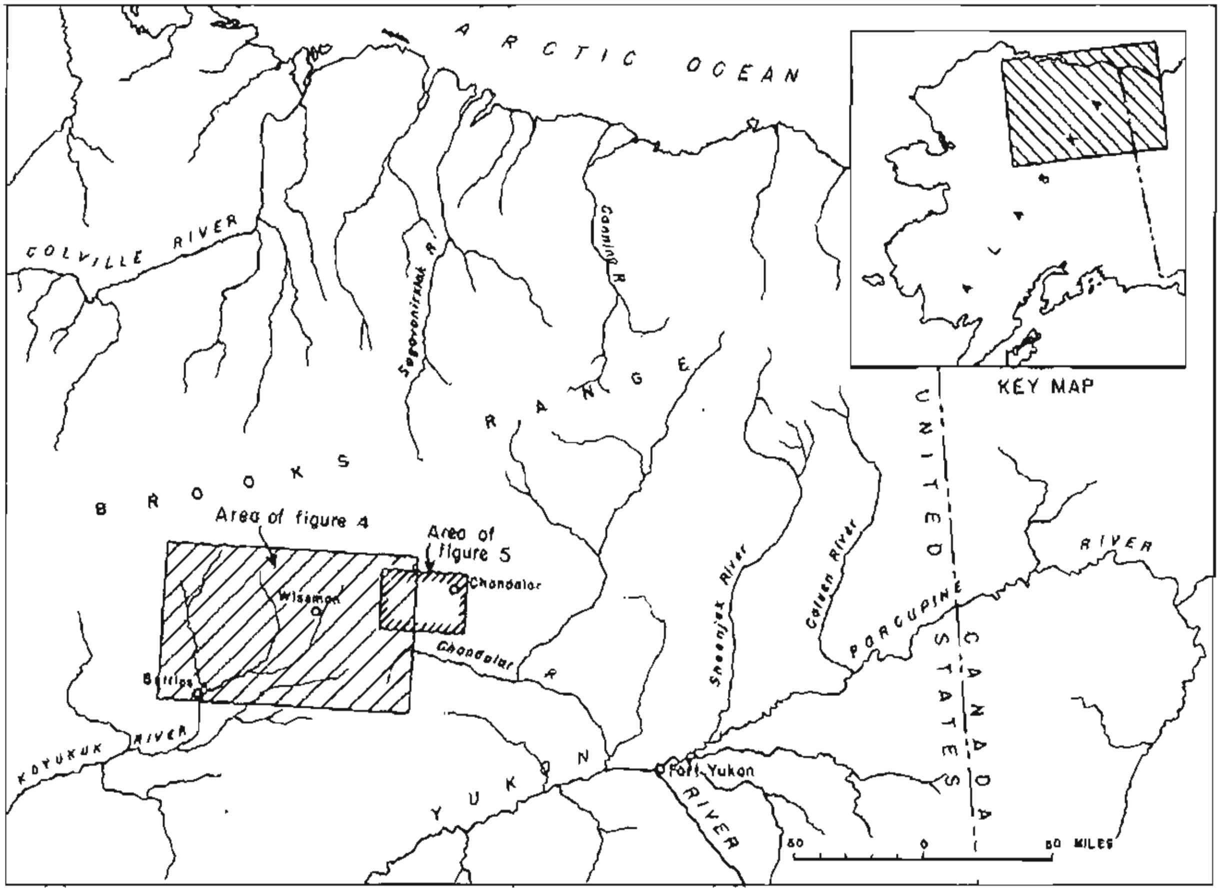
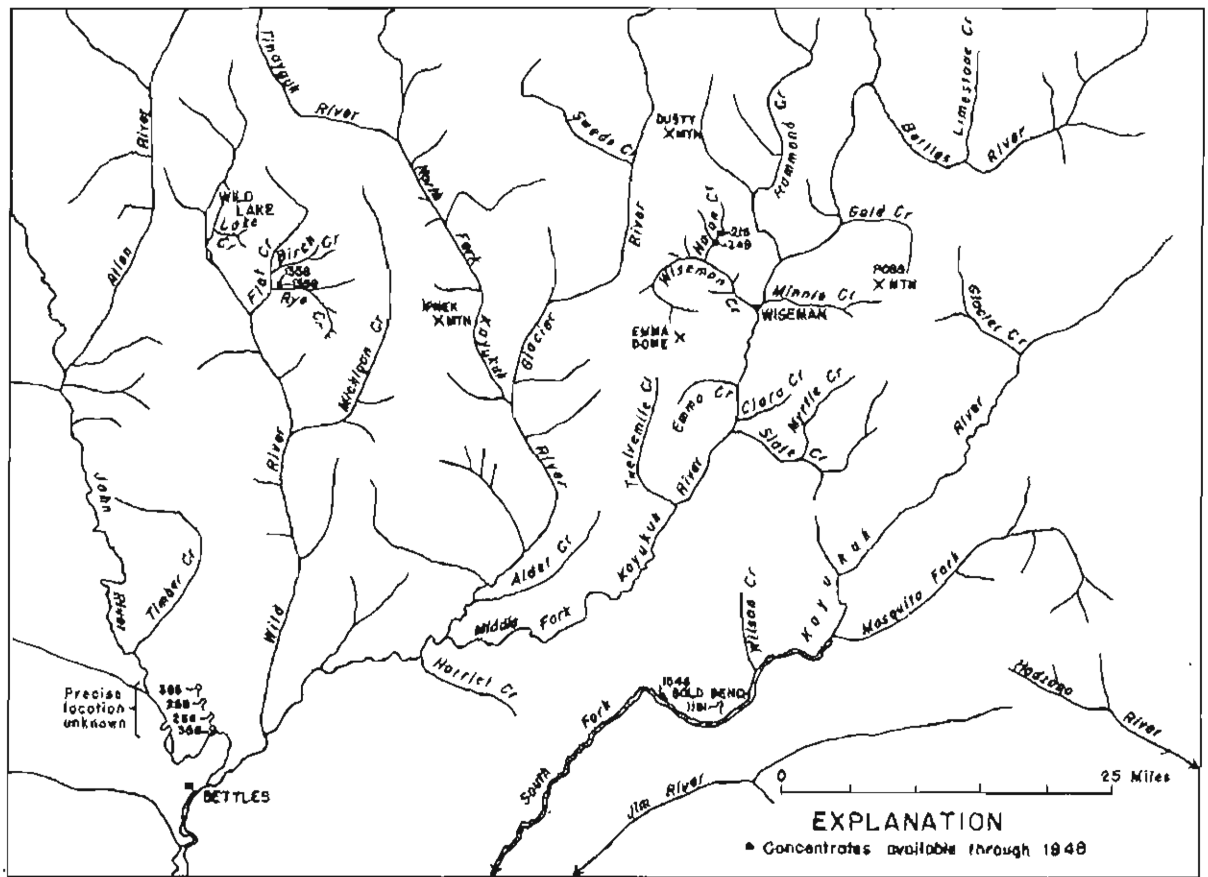


Figure 3.--Map of northeastern Alaska showing location of parts of the Wiseman and Chandalar districts.



Base from U.S. Geological Survey Bull. 844-E

Figure 4.--Sketch map of a portion of the Wiseman district, northeastern Alaska.

Table 3.--Radiometric and mineralogic data on placer concentrates from the Wiseman district, northeastern Alaska

Sample no.	Location	Equivalent uranium (percent)	Mineral composition	
			Minerals	Percent
215	Nolan Creek, west of Wiseman.	([a])	Pyrite	60
			Arsenopyrite	30
			Galena	5
			Garnet	3
			Gold	Tr.
			Magnetite	Tr.
249	-do-	([a])	Magnetite	40
			Pyrite	35
			Galena	15
			Hematite	5
			Spinel	2
			Garnet	2
259	Vicinity of Bettles and John River, exact locality unknown.	([a])	(Chalcocite fragments up to 1 in. in diameter coated with malachite.)	--
266	-do-	([a])	Galena (coated with cerussite).	65
			Pyrite	25
			Schist, quartzite, and granite fragments.	10
356	-do-	([a])	Hornblende	55
			Garnet	40
			Magnetite	3
			Pyrite	1
			Biotite	1
365	-do-	([a])	Galena (coated with cerussite).	100
1151	Gold Bench (or Ironside Bar, about a mile above Gold Bench), South Fork, Koyukuk River.	.010	Magnetite	60
			Garnet	25
			Hematite	8
			Rock minerals (olivene, epidote).	4
			Sphene	2
			Zircon	1
			Pyrite	Tr.
			Rutile	Tr.
			Scheelite	Tr.
			Galena	Tr.
			Cassiterite	Tr.
			Thorianite(?)	Tr.
1358	Rye Creek---------------	.014	Ilmenite	35
			Schist fragments	25
			Chlorite	20
			Andalusite	7
			Zoisite	5
			Epidote	5
			Pyrite	3
			Zircon	Tr.
			Chalcopyrite	Tr.
			Monazite	Tr.

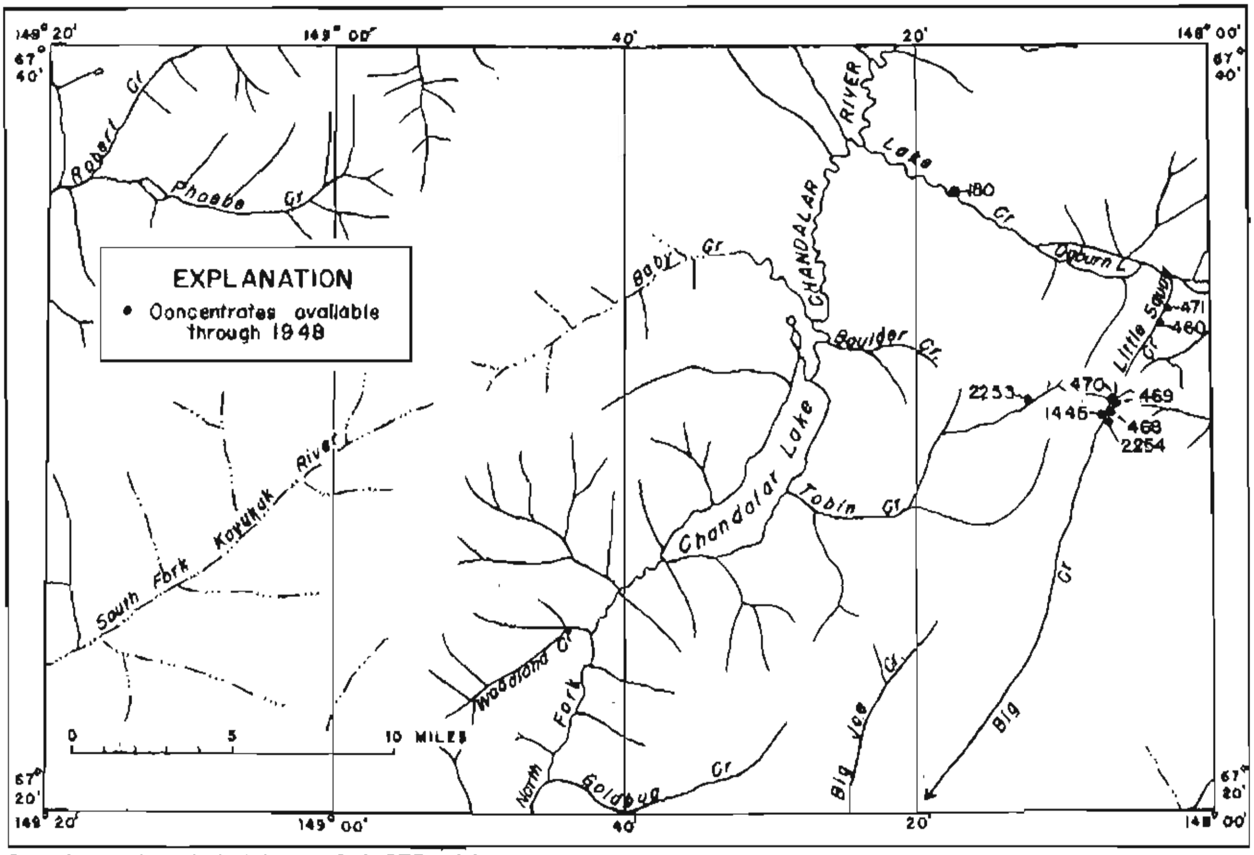
Table 3.--Radiometric and mineralogic data on placer concentrates from the Wiseman district, northeastern Alaska--Continued

Sample no.	Location	Equivalent uranium (percent)	Mineral composition	
			Minerals	Percent
1358	Rye Creek--Continued	.014	Kyanite	Tr.
			Sphene	Tr.
			Galena	Tr.
			Scheelite	Tr.
			Gold	Tr.
1359	Rye Creek--------------	.001	(Mineralogy is similar to sample 1358, but does not contain monazite.)	--
1548	Gold Bench, South Fork, Koyukuk River.	.027	Magnetite	65
			Garnet	25
			Hematite	5
			Zircon	2
			Rock minerals (olivene, epidote)	2
			Sphene	1
			Pyrite	Tr.
			Scheelite	Tr.
			Galena	Tr.
			Chalcopyrite	Tr.
			Rutile	Tr.
			Cinnabar	Tr.
			Cassiterite	Tr.
			Bismuthinite(?)	Tr.
			Thorianite(?)	Tr.

[a]Indicates less than 0.001 percent equivalent uranium.

Table 4.--Radiometric and mineralogic data on placer concentrates from the Chandalar district, northeastern Alaska

Sample no.	Location	Equivalent uranium (percent)	Mineral composition	
			Minerals	Percent
180	Lake Creek-------	0.017	--	--
460	Little Squaw Creek.	.002	--	--
468	Big Creek--------	.007	--	--
469	Big Creek--------	.005	--	--
470	Big Creek--------	.007	--	--
471	Little Squaw Creek.	.003	--	--
1445	Big Creek--------	.002	--	--
2253	Tobin Creek-------	.020	Hematite	50
			Rock minerals	25
			Monazite	10
			Scheelite	7
			Gold	3
			Pyrite	2
			Magnetite	Tr.
			Rutile	Tr.
			Galena	Tr.
2254	Big Creek--------	.050	Hematite	20
			Pyrite	20
			Arsenopyrite	20
			Monazite	15
			Rock minerals	15
			Scheelite	10
			Galena	Tr.
			Ilmenite	Tr.
			Rutile	Tr.
			Chalcopyrite	Tr.



Base from U.S. Geological Survey Bull. 773, pl. 8.

Figure 5. --Sketch map of a portion of the Chandalar district, northeastern Alaska.

Mertie (1925, p. 263) suggests that the gold and monazite in the district may be related genetically and that the bedrock source is probably some highly felsic granitic rock, possibly of pegmatitic origin. However, the only granitic rocks found in the vicinity of the placers are small bodies of a Paleozoic granitic gneiss, which are probably offshoots of a northeast-trending belt of gneiss north of Chandalar Lake. This granite is also exposed in the vicinity of Lake Creek, and further search may reveal its presence in the valleys of other creeks.

CONCLUSIONS

Study of placer concentrates from the Wiseman district revealed the occurrence of uranium-bearing thorianite(?) associated with hematite and various metallic sulfides on the South Fork of the Koyukuk River. Such association suggests the possible occurrence of primary uranium ores in association with metalliferous lodes in the drainage area upstream from the point where the uranium-bearing thorianite(?) was found.

Relatively large amounts of hematite are associated with galena, chalcopyrite, pyrite, arsenopyrite, and monazite in concentrates from placer operations northeast of Chandalar Lake in the Chandalar district. Such an assemblage of minerals indicates the possibility of hematitic alteration in association with the deposition of metallic sulfides. This possible alteration and association, along with the occurrence of radioactive minerals, such as monazite, suggests that the area northeast of Chandalar Lake might contain primary uraniferous deposits.

REFERENCES CITED

Maddren, A. G., 1913, The Koyukuk-Chandalar region, Alaska: U. S. Geol. Survey Bull. 532.

Mertie, J. B., Jr., 1925, Geology and gold placers of the Chandalar district [Alaska]: U. S. Geol. Survey Bull. 773-E, pp. 215-263.