PRELIMINARY SUMMARY REVIEW OF THORIUM-BEARING MINERAL OCCURRENCES IN ALASKA

Trace Elements Memorandum Report 339

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

AEC-710/2

Dr. Phillip L. Merritt, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
P. O. Box 30, Ansonia Station
New York 23, New York

Dear Phil:

Transmitted herewith for your information and distribution are six copies of Trace Elements Memorandum Report 339, "Preliminary summary review of thorium-bearing mineral occurrences in Alaska", by Robert G. Bates and Helmuth Wedow, Jr., March 1952.

It is concluded from the information compiled for this report that none of the known Alaskan occurrences of thorium-bearing minerals have commercial possibilities for thorium alone. However, it is possible that thorium might be recovered economically as a byproduct of gold or tin placer mining in several areas, but more information on concentration ratios, thorium content and the economic situation is needed. Beyond continuing the compilation of available information on thorium as it develops through the routine study of radioactive materials, the Survey plans no direct work on Alaskan thorium occurrences in the near future. Additional information on the thorium content of the radioactive veins in the vicinity of Salmon Bay in southeastern Alaska will become available as a result of general reconnaissance for uranium in the northern part of Prince of Wales Island during the summer of 1952.

We plan to publish this report as a Geological Survey circular, and are asking Mr. Hosted, by a copy of this letter, whether the Commission has any objection to such publication.

Sincerely yours,

W. H. Bradley
Chief Geologist

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Geology - Mineralogy

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Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY SUMMARY REVIEW OF THORIUM-BEARING MINERAL OCCURRENCES IN ALASKA*

By

Robert G. Bates and Helmuth Wedow, Jr.

March 1952

Trace Elements Memorandum Report 339

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission

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By

Robert G. Bates and Helmuth Wedow, Jr.

ABSTRACT

Thorium-bearing minerals are known at 47 localities in Alaska. At these localities the thorium occurs as a major constituent or in minor amounts as an impurity in one or more of the following 12 minerals: allanite, columbite, ellsworthite, eschynite, gummite, monazite, orangite, parisite, thorianite, thorite, xenotime, and zircon. In addition other minerals, such as biotite and sphene, are radioactive and may contain thorium. Several unidentified columbate minerals with uranium or thorium and uranium as major constituents have been recognized at some localities.

The distribution, by type of deposit, of the 47 thorium occurrences is as follows: lode - 3, lode and placer - 1, granitic rock - 3, granitic rock and related placer - 14, and placer - 26. Of the four lode occurrences only the radioactive veins at Salmon Bay in southeastern Alaska and the contact metamorphic deposit in the Nixon Fork area of central Alaska warrant further consideration, although insufficient data are available to determine whether these two deposits have commercial possibilities.

The remaining occurrences of thorium-bearing minerals in Alaska are limited to placer deposits and disseminations of accessory minerals in granitic rocks. In most of these occurrences the thorium-bearing minerals occur in only trace amounts and consequently warrant little further consideration. More data are needed to determine the possibilities of byproduct recovery of thorium-bearing minerals from several of the gold and tin placers.

INTRODUCTION

Prior to the initiation of the Geological Survey's Trace Elements program in 1944, little was known about the occurrence of thorium-bearing minerals in Alaska. Mertie (1925, p. 260) reported the presence of monazite in the placers of Big Creek in the Chandalar district north of Fort Yukon. Eschynite, xenotime, and monazite were identified in the tin-bearing placers of the Manley Hot Springs district west of Fairbanks (Mertie and Waters, 1934, pp. 229, 239, 240). During World War II J. H. Skidmore (1944) reported to the Union Mines Development Corporation on the radioactivity of various Alaskan placers, noting that concentrates from mining operations on Sweepstakes Creek in the eastern Seward Peninsula were especially radioactive. Later work (Gault et al., 1946; Killeen and White, 1950) by the Geological Survey found that the chief radioactive mineral in the concentrates from Sweepstakes Creek and other nearby streams is uranothorianite.

Considerable information has been accumulated on the occurrence of thorium-bearing minerals during the course of the Geological Survey's reconnaissance investigations for uranium in Alaska. All available data on thorium-bearing minerals in Alaska are now being compiled, and the purpose of this report is to present a preliminary summary of the data compiled to date. The spectrographic and chemical analyses, and most of the radiometric analyses and mineral identifications used in this report were made in the Geological Survey's Trace Elements Section Washington Laboratory; a few of the radiometric analyses and mineral identifications were done by members of the Survey's Alaskan Trace Elements Unit. This work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

DISCUSSION OF DATA

Thorium-bearing minerals

Twelve minerals containing thorium, either as a major constituent or in minor amounts as an impurity, are known in Alaska. These minerals are allanite, columbite, ellsworthite, eschynite, gummite, monazite, orangite, parisite, thorianite, thorite, xenotime, and zircon. For the convenience of the reader, brief general descriptions of these minerals, summarized from Ford (1932), Frondel and Fleischer (1950), George (1949), and Palache, et al. (1951) are given in table 1. It should be emphasized that these mineral descriptions, particularly the thorium percentages, refer to mineral occurrences outside of Alaska; very few data are available on the thorium-bearing minerals in Alaska beyond the fact that their presence at a particular locality has been noted. In addition, other minerals, such as biotite and sphene, are radioactive and may contain thorium. Several unidentified columbate minerals with uranium or thorium and uranium as major constituents have been recognized at some localities.

Thorium occurrences of particular note

Thorium is known to be present because of the identification of thorium-bearing minerals, or assumed to be present because of discrepancies between equivalent uranium and uranium analyses, at 47 localities in Alaska. Pertinent data on these occurrences are given in table 2 at the end of the report. The distribution of the 47 occurrences by type of deposit is as follows:

lode	3
lode and placer	1
granitic rock	3
granitic rock and placer	14
placer only	26

Thirteen of these localities are worthy of further study because samples from them have a relatively high thorium content, or because thorium-bearing minerals occur in more than trace amounts. The distribution by type of deposit of these 13 localities is as follows:

lode	1
lode and placer	1
granitic rock and placer	5
placer	6

Summary descriptions of these 13 localities are given below.

Salmon Bay area

In the vicinity of Salmon Bay (no. 2, fig. 1 and table 2) at the northern end of Prince of Wales Island, southeastern Alaska, radioactive hematite-carbonate veins cut metamorphosed sedimentary rocks of Silurian age (Houston, 1951, pp. 6, 9). Most of the veins are less than 5 inches wide, but at one locality a vein 6 to 10 feet wide is exposed for about 300 feet. A sample from a 2- to 3-inch vein contains 0.07 percent equivalent uranium, but only 0.003 percent uranium. The difference is probably due to thorium. In addition to the hematite and carbonates, the veins contain small amounts of pyrite, and, locally, minor amounts or traces of purple fluorite, chalcedony, feldspar, and mica. Parisite (a fluocarbonate of the cerium metals) has been identified in samples from a 6- to 10-foot thick vein (Houston, in preparation). The radioactive elements in these veins are thought to be substituting for iron in the hematite or carbonates, or may also occur as impurities in the fluorite or parisite.

Tobin Creek-Big Creek area

Placer concentrates from the Tobin Creek-Big Creek area (no. 26, fig. 1 and table 2) of the Chandalar district on the south flank of the Brooks Range in northeastern Alaska contain as much as 15 percent monazite (White, 1952), which is associated with variable amounts of hematite, pyrite, scheelite, arsenopyrite, galena, chalcopyrite, and gold. The maximum equivalent uranium content of any of the placer concentrates so far obtained from the Chandalar district is 0.05 percent. The source of the monazite may be "a highly acidic granitic rock, possibly of pegmatitic character" (Mertie, 1925, p. 263).

Manley Hot Springs district

Eureka area.--In the Eureka area (no. 28, fig. 1 and table 2) of the Manley Hot Springs district in central Alaska, Moxham (in preparation) found monazite and radioactive zircon in granite at Elephant Mountain. This granite averages about 0.004 percent equivalent uranium. Concentrates from placers in the Eureka area contain from 0.004 to 0.042 percent equivalent uranium and average about 0.02 percent equivalent uranium. The radioactivity is attributed mostly to thorium, as monazite constitutes up to 10 percent of the concentrates and is the chief radioactive mineral . The monazite in the Eureka placers was probably derived from the granite at Elephant Mountain.

Tofty tin belt.--Concentrates from placers of the Tofty tin belt (no. 29, fig. 1 and table 2), southwest of the Eureka area in the Manley Hot Springs district, contain monazite, xenotime, columbite, ellsworthite, eschynite, and radioactive zircon (Moxham, in preparation). A concentrate from Idaho Gulch was found to contain as much as 2.3 percent equivalent uranium, although generally the radioactivity of the Tofty concentrates is in the 0.0X range of percent equivalent uranium. Moxham (in preparation) indicates that the eschynite contains less than 1 percent thorium and no uranium; the columbite has an equivalent uranium content of about 0.1 percent; the equivalent uranium content of the monazite does not exceed 1 percent; and the zircon averages about 0.07 percent equivalent uranium.

The bedrock source of the radioactive minerals in the Tofty concentrates has not been discovered, but may be a differentiate phase of the intrusive at Rough Top Mountain to the north or the granite at Hot Springs Dome to the south or both (Mertie and Waters, 1934, pp. 244-246).

Hot Springs Dome area.--In the Hot Springs Dome area (no. 30, fig. 1 and table 2) monazite and xenotime are found in most of the placers of creeks draining the granite area of Hot Springs Dome (Moxham, in preparation). The equivalent uranium content of this granite averages 0.003 percent.

Although the radioactivity of the heavy-mineral fractions (those greater than 3.3 specific gravity) of the placer concentrates from the Hot Springs Dome area is in the 0.0X range of percent equivalent uranium, one concentrate from a tributary of Hot Springs Slough on the south side of the Dome contains 0.3 percent equivalent uranium and about 20 percent monazite and 5 percent xenotime. Another concentrate from glacial material just east of Blowback Creek on the north side of Hot Springs Dome contains 0.155 percent equivalent uranium and about 20 percent monazite.

Long area

In the Long area (no. 31, fig. 1 and table 2) of the Ruby-Poorman district in central Alaska, allanite and thorite are the chief radioactive minerals found in granite and in placers derived from the granite (White and Stevens, in preparation-b). The equivalent uranium content of the granite averages 0.005 percent; heavy-mineral fractions (those greater than 2.8 specific gravity) of the placer concentrates contain as much as 1.6 percent equivalent uranium and average 0.3 percent equivalent uranium. The thorite content of the heavy-mineral fractions from both the granite and placer concentrates ranges from a trace to about 10 percent.

Qualitative spectrographic analysis of the thorite indicates uranium(?), thorium, and silicon as major constituents, and calcium, iron, titanium, and yttrium as minor constituents. Chemical analysis of the thorite shows the uranium content to be about 8 percent. No analytical data are available on the allanite except that it gives a positive flux test for uranium.

Nixon Fork area

Uranium-bearing thorianite, allanite, and other radioactive minerals have been reported from the Nixon Fork area (no. 33, fig. 1 and table 2) in central Alaska (White and Stevens, in preparation-a). The thorianite occurs in placers, where it is associated with uraniferous hematite, malachite, sphene, and zircon. The concentrate exhibiting the greatest radioactivity contains 0.078 percent equivalent uranium, most of which is attributed to the uraniferous thorianite. The bedrock source of the radioactive minerals has not been located.

Large fragments of an altered limestone on the dump of the Whalen mine contain a high percentage of radioactive allanite. The altered limestone is apparently closely associated with contact-metamorphic gold-copper ores along a limestone-monzonite contact. The altered limestone contains as much as 0.05 percent equivalent uranium, which is ascribed to thorium, as chemical analyses show a content of only 0.004 percent uranium. About a quarter of the altered limestone consists of minerals of greater than 2.8 specific gravity. Of this heavy fraction 98 percent is allanite; zircon, kyanite, and scheelite constitute the remaining 2 percent.

Near the shaft of the Whalen mine a highly altered phase of the limestone is exposed containing about 0.025 percent equivalent uranium and 0.002 percent uranium. The radioactive mineral here is parisite, which in the samples taken makes up about 95 percent of the heavy-mineral fraction (that greater than 2.8 specific gravity) of the rock.

Buckland-Kiwalik district

Clem Mountain area.--Uranothorianite and traces of thorite have been identified in several placer concentrates from the Clem Mountain area (no. 36, fig. 1 and table 2) in the northern part of the Buckland-Kiwalik district (West and Matzko, in preparation) of the eastern Seward Peninsula.

Heavy-mineral fractions (those greater than 2.8 specific gravity) containing more than 0.025 percent equivalent uranium were obtained from concentrates of placers in Duck, East Clem, and West Clem Creeks. The heavy-mineral fraction with the greatest radioactivity (0.106 percent equivalent uranium) was obtained on Duck Creek above the mouth of West Clem Creek.

Although the source of the radioactive minerals is not known, it is likely that they are disseminated accessory minerals in the granitic intrusives that form the backbone of the Buckland-Kiwalik divide, as the radioactive minerals are found only in the creek gravels containing granitic pebbles.

Hunter Creek-Connolly Creek-Fairhaven Creek area.--Placer concentrates from creek gravels within the headwater drainage of Hunter, Connolly, and Fairhaven Creeks (no. 37, fig. 1 and table 2), south of the Clem Mountain area, contain thorite, uranothorianite, gummite, and traces of orangite (West and Matzko, in preparation). Concentrates with heavy-mineral fractions containing more than 0.025 percent equivalent uranium were obtained from numerous sites in the Hunter Creek-Connolly Creek-Fairhaven Creek area. The sample with the greatest radioactivity was taken on Muck Creek, a left-limit tributary of Hunter Creek, and contains 0.16 percent equivalent uranium.

The bedrock source of the radioactive minerals is not certain, but, as in the Clem Mountain area, is presumed to be the granitic rocks in the drainage basins of the streams with radioactive placers. The thorite and orangite appear to be restricted to the gravels in the headwaters of Fairhaven Creek, and the uranothorianite and gummite appear to be limited to placers in the headwaters of Hunter and Connolly Creeks.

Granite Mountain area.--Granite Mountain (no. 38, fig. 1 and table 2) in the eastern Seward Peninsula is composed largely of a syenitic stock which was intruded into a complex of andesitic flows and intrusives (Gault, et al., 1946; Killeen and White, 1950; West and Matzko, in preparation). The average radioactivity of the syenite is about 4 times that of the andesitic rocks. The chief radioactive minerals in placer and bedrock samples from the Granite Mountain area are allanite, uranothorianite, thorite, and gummite. The equivalent uranium content of the heavy-mineral fractions (those greater than 2.8 specific gravity) of the placer concentrates is generally 0.0X percent. Concentrates with more than 0.025 percent equivalent uranium have been obtained from the placers of headwater tributaries of the Peace River, Anzac Creek, Rube Creek, Sweepstakes Creek, headwater tributaries of the Kiwalik River, the South Fork of Quartz Creek, Cub Creek, and an unnamed tributary of the West Fork of the Buckland River. In all the radioactive concentrates the uranothorianite appears to be the main radioactive mineral. Although allanite is relatively abundant in a pegmatitic facies of the granitic rock near the top of Granite Mountain, and traces of uranothorianite have been identified among the accessory minerals of a specimen of syenite from the north flank of Granite Mountain in the headwaters of Quartz Creek, no lode concentrations of the radioactive minerals have yet been found.

However, several placer concentrates from the extreme headwaters of the Peace River on the east flank of Granite Mountain near the andesite-syenite contacts have an equivalent uranium content of about 0.2 to about 0.8 percent or approximately 10 times that of the average uranothorianite-bearing concentrates found elsewhere in the eastern Seward Peninsula. These more radioactive concentrates contain a higher content of the radioactive minerals, particularly uranothorianite, than the other radioactive concentrates; in addition they contain copper sulfide minerals, silver, and bismuth, which have not been identified in the average uranothorianite-bearing samples. The greater amount of uranothorianite and the occurrence of minerals believed to be of hydrothermal origin in placers less than a mile from stream divides suggest the presence of a lode containing radioactive minerals.

Darby Mountains district

Tubutulik River area.--The chief radioactive minerals found in the placers of the Tubutulik River area (no. 40, fig. 1 and table 2), in the northeastern part of the Darby Mountains district in the eastern Seward Peninsula, are allanite and unidentified columbate minerals (West, in preparation). The heavy-mineral fractions (those greater than 2.8 specific gravity) of the concentrates contain as much as 0.1 percent equivalent uranium, but average only about 0.02 percent equivalent uranium. In three samples from the area the columbates are estimated to constitute from 5 to 10 percent of the heavy-mineral fractions of the concentrates. Qualitative spectrographic analyses show that in two samples the columbates contain uranium as a major element with no thorium recognized; in the third sample the columbate contains both uranium and thorium as major constituents. A spectrographic analysis of the allanite in one sample shows thorium as a major constituent with no uranium found. The bedrock source of the allanite is unknown, but is assumed to be differentiate phases of granitic rock in the drainage areas of the streams from which the samples were obtained. The presence of topaz and traces of cassiterite along with the columbates suggests that these minerals may be genetically related to lode tin occurrences. It is also possible that these minerals may have originated in pegmatites.

Golovin Bay area.--The most radioactive minerals in various types of placers along the east shore of Golovin Bay (no. 42, fig. 1 and table 2), in the western part of the Darby Mountains district, are allanite, monazite, and an unidentified columbate mineral (West, in preparation). The equivalent uranium content of the heavy-mineral fractions (those greater than 2.8 specific gravity) of concentrates from these placers ranges from 0.001 to about 0.08 percent.

The columbate mineral has been recognized only in a concentrate from slopewash on the beach about midway between Cheenik and Mission Creeks. The sample location is near the contact of a younger granite with an older intrusive complex. The heavy-mineral fraction of this concentrate has an equivalent uranium content of about 0.08 percent and is the most radioactive heavy-mineral fraction taken in the area. It is estimated that the unidentified columbate mineral comprises about 5 to 10 percent of the heavy-mineral fraction, which also contains minor amounts of sphene, topaz, hematite, allanite, and scheelite. Qualitative spectrographic analysis of the columbate shows uranium and thorium as major constituents.

Farther south along the Golovin Bay coast monazite and traces of allanite are found in a slopewash concentrate of which the heavy-mineral fraction contains about 0.05 percent equivalent uranium. This sample was taken near the contact of granite with an older intrusive complex.

The remaining radioactive concentrates from the Golovin Bay area, have equivalent uranium contents that range from about 0.01 to about 0.03 percent. This radioactivity is ascribed largely to traces of uranium or thorium in minor amounts of allanite, sphene, and zircon.

Cape Mountain area

The major radioactive minerals in placer concentrates from the Cape Mountain area (no. 47, fig. 1 and table 2), in the western Seward Peninsula, are monazite, xenotime, and zircon. The concentrates contain as much as 0.9 percent equivalent uranium and average about 0.03 percent equivalent uranium which, because of the monazite content of the concentrates, is ascribed mostly to thorium. The source of the radioactive minerals is probably the granite at Cape Mountain, although they may be genetically related to the tin mineralization in the area.

CONCLUSIONS

At 47 localities in Alaska thorium occurs as a major constituent or in minor amounts as an impurity in one or several of 12 minerals. These minerals are allanite, columbite, ellsworthite, eschynite, gummite, monazite, orangite, parisite, thorianite, thorite, xenotime, and zircon. At some localities sphene and biotite are also radioactive and may contain thorium; unidentified columbate minerals with uranium or thorium and uranium as major constituents have also been recognized. Lode thorium occurrences warranting further consideration are:

1) in radioactive hematite-carbonate veins in the Salmon Bay area on Prince of Wales Island, southeastern Alaska, and

2) in a limestone-monzonite contact zone in the Nixon Fork area in central Alaska.

Data on these two deposits, however, are not sufficient to determine their potentialities.

The remaining thorium occurrences of any significance are in placers or as accessory minerals in granitic rocks. It is possible that thorium might be obtained as a byproduct from gold or tin placer operations in the following localities:

Locality	Major thorium-bearing minerals
1) Tobin Creek-Big Creek area, Chandalar district, northeastern Alaska	Monazite
2) Manley Hot Springs district, central Alaska	Columbite Ellsworthite Eschynite Monazite Xenotime
3) Long area, central Alaska	Thorite
4) Nixon Fork area, central Alaska	Uranothorianite
5) Buckland-Kiwalik district, west-central Alaska (Seward Peninsula)	Uranothorianite Thorite
6) Cape Mountain area, west-central Alaska (Seward Peninsula)	Monazite Xenotime

More data are needed, however, to determine the thorium potentialities of these placer localities.

Table 1.--General description of thorium-bearing minerals belonging to species that are found in Alaska

Mineral	Chemical composition	Thorium (percent)	Description
Allanite	Hydrous silicate of aluminum, calcium, and the cerium metals	Up to 3	Color: brown to black Luster: resinous to submetallic Fracture: uneven to subconchoidal Habit: tabular, also long and slender, also massive Specific gravity: 2.7 - 4.2
Columbite	Columbate of iron and manganese	0.X	Color: black, grayish- and brownish-black Luster: submetallic to sub-resinous Fracture: subconchoidal to uneven Habit: short prismatic grains Specific gravity: 5.2 - 7.9
Ellsworthite	Complex hydrous oxides of columbium, tantalum, sodium, calcium, with hydroxyl and fluorine; may contain up to 17 percent uranium	0.5	Color: amber-yellow to dark brown Luster: adamantine Fracture: subconchoidal to slintery, uneven Habit: rounded grains, also massive Specific gravity: 3.8 - 4.2
Eschynite	Complex oxide of columbium, tantalum, and the rare earths with varying amounts of thorium and uranium	10 - 15	Color: brownish-yellow to black Luster: submetallic to resinous, nearly dull Fracture: small conchoidal Habit: mostly massive, also prismatic Specific gravity: 4.9 - 5.2
Gummite	Uranium with minor amounts of thorium, lead, and hydroxyl	Up to 22	Color: orange, yellow, orange-yellow Luster: dull to greasy Fracture: uneven to subconchoidal Habit: massive, dense, also in rounded or flattened masses or crusts Specific gravity: 3.9 - 6.4

Table 1.--General description of thorium-bearing minerals belonging to species that are found in Alaska (continued)

Mineral	Chemical composition	Thorium (percent)	Description
Monazite	Rare-earth phosphate with some thoria and silica	1 - 11	Color: yellowish- or reddish-brown, golden-yellow Luster: resinous Fracture: conchoidal to uneven Habit: small, often flattened grains Specific gravity: 4.9 - 5.3
Orangite	Thorium silicate, a variety of thorite	63	Color: bright orange or orange-yellow Luster: vitreous to glassy when fresh, dull to greasy when altered Fracture: conchoidal Habit: square prismatic crystals, sometimes massive Specific gravity: 4.1 - 6.3
Parisite	Fluocarbonate of calcium and the cerium group	0 - ?	Color: brownish-yellow, brown, wax-yellow Luster: vitreous to resinous Fracture: subconchoidal to splintery Habit: crystals small and slender, pyramidal or prismatic Specific gravity: 4.4
Thorianite	Oxide of thorium and uranium	34 - 63	Color: black, brownish or grayish Luster: submetallic to dull or greasy Fracture: uneven to subconchoidal Habit: cubic Specific gravity: 9.3
Thorite	Thorium silicate	25 - 63	Color: commonly black, brown, less commonly green Luster: vitreous to glassy when fresh, dull to greasy when altered Fracture: conchoidal Habit: square prismatic crystals, sometimes massive Specific gravity: 4.1 - 6.4

Table 1.--General description of thorium-bearing minerals belonging to species that are found in Alaska (continued)

Mineral	Chemical composition	Thorium (percent)	Description
Xenotime	Essentially yttrium phosphate	0.4 - 3.3	Color: shades of brown, yellow, green, grayish white, pink Luster: resinous to dull or earthy Fracture: uneven and splinty Habit: long or short prismatic crystals Specific gravity: 4.5 - 4.6
Zircon	Zirconium silicate, usually with some ferric oxide and often some thorium and uranium	Usually low but up to 13.1 reported	Color: various shades of red, brown, and gray when thorium-bearing Luster: usually dull or sub-resinous when thorium-bearing Fracture: conchoidal Habit: prismatic, commonly long, less commonly stout, also massive Specific gravity: 3.6 - 4.7

Table 2.--Occurrences of thorium-bearing minerals in Alaska

Note: Explanation of symbols used in table
G: granitic rock
L: lode deposit
P: placer
HMF: heavy mineral fraction (usually greater than 2.8 specific gravity)

Quadrangle references are the new 1:250,000 Alaska Reconnaissance Series, most of which are available at least in proof copy

REGION / Quadrangle / Reference no. (fig. 1) and location	Allanite	Columbite	Ellsworthite	Eschynite	Gummite	Monazite	Orangite	Parisite	Thorianite	Thorite	Xenotime	Zircon	Other	Occurrence	Equivalent uranium content (percent); presence of thorium assumed	References
SOUTHEASTERN ALASKA																
Craig(?)																
1. Kasaan Peninsula(?)	X	-	-	-	-	-	-	-	-	-	-	-	-	L1/	L:0.094	Wedow, et al, 1951, p. 63
Petersburg																
2. Salmon Bay area, Prince of Wales Island	-	-	-	-	-	-	-	X2/	-	-	-	-	X3/	L4/	L: up to 0.07	Houston, 1951, p. 4, table 1
Port Alexander																
3. Goddard Hot Springs area	X	-	-	-	-	X	-	-	-	-	-	-	-	GP	HMF: up to 0.016	West and Benson, in preparation
SOUTH-CENTRAL ALASKA																
Bering Glacier																
4. Yakataga area	-	-	-	-	-	-	-	-	-	-	-	X	X5/	P	HMF: up to 0.32, av. 0.044	Moxham, 1952
Anchorage																
5. Fishhook Creek-Archangel Creek area, Willow Creek mining district	X	-	-	-	-	-	X	-	-	X	-	-	X6/	L7/	L: av. 0.004 HMF: up to 2.93 av. 0.15	Moxham and Nelson, 1952

1/ Allanite occurs in sample from contact copper-iron ore; location in doubt

2/ Parisite not known to be radioactive, study now in progress

3/ Thorium may be replacing iron in hematite or carbonates

4/ Radioactive hematite-carbonate veins

5/ Two other minerals belonging to zircon group

6/ Other minerals are crytolite

7/ Pegmatites

Table 2.--Occurrences of thorium-bearing minerals in Alaska (continued)

REGION / Quadrangle / Reference no. (fig. 1) and location	Allanite	Columbite	Ellsworthite	Eschynite	Gummite	Monazite	Orangite	Parisite	Thorianite	Thorite	Xenotime	Zircon	Other	Occurrence	Equivalent uranium content (percent); presence of thorium assumed	References
SOUTH-CENTRAL ALASKA																
<u>Tyonek</u>																
6. Mount Spurr area	–	–	–	–	–	X	–	–	–	–	–	X	–	P	HMF: in 0.0X range	File data, prospector's samples
7. Roundbend and Red Hill Bars, Kahiltna River	–	–	–	–	–	X	–	–	X	–	–	–	–	P	Concentrates contain 0.083 percent thorium	Harder and Reed, 1945, pp. 5, 17, appendix
<u>Talkeetna</u>																
8. Shalon Bar, Kahiltna River	–	–	–	–	–	X	–	–	X	–	–	–	–	P	Concentrate contains 0.044 percent thorium	do
9. Petersville area	–	–	–	–	–	X	–	–	–	–	–	X	–	P	HMF: up to 0.064	Robinson, et al, 1946, pp. 22, 23, table 5
10. Cache Creek, near mouth of Dollar Creek	–	–	–	–	–	X	–	–	X	–	–	–	–	P	Concentrate contains 0.03 percent thorium	Harder and Reed, 1945, pp. 5, 17
11. Poorman Creek	–	–	–	–	–	X	–	–	–	–	–	–	–	P	Concentrate contains 0.044 percent thorium	Harder and Reed, 1945, pp. 5, 6, appendix
EAST-CENTRAL ALASKA																
<u>Tanacross</u>																
12. Alaska Highway, about 2 miles southeast of Northway Junction	X	–	–	–	–	–	–	–	–	–	–	X	–	G	G: 0.004	Wedow and Matzko, 1947, pp. 31, 58
13. Alaska Highway, about 15-23 miles northwest of Northway Junction	X	–	–	–	–	–	–	–	–	–	–	X	–	G	G: 0.004	Wedow and Matzko, 1947, pp. 31, 60
<u>Mount Hayes</u>																
14. Ober Creek	–	–	–	–	–	X	–	–	–	–	–	–	–	P	HMF: up to 0.011, av. 0.006	Wedow and Matzko, 1947, pp. 36, 63
<u>Big Delta</u>																
15. Harding Lake-Richardson area	?	–	–	–	–	–	–	–	–	–	–	X	–	GP	G: 0.004 HMF-P: up to 0.02	Wedow and Matzko, 1947, pp. 27, 55-57
<u>Eagle</u>																
16. Atwater Bar, Mosquito Fork, South Fork, Fortymile River	–	–	–	–	–	X	–	–	X	–	–	–	–	P	HMF: up to 0.041	White, 1950 Wedow and Tolbert, in preparation-b
17. Mission Creek area	?	–	–	–	–	–	–	–	–	–	–	X	–	GP	G: up to 0.006, av. 0.004 HMF-P: up to about 0.1	Wedow, in preparation
18. Slate Creek area	X	–	–	–	–	X	–	–	–	–	–	–	–	GP	G: up to 0.005 HMF-P: up to 0.096	Wedow and Tolbert, in preparation-b
19. Copper Creek	–	–	–	–	–	X	–	–	–	–	–	–	–	P	HMF: 0.013	Wedow and Tolbert, in preparation-a
<u>Charley River</u>																
20. Coal Creek-Woodchopper Creek	–	–	–	–	–	X	–	–	–	–	–	–	–	P	HMF: 0.009	File data

Table 2.--Occurrences of thorium-bearing minerals in Alaska (continued)

REGION / Quadrangle / Reference no. (fig. 1) and location	Allanite	Columbite	Ellsworthite	Eschynite	Gummite	Monazite	Orangite	Parisite	Thorianite	Thorite	Xenotime	Zircon	Other	Occurrence	Equivalent uranium content (percent); presence of thorium assumed	References
EAST-CENTRAL ALASKA																
<u>Circle</u>																
21. Hot Springs, Portage, and Ketchum Creeks	X	-	-	-	-	-	-	-	-	-	-	X	-	P	HMF: up to about 0.06	White and Tolbert, 1952
22. Nome Creek	-	-	-	-	-	X	-	-	-	-	-	-	-	P	HMF: 0.012	Wedow and Matzko, 1947, p. 19
<u>Livengood</u>																
23. Ruth Creek	-	-	-	-	-	X	-	-	-	-	-	X	-	P	HMF: 0.010	Wedow and Matzko, 1947, p. 22, 23
NORTHEASTERN ALASKA																
<u>Wiseman</u>																
24. Gold Bench and/or Ironside Bar, South Fork, Koyukuk River	-	-	-	-	-	-	-	-	?	-	-	-	-	P	HMF; up to 0.027	White, 1952, p. 10, table 1
25. Rye Creek	-	-	-	-	-	X	-	-	-	-	-	-	-	P	HMF: 0.014	White, 1952, p. 6, table 1
<u>Chandalar</u>																
26. Tobin Creek-Big Creek area	-	-	-	-	-	X	-	-	-	-	-	-	-	P	HMF: up to 0.05	White, 1952, pp. 10-13 Mertie, 1925, pp. 260-263
<u>Mount Michelson</u>																
27. Okpilak River	-	-	-	-	-	-	-	-	-	-	-	X	x8/	GP	G: 0.007 HMF-G: up to 0.08, av. 0.052 HMF-P: av. 0.028	White, 1951
CENTRAL ALASKA																
<u>Tanana</u>																
28. Eureka area	-	-	-	-	-	X	-	-	-	-	-	X	-	GP	G: 0.004 HMF-P: up to 0.042, av. 0.02	Moxham, in preparation
29. Tofty tin belt	-	X	X	X	-	X	-	-	-	-	-	X	-	P	HMF: up to 2.3, but generally in 0.0X range	Moxham, in preparation Mertie and Waters, 1934, pp. 238-241
30. Hot Springs Dome area	-	-	-	-	-	X	-	-	-	-	X	-	-	GP	G: 0.003 HMF-P: up to 0.3, but generally in 0.0X range	Moxham, in preparation

8/ Major radioactive mineral is biotite; radioactivity mostly due to uranium

Table 2.--Occurrences of thorium-bearing minerals in Alaska (continued)

REGION Quadrangle Reference no. (fig. 1) and location	Allanite	Columbite	Ellsworthite	Eschynite	Gummite	Monazite	Orangite	Parisite	Thorianite	Thorite	Xenotime	Zircon	Other	Occurrence	Equivalent uranium content (percent); presence of thorium assumed	References
CENTRAL ALASKA																
Ruby																
31. Long area	X	-	-	-	-	-	-	-	-	X	-	-	-	GP	G: 0.005 HMF-P: up to 1.63, av. about 0.3	White and Stevens, in preparation-b
32. Solomon Creek	-	-	-	-	-	-	-	-	-	-	-	-	X[9]	P	HMF: 0.056	do
Medfra																
33. Nixon Fork area	-	-	-	-	-	-	-	-	X	-	-	X	-	P	HMF: up to 0.078, av. 0.015	Harder and Reed, 1945, p. 5 White and Stevens, in preparation-a
do	X	-	-	-	-	-	-	X	-	-	-	-	-	L[10]	L: up to 0.05 HMF: up to 0.14, av. 0.04	White and Stevens, in preparation-a
SOUTHWESTERN ALASKA																
Iditarod																
34. Julian Creek	-	-	-	-	-	X	-	-	-	-	-	-	-	P	HMF: 0.03	White and Killeen, 1950
35. Flat area	-	-	-	-	-	-	-	-	-	-	-	X	-	GP	G: av. prob. 0.004 HMF-P; up to 0.1, but generally in 0.0X range	Harder and Reed, 1945, pp. 5, 19 White and Killeen, in preparation
WEST-CENTRAL ALASKA (Seward Peninsula)																
Candle																
36. Clem Mountain area, Buckland-Kiwalik district	-	-	-	-	-	-	-	-	X	X	-	-	-	P	HMF: up to 0.106, but generally in 0.0X range	West and Matzko, in preparation
37. Hunter Creek-Connolly Creek-Fairhaven Creek area	-	-	-	-	X	-	X	-	X	X	-	-	-	P	HMF: up to 0.16, but generally in 0.0X range	do
38. Granite Mountain area	X	-	-	-	X	-	-	-	X	X	-	X	X[11]	G(?) P	G: prob. av. about 0.004 HMF-P: up to 0.076, but generally in 0.0X range [11]	Gault, et al, 1946 Killeen and White, 1950 West and Matzko, in preparation

9/ Radioactive mineral belonging to spinel group

10/ Contact metamorphic zone between limestone and monzonite

11/ Heavy mineral fractions containing more than 0.2 percent equivalent uranium restricted to headwaters of Peace River; other possible thorium-bearing mineral in Granite Mountain area is radioactive sphene

Table 2.--Occurrences of thorium-bearing minerals in Alaska (continued)

REGION / Quadrangle / Reference no. (fig. 1) and location	Allanite	Columbite	Ellsworthite	Eschynite	Gummite	Monazite	Orangite	Parisite	Thorianite	Thorite	Xenotime	Zircon	Other	Occurrence	Equivalent uranium content (percent); presence of thorium assumed	References
WEST-CENTRAL ALASKA (Seward Peninsula)																
Bendeleben																
39. Candle Creek area	-	-	-	-	-	-	-	-	X	-	-	-	-	P	HMF: av. about 0.01	Gault, 1949
Solomon																
40. Tubutulik River area	X12/	-	-	-	-	-	-	-	-	-	-	-	X13/	P	HMF: up to 0.104, av. 0.02	West, in preparation
41. Headwaters of Kwiniuk River	X	-	-	-	-	-	-	-	X	-	-	-	-	P	HMF: up to 0.039, av. 0.01	do
42. Golovin Bay area	X	-	-	-	-	X	-	-	-	-	-	-	X14/	P	HMF: up to 0.074, av. 0.01	do
Nome and Solomon																
43. Cape Nome area	X	-	-	-	-	-	-	-	-	-	-	X	-	GP	HMF-G: up to 0.012 HMF-P: up to 0.006	West and Matzko, 1950
Bendeleben																
44. Serpentine Hot Springs area	X	-	-	-	-	-	-	-	-	-	-	X	-	GP	G: av. 0.008 HMF-P: up to 0.84	Moxham and West, 1949
Teller																
45. Ear Mountain area	-	-	-	-	-	X	-	-	-	-	-	X	-	GP	G: 0.002 HMF-P: up to 0.26, av. 0.056	Harder and Reed, 1945, p. 12 Killeen and Ordway, 1946
46. Brooks Mountain area	-	-	-	-	-	X	-	-	-	-	X	X	-	G	G: 0.003	White and West, 1952, p. 8
47. Cape Mountain area	-	-	-	-	-	X	-	-	-	-	X	X	-	GP	HMF: up to 0.9, av. 0.03	Harder and Reed, 1945, p. 9 Also file data

12/ Spectrographic analysis shows thorium and no uranium

13/ Three unidentified columbate minerals; two with uranium and no thorium, one with both thorium and uranium as major constituents

14/ Unidentified columbate mineral containing uranium and thorium as major constituents

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