Hardrock Uranium Potential in Alaska

by

Thomas P. Miller

U. S. Geological Survey

OPEN FILE REPORT 76-246

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.

Hardrock Uranium Potential in Alaska 1/

by

Thomas P. Miller
U.S. Geological Survey, Anchorage, Alaska

Discussing the potential of "hardrock" (i.e., non-sedimentary type) uranium deposits in a 586,000 mi^2 portion of the North America Cordillera is a difficult task compounded by the fact that the remoteness of much of the region and the logistical difficulties have resulted in only reconnaissance geologic information being available for large parts of the state.

Cobb (1970) has listed known occurrences of uranium and thorium minerals in the state and a somewhat modified version of his compilation showing chiefly hardrock occurrences is given in figure 1; it should be emphasized that these are occurrences only and not necessarily deposits of possible economic significance. The distribution pattern shows a concentration of occurrences in southeastern Alaska and particularly in the interior.

The only production of uranium in Alaska from any type of deposit has been from a hardrock deposit, that being the roughly 120,000 tons of ore averaging about one percent U_3O_8 from the Ross-Adams mine near Bokan Mountain on Prince of Wales Island close to the southern tip of southeastern Alaska.

The Bokan Mountain uranium-thorium area includes about 71 mi^2 and is largely underlain by plutonic rocks (MacKevett, 1963). The plutonic rocks range from pyroxenite to peralkaline granite and syenite, but they consist chiefly of diorite, quartz diorite, granodiorite, and quartz monzonite. The peralkaline granite, a small pluton about 3 mi^2 in area, is Late Triassic or Early Jurassic in age while the other plutonic rocks are early Paleozoic.

Most of the uranium-thorium deposits are genetically related to the peralkaline granite, and they occur either in the granite or within an altered (albitized) aureole, as much as 1½ miles wide, that surrounds the pluton. The uranium-thorium deposits are mainly of hydrothermal origin; veins or local replacements that contain uranium-thorium minerals of hydrothermal origin in or near fractures are the dominant occurrence of most of the Bokan Mountain area urnaium-thorium deposits.

1/ Abstract for this paper was previously released in Open File report 75-595 "Abstracts of the 1975 Uranium and Thorium Research and Resources Conference."

This report is based on a talk given at the U.S. Geological Survey Uranium and Thorium Research and Resource Conference held December 8-10, 1975 at Golden, Colorado.

The uranium- and thorium-bearing minerals, which are predominantly primary, consist chiefly of uranothorite, uranothorianite, and uraninite with subordinate phosphates, niobates, and complex silicates.

Anomalous amounts of uranium and thorium have been reported from at least 14 other localities in southeastern Alaska, generally near the margins of intrusive rocks.

A uranium-thorium metallogenic province has been suggested for an area of western Alaska by Clark and others (1975). This designation was based on occurrences of a variety of plutonic rocks known elsewhere in the world to be uraniferous together with many occurrences of uranium and thorium minerals in the region. Within the past few years this area has been subjected to considerable reconnaissance exploration and a drilling program is proceeding at one site. The Geological Survey will be conducting detailed studies in certain selected sites in this area this coming summer (1976).

The plutons of western Alaska occur in the Seward Peninsula and Yukon-Koyukuk provinces (fig. 2). Most of the Seward Peninsula is underlain by a province of thrustfaulted metamorphic and sedimentary rocks of Precambrian and Paleozoic age (Sainsbury, 1969). Flanking the Seward Peninsula is the Yukon-Koyukuk volcanogenic province of Mesozoic age consisting of Lower Cretaceous andesite volcanics, graywacke, and mudstone (Patton, 1970).

The plutonic rocks show a wide range in composition (Miller, 1970) including more or less typical calc-alkaline rocks to strongly potassic subsilicic rocks to highly silicic biotite granite. They range in age from mid-Cretaceous to perhaps early Tertiary.

The Zane Hills pluton is one of the areas of particular interest in regard to uranium and thorium (fig. 2). Most of the pluton is composed of a medium-grained equigranular biotite-hornblende granodiorite. Two areas near the edge of the pluton contain coarse-grained porphyritic to gneissic monzonite and syenite that are several times more radioactive than the granodiorite. A sample of typical material from this unit yielded 12.5 ppm (parts per million) uranium and 124 ppm thorium (Miller and Bunker, 1975a). Uraninite, thorite, and betafite have been identified in this unit.

The Wheeler Creek pluton underlies the Purcell Mountains west of the Zane Hills (Miller, 1970), and alaskite, which may be of interest for its uranium and thorium content, underlies about 30 mi^2 of the western part of the pluton.

Farther west is a group of slightly older plutons of mid-Cretaceous age consisting of variety of rock types that range from quartz monzonite to monzonite and syenite. This suite is characterized by a relatively low quartz content (generally less than 10%) and a high K-feldspar content. The uranium and thorium content of these rocks is variable but usually high, with selected grab samples containing as much as 20 ppm uranium and 60 ppm thorium.

Associated with these plutons are alkaline, highly potassic subsilicic rocks which form a well-defined belt of intrusive complexes, zoned plutons, and dike swarms that extends for about 730 miles from west-central Alaska through St. Lawrence Island to the Chukotsk Peninsula (Miller, 1972). They are generally single-feldspar nepheline-bearing rocks that are highly alkaline, predominantly potassic, and strongly undersaturated in silica. They are not subaluminous and the molar ration of alkali to alumina is always less than one. Analyses of selected samples of these alkaline rocks have uranium contents as high as 30 ppm and thorium as high as 180 ppm.

The Selawik Hills pluton, one of the large syenite-monzonite plutons, is composed of strongly faulted quartz monzonite, monzonite, and hybrid syenite cut by nepheline syenite dikes. Locally the pluton appears to have been subjected to potassium metasomatism resulting in K-rich gneissic syenite along the northern margin. Grab samples of representative syenite have yielded as much as 20 ppm uranium and 65 ppm thorium. Part of the pluton has recently been drilled for uranium.

Another interesting occurrence of uranium in the region is at the upper Peace River in the eastern Seward Peninsula near Granite Mountain (fig. 2) where the presence of uranium-bearing veins is suggested by the association of uranium, silver, molybdenum, bismuth, copper, and lead in pan concentrates, stream sediments, and rock samples (Gault and others, 1953; Miller and Elliott, 1969). Uranothorianite and gummite have been identified in the pan concentrates. Country rock consists of poorly exposed fractured syenite which is probably part, or a satellite, of the Granite Mountain pluton.

Finally, uranium minerals such as zuenerite together with radioactivity anomalies have been reported associated with some of the Late Cretaceous-Early Tertiary tin granites of northwestern Seward Peninsula (West and White, 1952; Sainsbury and others, 1970).

The Darby pluton in the southeastern Seward Peninsula (fig. 2) is an example of a particularly uraniferous pluton (Miller and Bunker, 1975b). It is composed of highly silicic coarse-grained quartz monzonite of Late Cretaceous age and has an average content of about 11 ppm uranium and 59 ppm thorium. This large pluton is comparable in uranium and thorium content to the Conway Granite of New Hampshire which has been mentioned as a possible low-grade thorium resource (Adams and others, 1962).

The occurrence of above average amounts of uranium and thorium in plutonic rocks that have an age range of at least 35 m.y., have a compositional range from biotite granite to nepheline syenite, and are in quite different geologic settings certainly suggests the existence of a uranium-thorium province. There is perhaps some evidence that the area is more of a thorium province but enough anomalous uranium occurrences exist to show the area has considerable uranium potential.

High grade metamorphic rocks of Precambrian age occur in several areas in Alaska and may be areas with uranium potential. These rocks of the amphibolite facies, including both para- and orthogneiss, are intruded by younger granitic plutons. Rocks of this type are found in the central and southeastern Seward Peninsula, in the Kanektok district of southwest Alaska, and perhaps in interior Alaska in the Kokrines-Hodzana Highlands and Kaiyuh Hills (fig. 1).

Any region the size of Arizona, Colorado, Idaho, New Mexico, Utah, and Wyoming located within the North America Cordillera must be considered to have at least some hardrock uranium potential. A uranium-thorium province has already been at least partially outlined in western Alaska and another may well exist in southeastern where production has already been obtained. As more detailed geological and geophysical studies are done in these and other parts of Alaska, other provinces and deposits are likely to be found.

References Cited

Adams, J. A. S., Kline, M. C., Richardson, K. A., and Rogers, J. J. W., 1962, The Conway Granite of New Hampshire as a major low-grade thorium resource: Natl. Acad. Sci. Proc., v. 48, p. 1898-1905.

Clark, A. L., Berg, H. C., Cobb, E. H., Eberlein, G. D., MacKevett, E. M., Jr., and Miller, T. P., 1975, Metal provinces of Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I-834.

Cobb, E. H., compiler, 1970, Uranium, thorium and rare-earth elements in Alaska: U.S. Geol. Survey Mineral Inv. Resources Map MR-56, 3 p.

Gault, H. R., Killeen, P. L., West, W. S., and others, 1953, Reconnaissance for radioactive deposits in the northeastern part of the Seward Peninsula, Alaska, 1945-47 and 1951: U.S. Geol. Survey Circ. 250, 31 p.

MacKevett, E. M., Jr., 1963, Geology and ore deposits of the Bokan Mountain uranium-thorium area, southeastern Alaska: U.S. Geol. Survey Bull. 1154, 125 p.

Miller, T. P., 1970, Petrology of the plutonic rocks of west-central Alaska: U.S. Geol. Survey open-file report, 132 p.

Miller, T. P., and Bunker, C. M., 1975a, U, Th, and K analyses of selected plutonic rocks from west-central Alaska: U.S. Geol. Survey open-file report 75-216, 5 p.

Miller, T. P., and Bunker, C. M., 1975b, A reconnaissance study of the U and Th content of plutonic rocks in the southeastern Seward Peninsula, Alaska: U.S. Geol. Survey open-file report 75-217, 26 p.

Miller, T. P., and Elliott, R. L., 1969, Metalliferous deposits near Granite Mountain, eastern Seward Peninsula, Alaska: U.S. Geol. Survey Circ. 614, 19 p.

Patton, W. W., Jr., 1970, Discussion, in Tailleur, I. L., and Brosgé, W. P., Tectonic history of northern Alaska: Proceedings of the geological seminar on the north slope of Alaska, Pacific Sect., Am. Assoc. Petroleum Geologists, p. E20.

Sainsbury, C. L., 1969, The A. J. Collier thrust belt of the Seward Peninsula: Geol. Soc. America Bull., v. 80, n. 12, p. 2595-2596.

Sainsbury, C. L., Hudson, T. L., Kachadoorian, Reuben, and Richards, Thomas, 1970, Geology, mineral deposits, and geochemical and radiometric anomalies, Sepentine Hot Springs area, Seward Peninsula, Alaska: U.S. Geol. Survey Bull. 1312, 19 p.

West, W. S., and White, M. G., 1952, The occurrence of zeunerite at Brooks Mountain, Seward Peninsula, Alaska: U.S. Geol. Survey Circ. 214, 7 p.

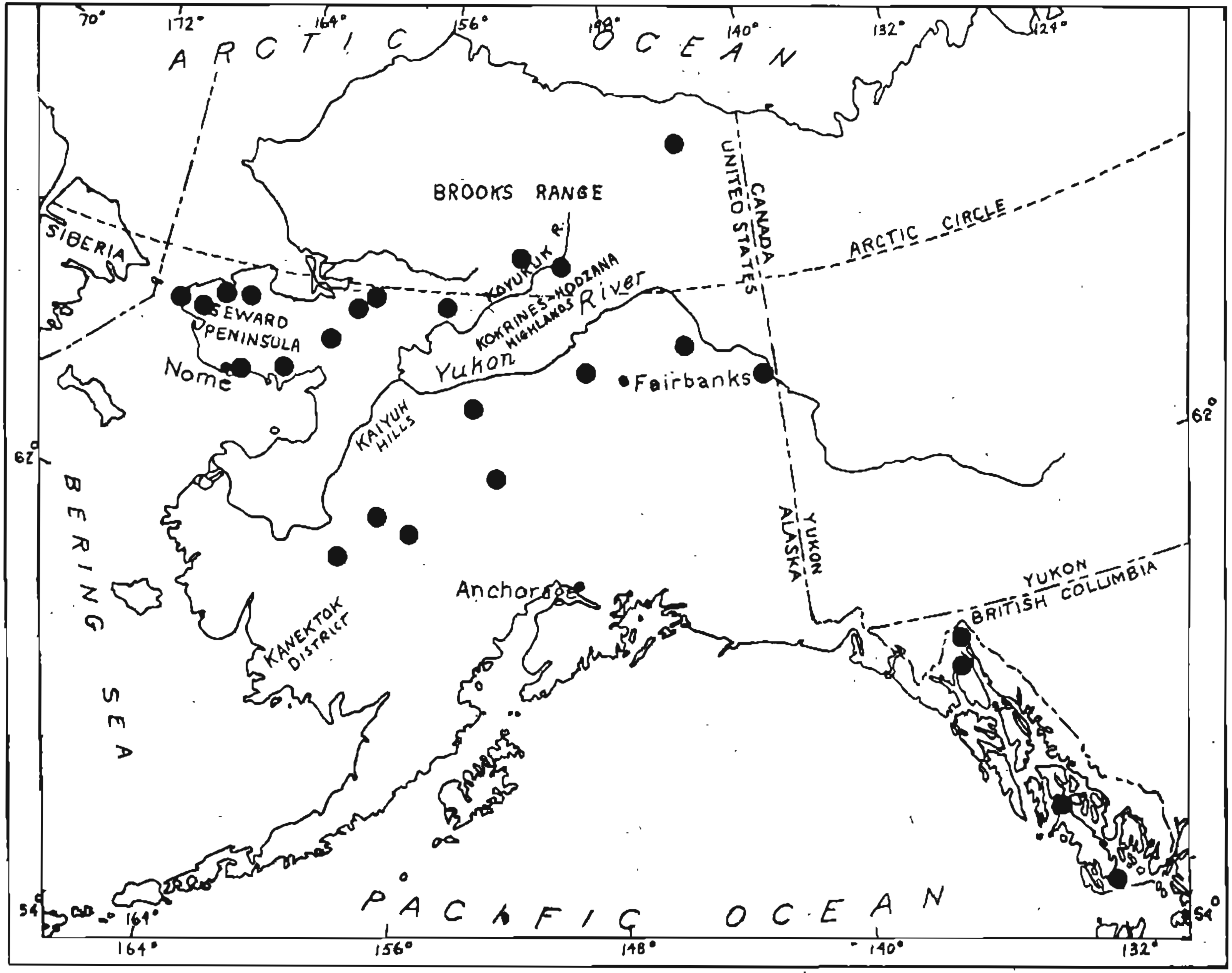

Figure 1. General index map of Alaska showing location of hardrock occurrences of uranium-thorium minerals (modified from Cobb, 1970).

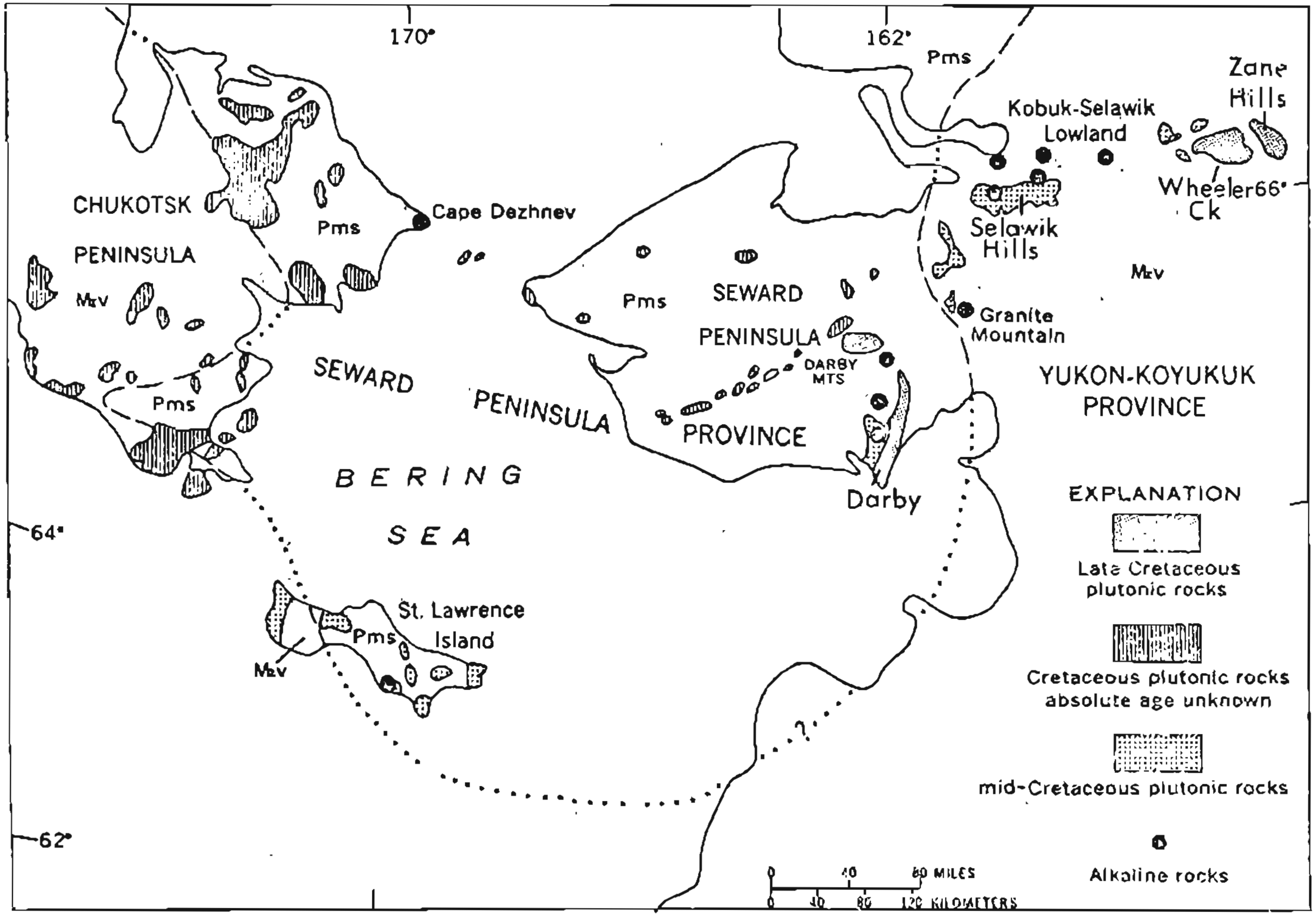

Figure 2. Distribution of Mesozoic plutonic rocks in western Alaska and the Bering Sea Region.