UNITED STATES
DEPARTMENT OF THE INTERIOR
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PROGRESS REPORT ON URANIUM INVESTIGATIONS IN THE ZANE HILLS AREA, WEST-CENTRAL ALASKA

By

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

Introduction

The Zane Hills pluton underlies a mountainous area of about 460 km^2 in west-central Alaska and is locally enriched in uranium and thorium (Miller and Ferrians, 1968; Miller, 1970; Staatz and Miller, 1976). While over 90 percent of the pluton consists of granodiorite with average contents of uranium and thorium, zones of porphyritic to gneissic monzonite along the southern and eastern margins of the pluton (fig. 1) contain as much as 100 ppm (parts per million) uranium and 269 ppm thorium (Staatz and Miller, 1976; table 1, this report). This report presents information obtained in 1976 on the relationship of the uraniferous monzonite to the granodiorite and on uranium enrichment outside the pluton as part of an on-going study of the area.

Geologic setting

The Zane Hills pluton is part of the Hogatza plutonic belt of west-central Alaska and is composed chiefly of light-gray, generally medium-grained, hypidiomorphic and equigranular leucocratic granodiorite and quartz monzonite (Miller, 1970). Biotite is the only varietal mafic mineral found in the granodiorite over the south half of the pluton; hornblende occurs along with biotite over the north half. Border phases of heterogeneous monzonite and syenite occur locally along the southern and eastern margins of the pluton. Rocks of this unit are characterized by a gneissic to porphyritic texture, are fine- to coarse-grained, and generally more mafic than the granodiorite. A coarse-grained porphyritic quartz monzonite occurs at the north end of the pluton (fig. 1).

The plutonic rocks intrude andesitic volcanic rocks of Early Cretaceous age (Patton and Miller, 1966); a K-Ar age measurement of 81.9±3.0 m.y. has been obtained on hornblende from the monzonite near the southern margin of the pluton (Miller, 1970). The contact between granodiorite and the host-rock andesite is sharp and abrupt; the contact between monzonite and andesite is less abrupt and some potassium metasomatism of the andesite appears to have occurred.

Copper and molybdenum mineralized areas occur in the Zane Hills (Miller and Ferrians, 1968) and a placer gold mine has been operated at Hogatza (fig. 1) in recent years.

Relationship of monzonite and granodiorite

The contact between the granodiorite and the monzonite was known from previous work to be abrupt (Miller, 1970); however, because of the combination of poor outcrop, extensive frost-heaving, and lack of detailed mapping the mutual relationship of the two units was unknown. An attempt to determine this relationship was one of the primary goals of the 1976 study in the Zane Hills.

Near locality 4 (fig. 1) at the southern border of the pluton, the contact between granodiorite and monzonite strikes obliquely across a narrow, almost knife-like ridge. Although the surface of the ridge consists of large angular frost-riven blocks with no true outcrop, the narrowness of the ridge allows the contact to be located to within a meter. Near the contact the monzonite is a fresh unaltered trachytoid rock with alkali feldspar phenocrysts 2 cm or more in length. It is composed essentially of microcline, plagioclase, hornblende, biotite, and minor quartz; accessory minerals are allanite, sphene, apatite, magnetite, zircon, and betafite(?). An analysis of the monzonite showed 17 ppm uranium and 131 ppm thorium (no. 76AMm8A1, table 1); radioactivity readings of 850 cps (counts per second) total count were recorded with a hand-held scintillometer over the monzonite. The monzonite shows no apparent change in either composition or texture as the contact with the granodiorite is approached.

The contact between the two units occurs along the margin of a 1-meter wide tundra-covered saddle. The granodiorite in this contact zone is strongly altered to a bleached fine-grained, sericitic rock showing numerous slickenslide surfaces; the texture of the granodiorite is cataclastic. Radioactivity over the contact zone is about 350 cps total count. The original biotite is completely altered and the rock appears to have been deformed along the original biotite grains. The feldspars are strongly sericitized.

Further away from the contact the granodiorite is less altered and contains accessory pyrite. The original biotite grains are seen as pseudomorphs completely altered to sericite. Radioactivity background is 250 to 300 cps total count.

Analyzed samples of strongly and moderately altered granodiorite showed 11.3 ppm and 10 ppm uranium respectively with 17 and 18 ppm thorium. The uranium values are markedly higher than the 6.9 ppm reported for typical biotite granodiorite collected about 3 km away (no. 7, fig. 1; table 1).

The contact relations suggest two possibilities: (1) the contact is a fault, or (2) the monzonite is the younger unit which intruded and altered the granodiorite. The second interpretation is favored by us since the monzonite shows no sign of the deformation that might be expected at a fault contact. Furthermore the granodiorite adjacent to the monzonite is enriched in uranium compared to granodiorite further away from the contact suggesting uranium was introduced during intrusion of the uraniferous monzonite into the granodiorite.

Uranium content of monzonite border phases

The porphyritic monzonite mapped along the southern and eastern borders is a heterogeneous unit which includes monzonite, syenite, quartz monzonite, and hybrid diorite; the texture and grain size vary from porphyritic and trachytoid to gneissic and from fine- to coarse-grained. The uranium and thorium content of 19 analyzed samples is similarly variable with a range of 11 to 99 ppm uranium, 46 to 269 ppm thorium, and a Th/U ratio from 1.8 to 10.3 (table 1). The average of these 19 samples is 30 ppm uranium and 125 ppm thorium; however, the sampling was by no means systematic and was probably biased towards the more radioactive samples. The analyzed samples do show that the monzonite unit as a whole is enriched in uranium and thorium and that concentrations of 100 ppm uranium or more occur locally. Most of the uranium and thorium appears to be concentrated in uranothorianite, thorite, betafite, allanite, zircon, and sphene disseminated in monzonite. No vein-type uranium mineralization was noted. Some fine-grained aplitic dikes appear to be enriched in uranium and thorium; one of these dikes (no. 15, table 1) yielded 130 ppm uranium, the highest value obtained from any sample from the pluton, and 189 ppm thorium. The uranium-bearing minerals in the dikes also appear to occur as disseminated accessory minerals. The radioactivity of the monzonite unit ranges from 500 cps to 2000 cps as compared to about 250 cps for the granodiorite.

The monzonite border phases of the Zane Hills pluton are clearly anomalously rich in uranium and thorium and therefore constitute an exploration target. Detailed studies may indicate zones of uranium enrichment within the pluton sufficiently large to be of economic value, however no such concentrations have been encountered during the reconnaissance studies of the pluton.

Uraniferous dikes near Clear Creek

A swarm of alkali-rich dikes and hypabyssal intrusives with above average radioactivity crops out along two heavily forested ridges north of Clear Creek and east of the pluton (fig. 1). Other small intrusive bodies occur in the vicinity of Comeback Creek. The fine-grained intrusive rocks on the ridges north of Clear Creek are slightly to moderately altered and strongly radioactive with radioactivity ranging from 500 to 1000 cps as compared to 30 to 60 cps in the andesite. Many of the dikes are stained with hematite. They contain abundant alkali feldspar but little quartz and mafic minerals; magnetite is very abundant, an estimated 2 to 3 percent of the rock in some cases. At locality 21 (fig. 1), a fine-grained reddish felsic dike about 60 m wide cuts meta-andesite; the dike strikes approximately north-south and is nearly vertical. The tundra-covered saddle in which the dike occurs gives radioactivity readings as high as 850 cps compared to 30 to 40 cps in the adjacent andesite. A sample of the dike contained 52 ppm uranium and 226 ppm thorium (no. 21, 76AMm21, table 1). A swarm of poorly-exposed, commonly altered dikes occur further east on the same ridge. They range in composition from alkali-rich aplitic dikes to nepheline syenite. The alkali-rich dikes are similar to the "bostonite" dikes of the Front Range uranium district in Colorado (Sims and others, 1963). The nepheline syenite, a dense blue-gray fine-grained variety often termed pulaskite, is identical to pulaskite dikes found in the western Alaska alkaline rock province to the west (Miller, 1972) and thus extends the length of this province an additional 130 km. Similar dikes near Golovin in the southwestern Seward Peninsula are also enriched in uranium and thorium and appear to be the source of uranium enrichment in wallrock syenite which contains as much as 1500 ppm uranium in allanite-rich replacement bodies (Miller and others, 1976). The pulaskite dike north of Clear Creek contains 82 ppm uranium and 188 ppm thorium (no. 20, 76AMm25, table 1). Other dikes at this locality show similar high uranium and thorium contents (no. 20, table 1).

A large poorly-exposed hypabyssal intrusive body crops out on the ridge immediately north of Clear Creek (loc. 19, fig. 1) and appears to be composed chiefly of a dark blue-gray, feldspar porphyry which in turn is cut by a variety of dikes. An analyzed sample of feldspar porphyry yielded 35 ppm uranium and 80 ppm thorium. Rubble fragments of an altered, reddish "bostonite" dike, which apparently cuts the feldspar porphyry, are found in the tundra; this rock is strongly radioactive

(1100 cps recorded for a fragment 25 cm in length), and an analyzed sample contained 407 ppm uranium and 556 ppm thorium (no. 19, 76AMm26B, table 1). This altered "bostonite" consists of scattered alkali feldspar phenocrysts in an altered groundmass of K-feldspar. Magnetite is abundant, perhaps 2 to 3 percent of the rock, as is allanite. An isotropic, high-relief mineral which is yellowish-green in transmitted light is also abundant; a heated sample of this material produces the X-ray pattern of betafite, a uraniferous niobate mineral (M. H. Staatz, oral communication). Betafite and to a lesser extent allanite probably contain most of the uranium in the rocks. Some hornfelsic andesite was found as isolated blocks in the tundra and probably occurs as xenolithic inclusions in the intrusives; the andesite also was high in uranium (33 ppm) and thorium (105 ppm).

The occurrence of uraniferous rocks in the area north of Clear Creek is of interest since it indicates uranium enrichment is not necessarily confined to the pluton. Furthermore, the high uranium and thorium content in altered andesite xenoliths(?) indicates at least some enrichment of the country rock. The Th/U ratio of 1.4 to 4.4 (table 1) of the dikes is relatively low compared to a Th/U of 1.5 to 10.3 for monzonite of the Zane Hills pluton.

Summary

Recent work in the Zane Hills pluton indicates that the heterogeneous monzonite unit is anomalously rich in uranium and thorium (Miller and Ferrians, 1968; Miller, 1970; Staatz and Miller, 1976). This monzonite appears to have intruded the granodiorite that comprises over 90 percent of the pluton. Aplite and "bostonite" dikes that intrude both the monzonite and the andesitic country rock north of Clear Creek are enriched in uranium and thorium suggesting possible uranium deposits outside the pluton itself.

The occurrence of pulaskite dikes north of Clear Creek extends the belt of alkaline rocks in western Alaska (Miller, 1972) and eastern Siberia an additional 130 km to the east for a total length of about 1200 km.

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Table 1. Uranium and thorium analyses in parts per million (ppm) of selected grab samples from the Zane Hills area. Map number refers to Figure 1.

Map no.	Field no.	U ppm	Th ppm	Th/U	Description
1	67AMm259	32.94*	135.0 *	4.1	Gneissic monzonite
2	76AMm9	29.37	199.28	6.8	Fine-grained gneissic monzonite
3	67AMm256	14.48*	75.17*	5.2	Medium-grained porphyritic monzonite
4	76AMm8A1	17.36	131.09	7.6	Porphyritic monzonite
4	76AMm8A3	11.32	17.99	1.6	Strongly altered granodiorite
4	76AMm8A2	10.02	17.36	1.7	Moderately altered granodiorite
5	76AMm6	31.04	187.07	6	Medium-grained gneissic monzonite
6	67AMm246	22.47*	117.61*	5.2	Dioritic gneiss
7	67AMm136	6.94*	25.56*	3.7	Unaltered biotite granodiorite
8	67AMm150	26.07*	46.10*	1.8	Coarse-grained gneissic monzonite
8	67AMm150	45.06*	268.85*	6	Fine-grained gneissic monzonite
8	67AMm150	32.32*	69.93*	2.2	Coarse-grained gneissic monzonite
9	76AMm1	12.85	131.93	10.3	Fine-grained gneissic monzonite
10	67AMm151	25.08*	106.82*	4.3	Coarse-grained gneissic monzonite
10	67AMm151	33.68*	167.86*	5	Fine-grained gneissic monzonite
10	67AMm151	12.42*	123.92*	10	Coarse-grained porphyritic monzonite
11	76AMm20	16.74	128.78	7.7	Slightly gneissic aplite dike
12	A-5-74	47.79*	100.6 *	2.1	Coarse-grained gneissic monzonite
13	A-4-74	40.25*	83.23*	2.1	Medium-grained gneissic monzonite
14	A-3-74	11.09*	81.94*	7.4	Medium-grained gneissic monzonite
15	A-2-74	129.5 *	188.8 *	1.5	Aplitic dike
16	A-1-74	23.12*	117.3 *	5.1	Fine-grained gneissic monzonite
17	76AMm3	12.73	57.68	4.5	Medium-grained gneissic monzonite
18	A-8-74	98.50*	179.8 *	1.8	Medium-grained gneissic monzonite
19	76AMm26A	34.88	80.07	2.3	Altered feldspar porphyry intrusive
19	76AMm26B	407.14	556.49	1.4	Altered bostonite dike
19	76AMm26C	32.58	104.68	3.2	Meta-andesite hornfels
20	76AMm23	39.51	173.92	4.4	Altered bostonite dike
20	76AMm24	53.04	160.51	3	Altered bostonite dike
20	76AMm25	81.89	187.65	2.3	Altered bostonite dike
21	76AMm21	53.31	226.31	4.25	Altered bostonite dike

Analyses marked with * are by gamma-ray spectrographic methods and are taken from Staatz and Miller (1976) and Miller and Bunker (1975); all other analyses are by delayed neutron determination. The coefficient of variation of uranium analysed by delayed neutron determination is equal to or less than 2% and the coefficient of variation of thorium is equal to or less than 10%; analysts are H. T. Millard, Jr., A. J. Bartel, R. J. Knight, C. L. Shields, C. M. Ellis, R. L. Nelms, C. A. Ramsey, R. J. Vinnola, E. Brandt.

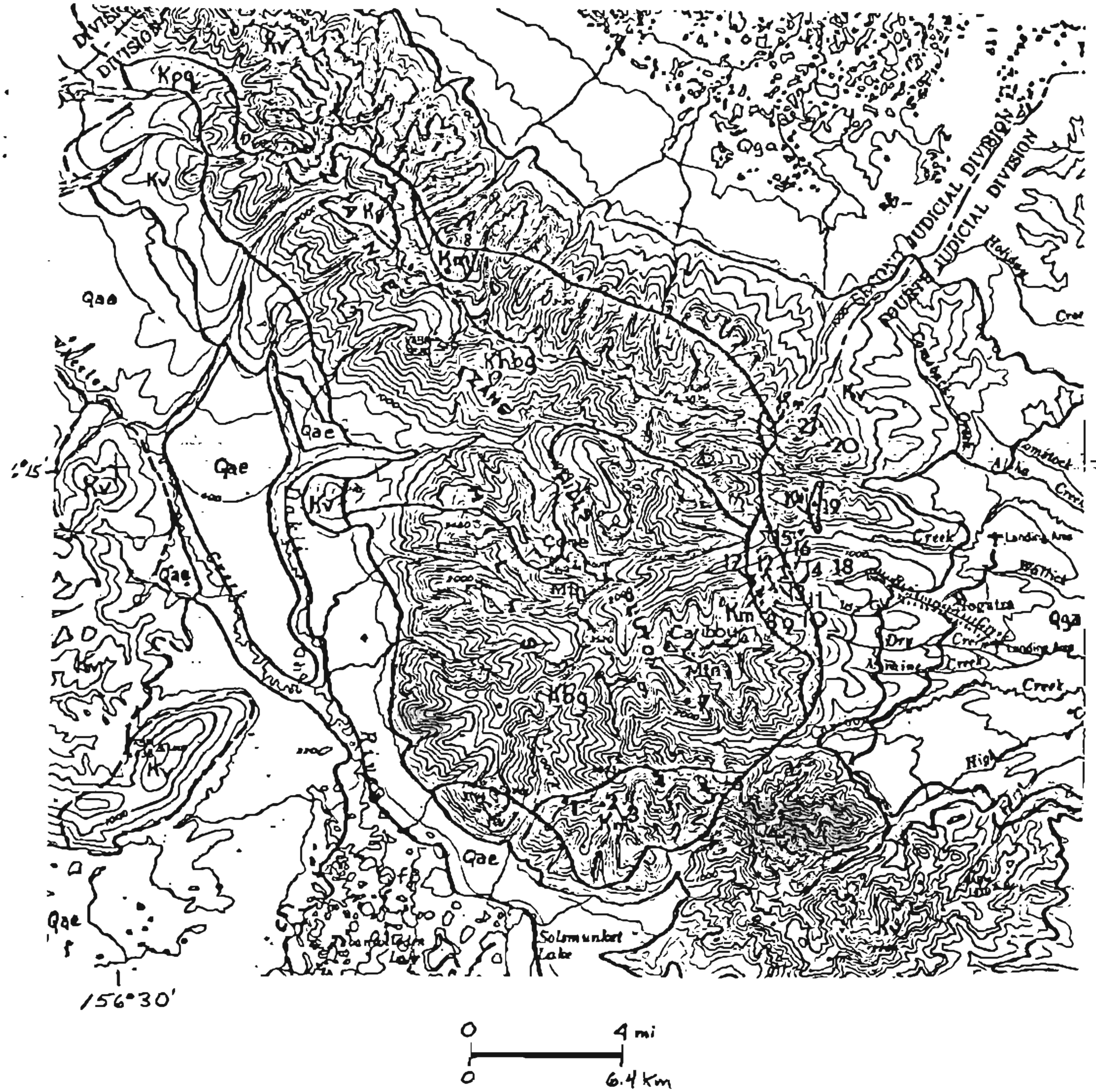


Figure 1. Geologic map of the Zane Hills area, west-central Alaska. Sample numbers refer to table 1. Map explanation on following page.

Map explanation for Figure 1.

Quaternary

Qfp

Floodplain deposits

Qga

Undifferentiated glacial drift, alluvium, and eolian deposits

Qae

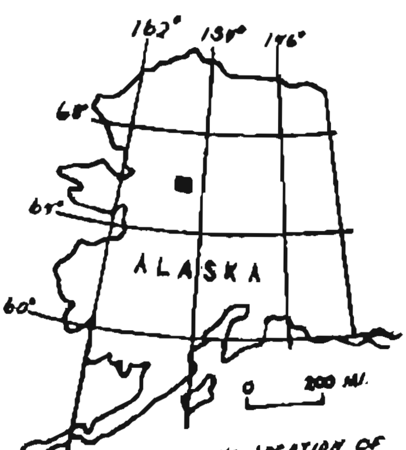
Undifferentiated alluvial and eolian deposits

Cretaceous

Km	Khbg	Kbg	Kpq
Monzonite and syenite	Hornblende-biotite granodiorite	Biotite granodiorite	Porphyritic quartz monzonite

Kv

Andesitic volcanic rocks



INDEX MAP SHOWING LOCATION OF REPORT AREA