UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY REPORT ON URANIUM-, THORIUM-, AND RARE-EARTH-BEARING ROCKS NEAR GOLOVIN, ALASKA

By

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Open-file report 76-71

1976

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

Introduction:

Uranium-, thorium-, and rare-earth bearing rocks were found by a U. S. Geological Survey field party 15 miles northeast of Golovin, Alaska, in the southeastern Seward Peninsula (fig. 1) in June 1976. The mineralized areas occur in syenite and appear to be concentrated along the margins of alkaline dikes, with allanite tentatively identified as the principal mineral containing the uranium-, thorium-, and rare-earths. Samples contain as much as 0.15 percent U_3O_8 and 1.05 percent ThO_2, and over 2 percent rare-earth elements. These mineralized rocks are closely associated with alkaline dikes which are part of a dike swarm that crops out over at least 250 km^2 (100 mi^2). This large dike swarm is thus of considerable economic interest.

These uranium-, thorium-, and rare-earth-rich rocks occur near the west end of the western Alaska uranium-thorium province (West, 1953; Clark and others, 1975; Miller, 1976) and were found during a regional investigation of this province by the Geological Survey. The alkaline dikes were known from previous mapping by the two senior authors (Miller and others, 1972) to be anomalously radioactive. The mineralized areas described in this report were found while making a brief study of (1) alteration and/or mineralization associated with these dikes and (2) their relation to similar dikes and rocks which occur elsewhere in the province (Miller, 1972).

Regional geology:

Potential resources of uranium-, thorium-, and rare-earths occur in the Kachauik pluton which underlies an area of about 500 km^2 (200 mi^2) in the upland area just west of the Darby Mountains (fig. 1). The

pluton is a composite body with granodiorite forming most of the west half of the pluton and monzonite and syenite forming the eastern part (Miller and others, 1972; Miller and Bunker, 1976). Samples representing the composition range of the monzonite-syenite unit in the Kachauik pluton average 5.2 ppm U and 21.9 ppm Th (Miller and Bunker, 1976, p. 373) and 6.4 ppm U and 23.4 ppm Th for the granodiorite. The radio-activity of the monzonite and syenite ranges from 200 to 400 cps (counts per second, total count). A more detailed petrologic description of the Kachauik pluton is contained in Miller and Bunker (1976).

The pluton intruded schistose marbles, quartz-mica schist, and a migmatite complex all of Precambrian age. A satellitic pluton to the northeast is intruded by quartz monzonite of the Darby pluton.

The Kachauik pluton is considered to be of mid-Cretaceous age based on K-Ar ages of 97.5±3 m.y. for the monzonite-syenite unit and 93.9±3 m.y. for the alkaline dikes (Miller and others, 1972). It is thought to be one of several plutons of similar age and composition that constitute the western half of the Hogatza plutonic belt (Miller, 1970) in western Alaska.

A swarm of alkaline dikes has intruded much of the northern half of the pluton and similar dikes cut schistose marble west of the pluton. The dikes inside the pluton have a consistent N. 40° E. strike, are 3 to 15 m (10-15 ft) wide, and dip steeply to vertical. They consist of pulaskite and pseudoleucite prophyry (Miller, 1972) and are generally blue-green, fine-graned, and dense. The pulaskite and pseudoleucite porphyry are composed of nepheline, a single alkali feldspar, abundant

pseudoleucite phenocrysts, and melanite garnet; purple fluorite is a common accessory. They are strongly radioactive with a total count ranging from 400 to 900 cps. They tend to form smaller talus and frost riven blocks than the enclosing monzonite. This characteristic, together with their lighter color, makes them readily apparent from the air on ridges normal to their northeast strike. Locally these dikes are very abundant; on some ridges, for example, as many as half a dozen dikes occur over a distance of 300 m (1000 ft). Whether this density holds for the entire area covered by the dike swarm is unknown; away from the cross-cutting ridges, the dike talus tends to be masked by the larger monzonite and syenite talus. The average length of these dikes is likewise unknown; at least one dike, however, can be traced for at least 900 m (3000 ft) along a ridge crest.

The alkaline dikes are found from the extreme north end of the Kachauik pluton (fig. 1) to just north of Cape Darby (a distance of 53 km or 33 mi) and from near the Kachauik River to about the Kwiniuk River (24 km or 15 mi). They appear to be concentrated, however, over an area of at least 250 km^2 (100 mi^2) centered around the upper Eagle River. Besides the alkaline dikes, numerous lamprophyre, aplite, and quartz latite dikes also intrude the Kachauik pluton.

Description of mineralized areas:

The principal mineralized area occurs on top of a small flat knoll (shown as hill 2109 in the SW ¼ of Sec. 18, T. 9 S., R. 20 W. on the Solomon C-2 1:63,360 quandrangle map, fig. 2) located on the crest of

a north-south ridge bounded on three sides by Eagle Creek (fig. 2). The mineralized rock consists of medium- to coarse-grained syenite characterized by large (as much as 1.25 cm or 0.5 in) brownish-black allanite crystals constituting 20 to 40 percent of the rock. Because of extensive frost-heaving, none of the allanite-rich rock can be found actually in place; however, abundant pieces of float of this material as much as 30 cm (12 in) across occur scattered over a zone 9-14 m (30-45 ft) wide and extending some 60 m (200 ft) across the top of the knoll. This zone lies near the east margin of a northeast-striking pulaskite dike which extends for some 900 m (3000 ft) along the ridge crest. Float of allanite-bearing syenite was found in several other places over a distance of 450 m (1500 ft) along the eastern margin of the dike south of hill 2109 suggesting the mineralized zone may have considerable strike length. The dike is offset as much as 15 m by faulting in at least two places.

The actual width of the mineralized zone is difficult to determine owing to the lack of true outcrop. The larger talus blocks of non-mineralized monzonite and syenite tend to mask the smaller blocks of allanite-bearing syenite on the slopes and on the ridge crest away from the flat-topped knoll at hill 2109.

The allanite-bearing syenite is strongly radioactive with a total count of up to 8000 cps being recorded for pieces of float up to 12 inches across. This is 20 to 25 times background for the syenite and monzonite of the Kachauik pluton. In addition to allanite, the mineralized rock contains K-feldspar, plagioclase, and nepheline with minor hornblende

and biotite. Zircon, apatite, and sphene are present as accessories. Nepheline has been previously noted at a few localities in the Kachauik pluton, but it does not appear to be widespread. It's occurrence next to a nepheline-bearing dike suggests that it may have been metasomatically introduced, perhaps along with the allanite.

Other pulaskite dikes occur on the west side of hill 2109 and strongly radioactive allanite-bearing syenite float was found along the margin of at least one of these dikes (sample 1, table 1).

Samples of the strongly radioactive allanite-bearing syenite pulaskite dike were analyzed for uranium and thorium and the results are given in table 1 (samples 1, 3, 4, and 5). These samples were selected as being typical of the most radioactive material found and were taken from float blocks as much as 30 cm (12 in) across. The uranium content of the radioactive allanite-bearing syenite averages 1325 ppm (0.156 percent U_3O_8) by neutron activation analysis and thorium averages 7990 ppm (0.91 percent ThO_2). A sample of the pulaskite (sample 2) dike yielded 34 ppm U (0.004 percent U_3O_8) and 96 ppm Th (0.011 percent ThO_2), which is about 7 times the uranium content for the average monzonite and syenite and about 4 times the thorium background.

Analyses of the rare-earth content of these same rocks are given in table 2. It should be noted that these are semi-quantitative spectrographic analyses and therefore are only approximate. The analyses, however, indicate that the rare-earth content, particularly that of the cerium group of rare-earths, may exceed 2 percent in some samples.

On a low flat-topped spur 1.5 mi to the north in the NW ¼ of Sec.

Table 1. Uranium and thorium analyses in parts per million (ppm) of samples from the Kachauik pluton. Map number refers to Figure 1.

Map no.	Field no.	U ppm 1/	Uppm 2/	Th ppm 1/	Th ppm 2/
1	76 AMm112	1107	1000	6619	5700
2	76 AMm112C	34	--	96	--
3	76AEr23	1162	1050	7692	6400
4	76AM112B	1486	--	9240	--
5	76AEr23B	1545	1500	8408	7000
6	76AMm110	--	392	--	9200

1/ Delayed neutron determination. The coefficient of variation of uranium and thorium is more than 1% for all samples. Analysts A. J. Bartel and R. J. Vinnola.

2/ Gamma-ray spectrometric analysis. The coefficient of variation of uranium and thorium is more than 2% for all samples. Analysts C. M. Bunker and C. A. Bush.

Table 2. Rare-earth content in parts per million (ppm) of samples from the Kachauik pluton. Analysis by 6 step spectrographic techniques with results reported as geometric mid-points (i.e. 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc.) of geometric brackets having the boundaries 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, 0.083, etc., or some multiple thereof. The precision of semiquantitative spectrographic results is approximately plus 100 percent or minus 50 percent. Analyst Leon A. Bradley.

Map no.		1	2	3	4	5
Field no.		76AMm112	76AMm112C	76AEr23	76AMm112B	76AEr23B
	La	7000	300	7000	7000	7000
	Ce	7000	700	7000	10,000	7000
	Pr	700	N	700	700	700
	Nd	3000	150	5000	5000	3000
	Sm	700	N	700	700	700
	Eu	70	N	70	70	70
	Gd	150	–	200	200	200
	Tb	N	–	N	N	N
	Dy	100	–	150	100	150
	Ho	30	–	50	70	70
	Er	70	–	70	70	100
	Tm	N	–	N	N	N
	Yb	15	20	15	10	50
	Lu	N	–	N	N	N
	Y	300	N	500	700	700

7, T. 9 S., R. 20 W. (fig. 2), radioactivity readings of 600 cps were recorded on the bog and tundra-covered ridge crest suggesting other mineralized areas may occur in this area.

Similar allanite-rich syenite was found occurring as isolated boulders on a largely tundra-covered ridge 10 km (6 mi) to the east in Sec. 12, T. 9 S., R. 20 W. north of Burnt Creek (fig. 2). A fist-sized sample (no. 6, table 1) taken from a large boulder yielded 392 ppm U (0.059 percent U_3O_8) and 9200 ppm Th (1.05 percent ThO_2).

Allanite appears to be the principal uranium-, thorium-, and rare-earth-bearing mineral in the several samples examined in thin-section. A detailed study of the mineralogy has not been made, however, and other uranium minerals may be present. The allanite occurs as euhedra as much as 1.25 cm (0.5 in) long, is strongly metamict, and cut by numerous anastomosing fractures. A characteristic bright reddish-brown weathered crust is found on the weathered surfaces of many of the allanite crystals; according to Hata (1939), this material consists mainly of ferric hydroxide, alumina, silica, and carbon dioxide. Zircon, while moderately abundant, occurs only as an accessory.

Land status:

The mineralized areas and much of the area of alkaline dike occurrence are in lands presently withdrawn for native village and/or regional corporation selections under the Alaska Native Claims Settlement Act (ANCSA) of 1971; the remainder of the area of alkaline dike occurrence is withdrawn under section D-2 of ANCSA for possible inclusion in national systems lands (Parks, Wildlife Refuges, etc.).

Summary:

The extent and value of the mineralized areas described here is unknown owing to the relatively poor exposures and the brief time spent in the area. The width of the mineralized zones are unknown and could be quite narrow; their strike length, however, could be considerable. The uranium, thorium, and rare-earth contents of samples are sufficiently high as to indicate further study of the economic potential of the deposits is warranted.

Of perhaps equal importance is the fact that similar mineralized material was found associated with alkaline dikes in two other localities, one of which is 6 miles away from the hill 2109 locality. These dikes are enriched in uranium and thorium as compared to the average monzonite-syenite of the pluton and may represent a lithologic and/or structural control of the uranium, thorium, and rare-earth mineralization. Since the alkaline dikes are part of a dike swarm that crops out over at least 250 km^2 (100 mi^2), this entire area appears worthy of more detailed exploration for uranium, thorium, and rare-earth elements.

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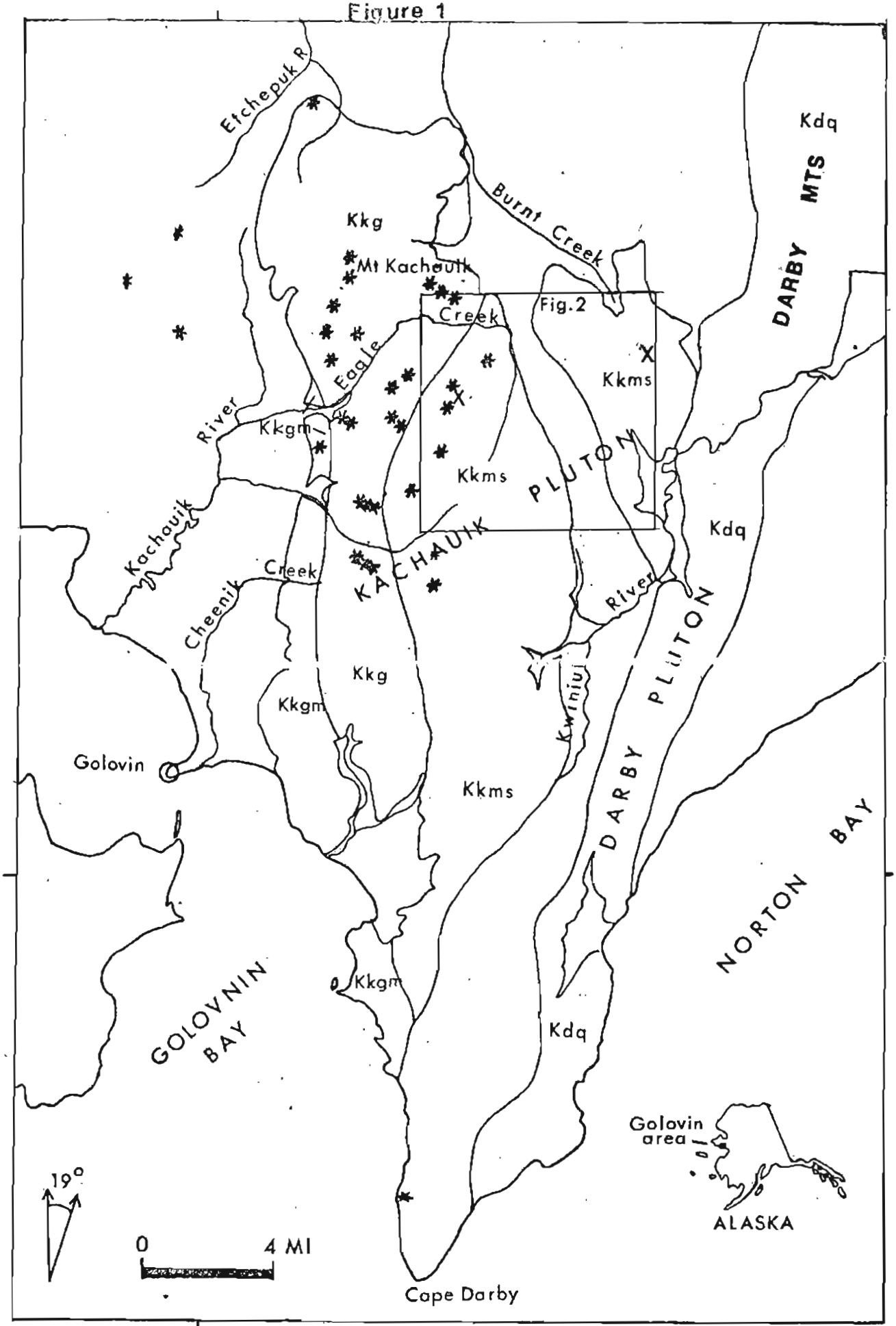
Figure 1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DARBY PLUTON
Golovin
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Figure 1. Generalized geologic map of the Kachauik pluton and adjoining areas taken from Miller and others (1972). Kkms = monzonite and syenite of Kachauik pluton; Kkg = granodiorite of Kachauik pluton; Kkgm = gneissic monzonite of Kachauik pluton; Kdq = quartz monzonite of Darby pluton; * = alkaline dike occurrence (many more dikes occur than are shown on this map); X = mineralized area described in text. Area included in Figure 2 also shown.

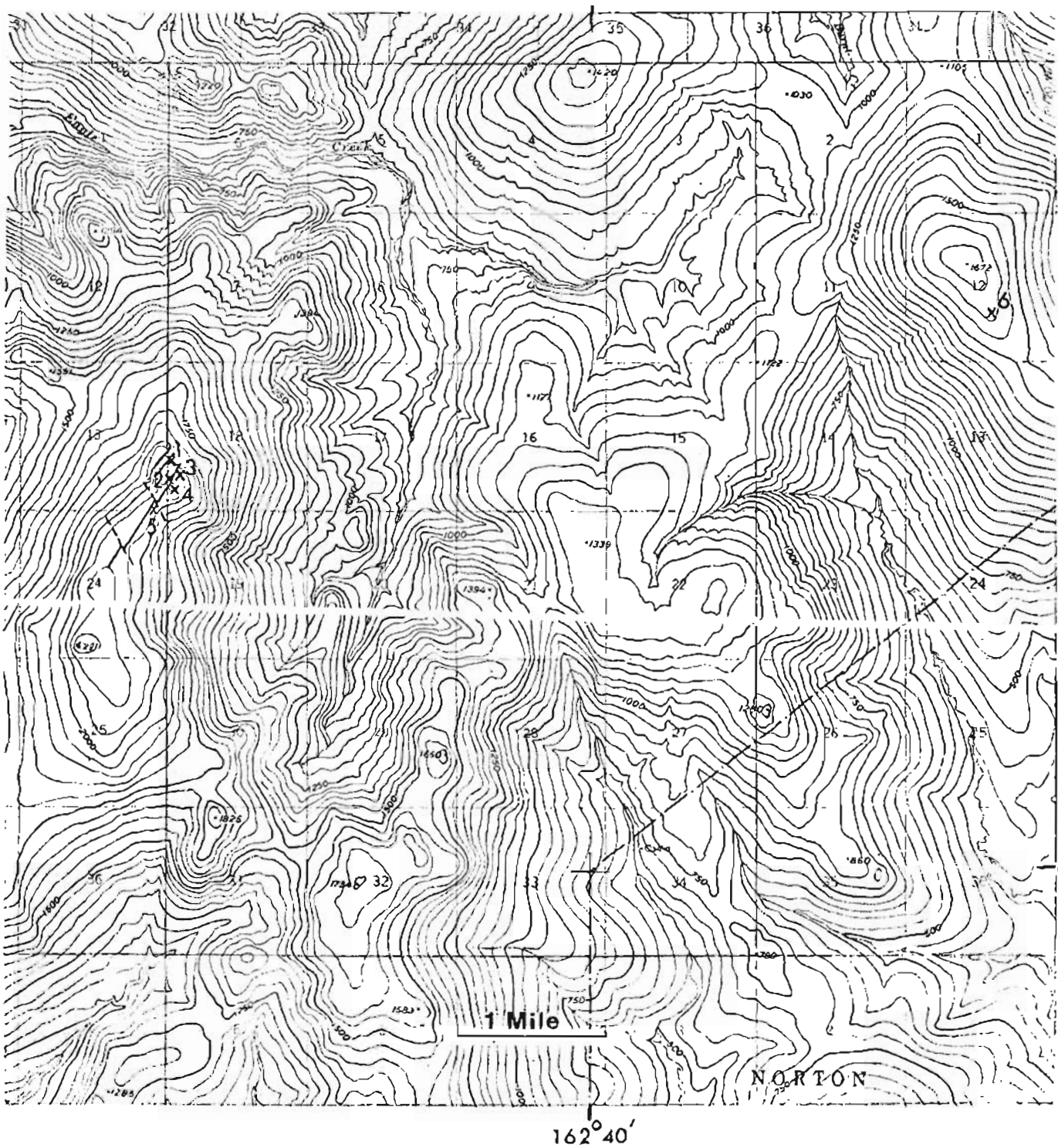

Figure 2. Location of mineralized areas and analyzed samples referred to in tables 1 and 2. Solid line = dike; dashed line = fault. See Figure 1 for general location.