Distribution of uranium and thorium in the lower Tertiary Orca Group and related rocks in Part of the Cordova quadrangle, southern Alaska

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INTRODUCTION

The reconnaissance airborne gamma-ray survey of the Cordova 1 x 3 degree topographic quadrangle along the coast of the Gulf of Alaska recorded six "preferred" anomalies partly or wholly over lower Tertiary sedimentary rock (LKB Resources, 1978). The purpose of the report is to describe the geologic setting and the distribution of uranium and thorium in the Orca Group, especially near these anomalies (fig. 1). Of all 83 quadrangles surveyed in Alaska, only the Cordova and the Healy quadrangles have anomalies over lower Tertiary sedimentary rock. In the Cordova quadrangle the anomalies were recorded over rock of the Paleocene to Eocene Orca Group and in the Healy quadrangle the anomalies were recorded over the Paleocene Cantwell Formation.

The statistical definition of anomalies and the basis for picking "preferred anomalies" are given by LKB Resources (1978). In general, preferred anomalies are those in which uranium appears to be enriched over potassium and thorium. The samples collected for this report were analyzed for uranium and thorium by the delayed neutron method (Millard, 1976).

Inclement weather, which included heavy rain and cloud cover, caused flooding and prevented many helicopter flights. Field work was limited to two and one-half days during August, 1981. The general areas of three of the anomalies and several road cuts near the village of Cordova were visited and sampled.

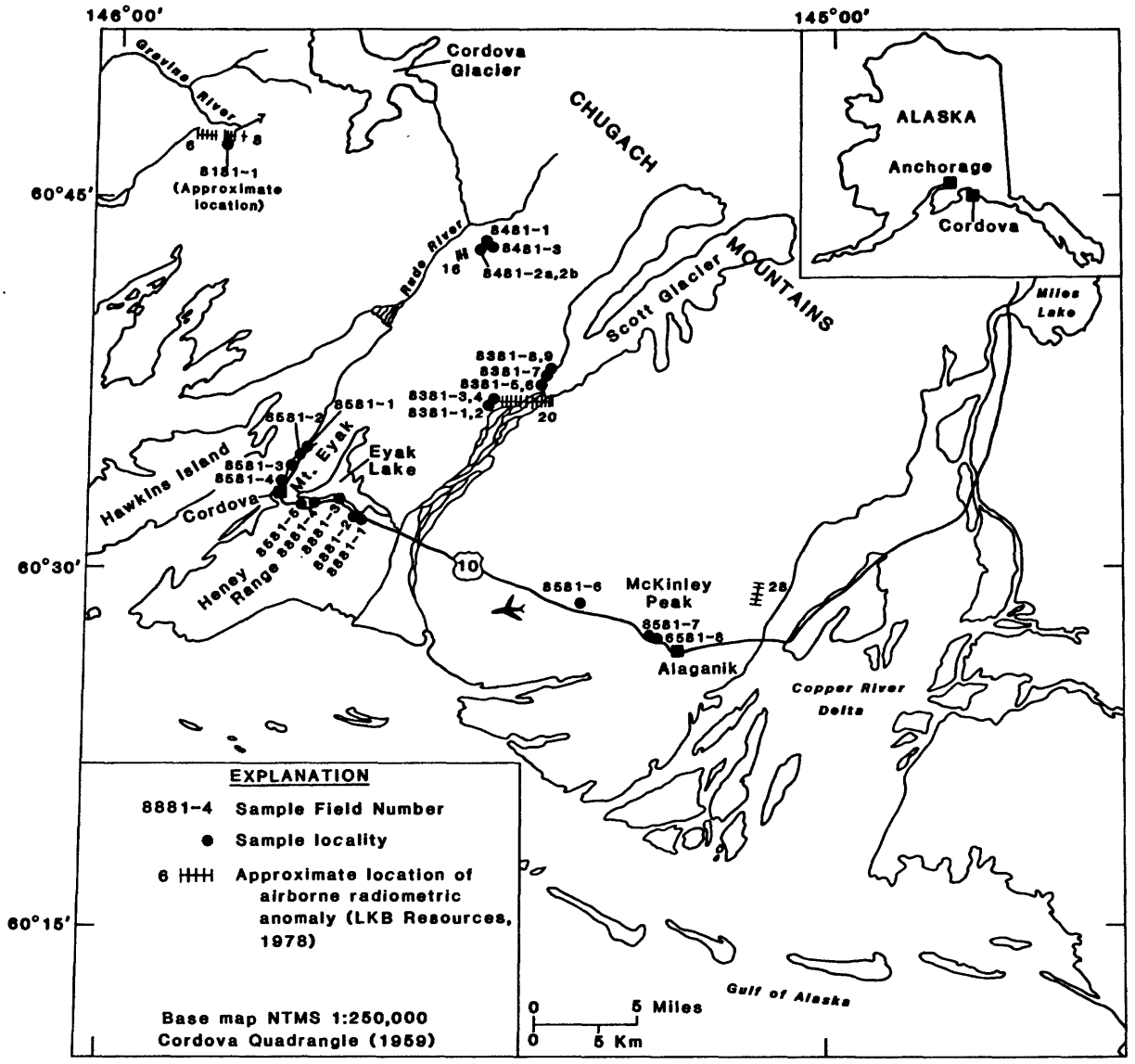

Figure 1.--Sample localities and geographic features of the Cordova area.

GEOLOGY

Rocks of the coastal area of the Gulf of Alaska near Cordova consists mainly of the complexly folded and metamorphosed lower Tertiary Orca Group and younger Tertiary plutons. Jurassic and Cretaceous rocks of the Chugach Mountains that are predominantly metamorphic lie inland to the north and are in apparent fault contact with the younger rocks. Rocks of the Orca Group are commonly faulted along the coast. They predominantly consist of dark-gray well-indurated flysch-like graywacke sandstone, siltstone, and mudstone that were deposited primarily by turbidity currents moving down the continental slope (table 1). The source of the sediment was probably the metamorphic terrane of the Chugach Mountains to the north. Tholeitic basalt deposited largely as pillow lavas is interbedded with the turbidites. According to Winkler (1976), about 15 to 20 percent of the Orca Group in the eastern Prince William Sound area north of Cordova consists of altered tholeitic basalt. Some of the pillow lavas are capped with marine limestone containing foraminifers. Limited microfaunal evidence suggests a Paleocene age for the entire Orca Group on Hinchinbrook Island (Winkler and Plafker, 1974).

The sedimentary rock of the Orca Group is well indurated, and gray to dark gray (table 1). The mudstone is commonly thin bedded and the sandstone commonly exhibits graded bedding and small-scale crossbeds. The rock has been metamorphosed to the prehnite-pumpellyite facies as a result of two metamorphic events. Slaty cleavage and crenulation of varying degrees is widespread. Veins of quartz or calcite are present in many of the outcrops; calcite veins tend to be more common in the mudstone. The veins formed in at least two stages; an earlier thicker set, averaging about 5.0 mm in width, that follows crenulation cleavage, and a later thinner set, ranging from 0.5 to 2.0 mm in width, that cuts the structure and the thicker set.

Table 1.--Uranium and thorium data for samples of Orca Group and related plutonic rocks.

Locality	Sample No.	Uranium (ppm)	Thorium (ppm)	Th/U ratio	Description
Gravina River Area	8181-1	2.5	10.1	4	Sandstone, gray, hard, argillaceous.
Scott Glacier	8381-1	3.1	7.8	2.5	Mudstone, dark-gray, hard, micaceous, indistinct bedding.
	2	3.0	8.9	3.0	Mudstone, dark-gray, hard, slightly foliated.
	3	1.2	2.9	2.4	Quartz vein, white, contains gray sandstone fragments.
	4	2.7	9.5	2.8	Siltstone, dark-gray, hard, irregularly thin-bedded.
	5	2.65	5.0	1.9	Siltstone, dark-gray, hard, contains white quartz veins 1 mm thick.
	6	3.0	7.8	2.6	Siltstone, dark-gray, hard, contains quartz veins along fracture planes.
	7	0.5	<1.7	<3.4	Metamorphic rock, dark-gray, hard, foliated.
	8	1.1	<2.0	<1.8	Volcanic rock, basaltic, altered.
	9	1.3	2.9	2.3	Volcanic rock, basaltic, altered, phaneritic, micaceous.
	10	1.5	4.5	2.9	Volcanic rock, basaltic, altered calcareous.
Rude River	8481-1	2.7	6.8	2.5	Quartzite, light gray to light brown, hard.
	2a	2.5	8.2	3.3	Quartzite, light-brown, hard.
	2b	2.1	5.4	2.6	Quartzite, light-brown, hard.
	8481-3	5.0	17.7	2.2	Diorite, light-gray, medium-grained, micaceous.
Cordova	8581-1	3.5	11.9	3.5	Siltstone, dark gray, hard, dense.
(Mt. Eyak)	2	3.3	7.4	2.3	Mudstone, dark-gray, hard, contains indistinct bedding platy fracture.
	3	3.0	10.3	3.5	Siltstone, dark-gray, dense, hard, displays intraclastic texture.
	4	<1.0	<0.1	---	Metamorphic rock, medium-grained, contains feldspar laths and pyrite.
	5	3.2	9.2	2.9	Siltstone, dark-gray, hard, dense.
(Heney Range)	8881-1	2.8	8.1	2.9	Mudstone, dark-gray, hard, silicified.
	3	2.1	4.6	2.2	Siltstone, dark-gray, hard, dense.
	4	2.1	6.5	3.1	Mudstone, dark-gray, hard, exhibits platy fracture.
Alaganik	8581-6	2.7	4.8	1.8	Diorite, light gray.
(McKinley Peak	7	2.8	7.5	2.6	Mudstone, dark-gray, slaty, hard.
area)	8	2.5	5.9	2.4	Mudstone, dark-gray, earthy, contains white calcite and carbonaceous(?) material.

The Tertiary intrusives are composed of granodiorite and quartz monzonite. Six closely concordant potassium-argon dates by Plafker and Lamphere (1974) from the Prince William Sound region and the Chugach Mountains range from 49.2 to 52.2 million years ago.

URANIUM AND THORIUM

The rocks of the Orca Group fall into two groups with regard to uranium and thorium content. One group is characterized by both low uranium and low thorium; average uranium content is less than 1.0 ppm and average thorium content is less than 2.8 ppm (table 1, fig. 2). The rocks of this group are highly altered, some contain nearly 50 percent chlorite, and are metamorphosed so that the original rock type may not be clearly determined (table 1). Based on their appearance and their low thorium and uranium contents they are believed to have been originally tholeite basalt.

The second group comprises the sedimentary rock samples (table 1, fig. 2). The sedimentary character of these samples is easily determined because they were less altered by diagenesis and metamorphism. They also contain more uranium (2.8 ppm average) and more thorium (7.8 ppm average). The source of the sediment that formed these rocks was the Chugach Mountains which contained Cretaceous and Jurassic metamorphic rocks, including the Valdez and Yakutat Groups, and various mafic and felsic igneous rocks. On the average the source of the sediments or the source of the source rocks was more felsic than the tholeite basalt of the Orca Group.

Only two samples of the Tertiary plutonic rock were analyzed for uranium and thorium (table 1, fig. 2). One sample, from the Rude River Pluton contained 5 ppm uranium and 17.7 ppm thorium and the other sample from the McKinley Peak area contained 2.7 ppm uranium and 4.8 ppm thorium. This meager

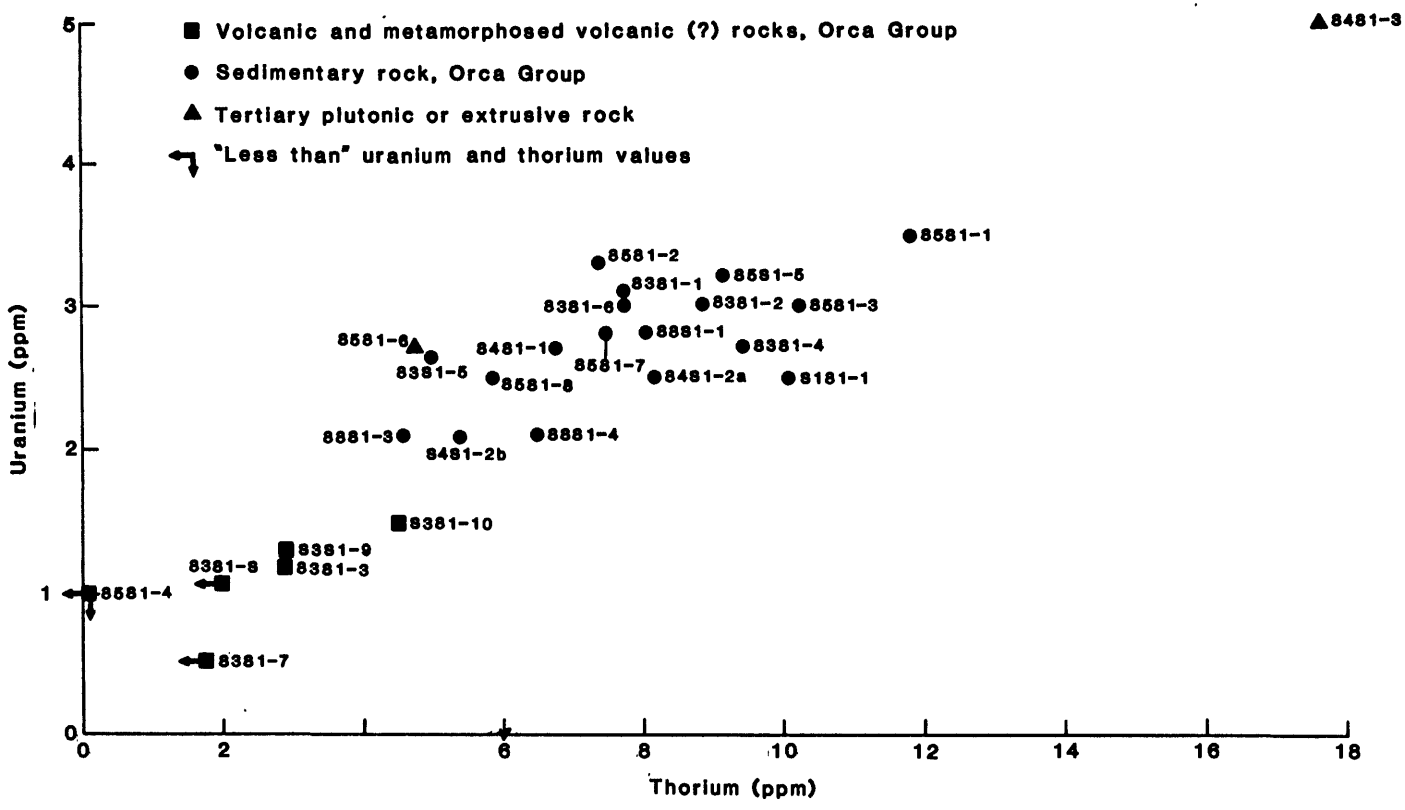

Figure 2.--Graph of uranium versus thorium from samples of the Orca Group and related plutonic rocks.

data suggests that the plutons contain as much or more uranium than does the metasedimentary facies of the Orca Group. In addition, sediment samples from streams draining the plutonic areas contain anomalous uranium; as much as 35.55 ppm uranium was found in one sample from the Port Gravina-Sheep Bay area located 20 km northwest of Cordova (Bendix Field Engineering Corp., 1981).

RADIOACTIVE ANOMALIES DETECTED BY AERIAL SURVEYS

Several preferred radioactive anomalies were located over lower Tertiary sedimentary rocks in the Cordova NTMS quadrangle by LKB Resources (1978) as a part of the National Uranium Resource Evaluation (NURE) program. The general locations of some of these anomalies are shown on figure 1.

Only one sample (sample no. 8181-1, table 1; table 2) was collected from the general location of anomalies 6, 7, and 8. That sample consisted of hard gray argillaceous sandstone of the Orca Group. The uranium and thorium content of that sample was about average for the Orca Group . These anomalies may have resulted largely from the contrast between the radioactive content of the Orca Group and lower radioactive content of the surrounding ice fields.

Four samples were collected from the vicinity of anomaly number 16 (fig. 1). Three of these samples were from metasedimentary rocks and have uranium and thorium contents near average for the Orca Group (table 1 and 2). The other sample was one of plutonic rock containing 5.0 ppm uranium and 17.7 ppm thorium (mentioned below), highest for any of the samples collected. In addition, a sample of stream sediment collected near this locality contained 48 ppm uranium (Bendix Field Engineering Corp., 1981). The radioactive anomaly may have resulted from a concentration of uranium in placer minerals in the Rude River or from the higher radioactive content of the Rude River pluton itself.

Table 2.--Statistical paramenters for uranum and thorium data.

	Number of Samples	$\bar{X}_u$	s_u	$\bar{X}_{th}$	s_{th}	$\bar{X}_{th/U}$	$s_{th/U}$
Orca Group Meta sediments	18	2.8	0.41	7.8	1.96	2.8	.53
Meta volcanics?	5	1.1	0.38	<2.8	1.09	<2.6	.61
Plutonic rock	2	3.9	1.63	11.3	9.12	2.4	.28

X = mean
s = standard deviation

Ten samples were collected near anomaly 20 in the vicinity of the toe of Scott Glacier. Five of these samples (numbers 8381-1, 8381-2, 8381-4, 8381-5, and 8381-6, table 1) were metasedimentary rock collected from the Orca Group, and they contained typical amounts of uranium and thorium for rocks of that group. Four other samples (numbers 8381-7, 8381-8, 8381-9, and 8381-10, table 1), also from the Orca Group, were highly altered material probably representing metamorphosed tholeitic basalt. These four samples were very low in both uranium and thorium. The anomaly found by LKB Resources may have been caused by the contrast between the radioactivity of the two basically different kinds of rock in the Orca Group.

SUMMARY

Rocks of the Orca Group fall into high and low groups in regard to uranium and thorium content. The low group averages less than 1 ppm uranium and 2.8 ppm thorium and probably represents altered tholeitic basalt. The high group averages 2.8 ppm uranium and 7.8 ppm thorium and represents sedimentary rock of turbidite origin. Two samples of Tertiary plutonic rock average 3.9 ppm uranium and 11.3 ppm thorium.

Several "preferred" radioactive anomalies over the lower Tertiary Orca Group have been reported. These anomalies apparently result from contrasts between basalt derived Orca Group rock, sediment-derived Orca Group rock, Tertiary plutonic rock, and ice fields. The potential for commercially significant concentrations of uranium near these anomalies or anywhere in the Orca Group is very low.

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