UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Minor element content, including radioactive elements and rare-earth elements, in rocks from the syenite complex at Roy Creek, Mount Prindle area, Alaska

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey standards and stratigraphic nomenclature.

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INTRODUCTION

The primary purpose of this report is to make available analytical data from rock samples collected from surface outcrop and drill core within the syenite complex at Roy Creek, Mount Prindle area, Alaska (fig. 1). Some of these data, as well as major-element content of selected samples, are to be published in a subsequent report dealing with the petrology and geochemistry of the syenite complex and associated thorium and rare-earth element deposits at Roy Creek.

The syenite complex is located at approximately 65°29′ north latitude and 147°06′ longitude on the divide between O'Brien Creek and Roy Creek in the Livengood (B-1) topographic quadrangle (fig. 1). The complex is about 25.5 km north of Mile 44 of the Steese Highway, which runs northeastward out of Fairbanks. The complex is located 29 km west of Mount Prindle.

Interest in the syenite complex stems from the fact that it is genetically and spatially associated with several small deposits that are extremely high in thorium and rare-earth elements (REE). These deposits contain abundant britholite, thorianite-uraninite, allanite, bastnaesite, and other base metal-, REE-, and radioactive element-bearing minerals. The area over and around the complex was originally staked for uranium in 1978 by MAPCO, Incorporated, of Tulsa, Oklahoma, as a result of information gathered from aeroradiometric surveying, geochemical prospecting, and reconnaissance geologic mapping.

I visited the MAPCO property and examined core drilled on their Y-block group of claims in July, 1981. A number of surface and drill-core samples was collected for additional petrographic and geochemical studies (Armbrustmacher, 1984).

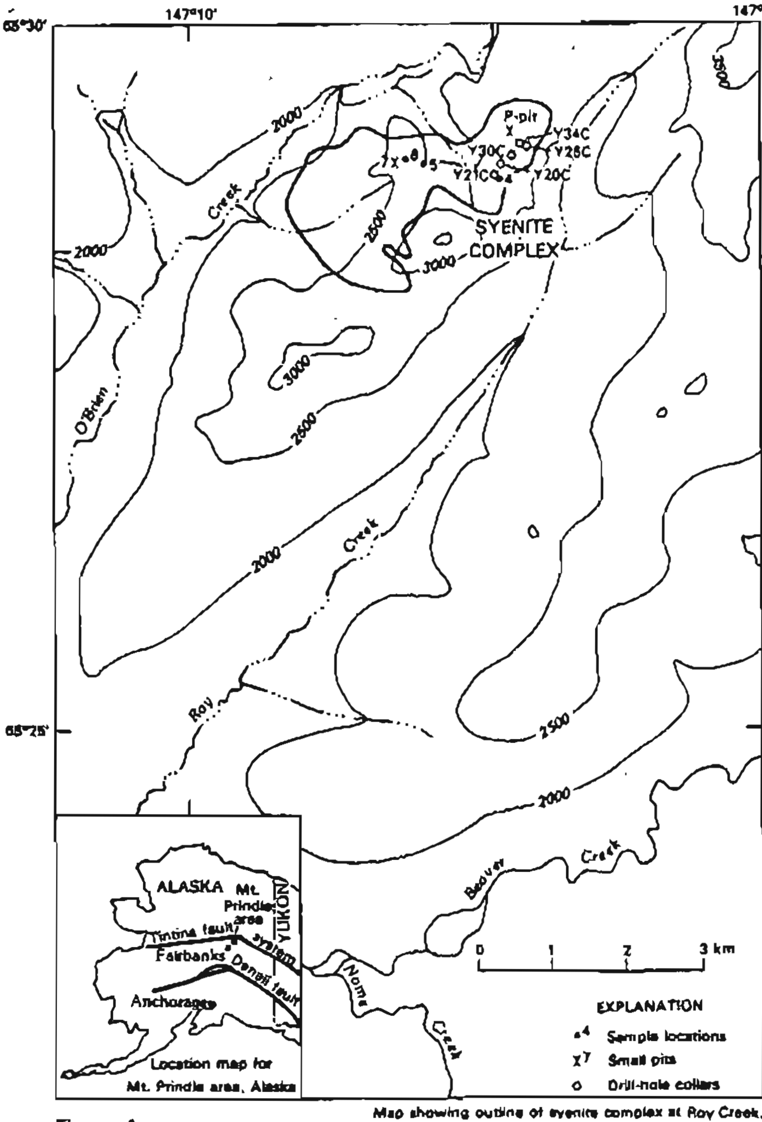

Figure 1

Map showing outline of syenite complex at Roy Creek, Mt Prindle area, Alaska (after Burton, 1981)

ANALYTICAL DATA

Samples of rock were submitted to the Branch of Analytical Chemistry for analysis of minor elements, radioactive elements, and REE; the results are presented in Table 1. Minor elements were determined by inductively coupled plasma-atomic emission spectrometry, analyst K. McKowen (Lichte, Golighty, and Lamothe, 1987). Radioactive elements were determined by delayed neutron analysis, analysts J. Storey, S. Danahey, B. Vaughn, and M. Coughlin (McKown and Millard, 1987). Rare-earth elements were determined by inductively coupled plasma-optical emission spectroscopy after preconcentration by ion exchange, analyst A. L. Meier (Lichte, Meier, and Crock 1987).

Samples with the prefix "PR" are samples collected from outcrops or shallow trenches. The samples with the prefix "Y" are drill-core samples; the "Y" is followed by the drill-hole number, such as "20C"; the remainder of the sample number indicates the depth, in feet, of the core from which the sample was collected.

GEOLOGIC SETTING

The syenite complex appears to lie within the Yukon-Tanana terrane, an area of about 78,000 km^2 in east-central Alaska that is approximately bounded by the Yukon and Tanana rivers. This terrane consists chiefly of a mid-Paleozoic volcanic-plutonic (arc?) assemblage and represents the innermost of the accreted terranes. It has been interpreted to be a subduction complex, deformed in early Mesozoic time and thrust northeastward onto the North American continental margin as a result of an arc-continent collision (Templeman-Kluit, 1979). The western part of the terrane, including the Mount Prindle area, is underlain by sedimentary and metasedimentary rocks of possible Precambrian to Tertiary age that have been intruded by a variety of epizonal granodiorite and granite plutons, including the syenite complex at Roy Creek. Around the syenite complex, the host rocks consist of weakly metamorphosed grit, quartzite, quartz-mica schist, and minor limestone and greenstone. The host rock for the complex is argillaceous quartzite referred to as the Wickersham Dome quartzite by Burton (1981).

The syenite complex appears to be one of a very few intrusions of silica-undersaturated rocks in the Yukon-Tanana terrane. Burton (1981) gives K-Ar ages for biotite from rocks of the complex of 86.7 ± 3.6 Ma and 85.4 ± 6.4 Ma.

Five distinct varieties of rocks occur within the syenite complex, quartz alkali-feldspar syenite (modal quartz greater than 5 percent) and petrographically similar "quartz-bearing" alkali-feldspar syenite (modal quartz present, but less than 5 percent), alkali-feldspar syenite (modal quartz absent) and petrographically similar nepheline-bearing alkali-feldspar syenite, and shonkinite. Rock names are modified after Streckeisen (1976). Exposures of the syenite are in general too poor to distinguish the relationships among the different varieties. Contacts between varieties tend to be gradational in drill core and presumably are similar in outcrop.

Fundamental differences exist in the mineralogy and the geochemistry of the syenitic rocks. Quartz alkali-feldspar syenite and "quartz-bearing" alkali-feldspar syenite contain riebeckite as the major mafic mineral and microperthite as the major felsic mineral. The alkali-feldspar syenite and nepheline-bearing alkali-feldspar syenite contain aegirine-augite alone, or as reaction rims on augite, as the major mafic mineral and a single-phase potassic feldspar similar to orthoclase as the major felsic mineral. Minor and accessory minerals are similar in all the varieties and include biotite, sphene, apatite, and interstitial sodic plagioclase. Barium, copper, strontium, lithium, and zinc are more abundant in the alkali-feldspar syenite and nepheline-bearing alkali-feldspar syenite than in the quartz alkali-feldspar syenite and "quartz-bearing" alkali-feldspar syenite; the light REE (La-Nd) are more abundant in the quartz-bearing syenites.

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Table 1. Description of rock samples. [PR-, sample from outcrop or shallow trench; YxxC, drill hole number, followed by depth, in feet, of core sample]

PR2A	Alkali-feldspar syenite
PR2B	Alkali-feldspar syenite
PR4	Nepheline-bearing alkali-feldspar syenite
PR5	Nepheline-bearing alkali-feldspar syenite
PR6	Alkali-feldspar syenite
PR7A	Alkali-feldspar syenite
PR7B	Alkali-feldspar syenite
PR8A	Alkali-feldspar syenite
PR8B	Alkali-feldspar syenite
PR8C	Alkali-feldspar syenite
Y20C,78	Alkali-feldspar syenite
Y20C,284-285	Quartz-bearing alkali-feldspar syenite
Y21C,73	Quartz-bearing alkali-feldspar syenite
Y21C,78-79	"Quartz-bearing" alkali-feldspar syenite
Y21C,160-169	"Quartz-bearing" alkali-feldspar syenite
Y22C,252	Alkali-feldspar syenite
Y24C,310-316	Alkali-feldspar syenite
Y25C,87-89	Alkali-feldspar syenite
Y30C,32-33	Alkali-feldspar syenite
Y30C,303-305	Alkali-feldspar syenite
Y30C,536	Alkali-feldspar syenite
Y30C,555	Alkali-feldspar syenite
Y30C,983	Alkali-feldspar syenite
Y30C,986-995	Alkali-feldspar syenite
Y30C,1144-1150	Alkali-feldspar syenite
Y30C,1434	Alkali-feldspar syenite
Y30C,1437	Alkali-feldspar syenite

Table 2. Analyses of minor elements, radioactive elements, and rare-earth elements, in rocks of the syenite complex at Roy Creek, Mount Prindle area, Alaska. Values given in parts per million.

	PR2A	PR2B	PR4	PR5	PR6	PR7A	PR7B
Minor elements							
Ba	6800	3800	4200	2600	2800	3700	2800
Be	6	4	8	7	7	12	10
Co	19	11	19	9	4	<2	3
Cr	16	63	49	28	28	17	27
Cu	150	22	110	29	24	12	25
Ga	10	20	10	10	20	10	10
Li	79	97	74	79	13	19	23
Mn	1200	800	1200	970	650	590	770
Ni	6	14	13	8	7	7	6
Pb	20	40	120	50	60	70	50
Sc	12	12	21	14	7	6	9
Sr	580	1200	1400	1700	1100	980	1100
V	210	98	170	140	71	90	100
Y	24	18	72	44	39	22	26
Zn	180	86	110	160	72	68	86
Radioactive elements							
Th	94.7	19.2	126	27.2	35.0	26.0	30.0
U	24.8	4.20	21.1	5.32	5.53	9.79	9.38
Rare-earth elements							
La	227	75.2	208	107	84.8	45.3	69.2
Ce	359	133	375	171	181	115	153
Pr	37.1	14.4	42.3	20.5	19.8	13.7	19.1
Nd	120	49.4	148	70.1	68.9	48.8	67.9
Sm	20.0	9.67	28.5	13.8	13.9	10.4	13.9
Eu	4.16	2.19	6.14	2.99	3.19	2.33	3.09
Gd	15.4	7.21	20.6	10.7	10.3	7.16	9.80
Tb	1.88	.96	2.68	1.41	1.53	.99	1.34
Dy	8.49	4.41	12.7	7.04	7.78	4.67	6.69
Ho	1.44	.77	2.05	1.17	1.37	.71	1.02
Er	3.54	1.72	4.88	2.81	3.67	1.63	2.40
Tm	.54	.23	.63	.41	.49	.24	.35
Yb	3.65	1.39	3.52	2.45	3.28	1.53	2.22
REE	802.20	300.55	855.0	411.38	400.01	252.46	350.01
$(La/Yb)_{CN}$[1]	41.8	36.3	39.9	29.5	17.5	20.0	21.0
Eu/Sm	.21	.23	.22	.22	.23	.22	.22

[1]Rare-earth element chondrite-normalization values from Boynton (1984, p. 91).

Table 2. (continued)

	PR8A	PR8B	PR8C	Y20C, 78	Y20C, 284-285	Y21C, 73	Y21C, 78-79
				Minor elements			
Ba	2800	4400	20000	2400	2200	1300	1100
Be	17	7	5	6	8	10	10
Co	10	16	25	6	4	2	2
Cr	150	14	30	12	11	17	14
Cu	13	180	200	120	140	11	32
Ga	<10	20	10	10	20	20	20
Li	38	110	71	120	27	26	40
Mn	1900	1500	1300	550	610	790	650
Ni	35	8	12	5	27	26	40
Pb	180	170	40	50	30	50	530
Sc	24	18	23	9	7	5	<5
Sr	1200	780	1900	890	1300	540	440
V	180	320	270	98	91	37	40
Y	41	60	39	97	44	80	37
Zn	140	220	100	92	51	55	360
				Radioactive elements			
Th	20.6	40.0	32.1	392	130	269	48.7
U	6.38	13.7	7.54	30.4	16.2	31.3	19.9
				Rare-earth elements			
La	72.3	112	150	280	104	266	164
Ce	160	225	274	515	202	411	241
Pr	20.2	27.9	32.7	56.0	22.7	39.9	23.1
Nd	73.0	102	118	184	75.3	119	69.9
Sm	15.9	22.4	26.3	32.4	14.4	19.3	12.0
Eu	3.52	5.26	5.81	6.87	3.09	4.16	2.71
Gd	10.9	17.8	17.3	25.5	11.0	14.9	9.47
Tb	1.53	2.68	2.11	3.53	1.53	1.99	1.37
Dy	7.20	14.2	9.59	17.0	7.94	9.64	6.91
Ho	1.10	2.49	1.48	2.77	1.34	1.70	1.26
Er	2.64	6.30	3.27	6.54	3.25	4.11	3.24
Tm	.34	.92	.45	.83	.45	.53	.45
Yb	1.99	5.40	2.41	4.24	2.47	2.85	2.64
REE	370.62	544.35	643.42	1134.38	449.47	895.08	538.05
$(La/Yb)_{CN}$	24.5	14.0	42.1	44.5	28.4	63.1	42.0
Eu/Sm	.21	.23	.22	.22	.21	.22	.23

Table 2. (continued)

	Y21C, 160-169	Y22C, 252	Y24C, 310-316	Y25C, 87-89	Y30C, 32-33	Y30C, 303-305	Y30C, 536
				Minor elements			
Ba	1200	2900	4500	3500	4800	3200	2900
Be	23	8	12	6	15	13	14
Co	3	3	6	7	27	23	9
Cr	14	13	10	18	33	48	31
Cu	27	17	45	64	60	180	60
Ga	20	20	10	10	<10	20	20
Li	94	17	16	19	140	99	120
Mn	410	790	1400	770	1800	1700	1200
Ni	6	<5	<5	<5	24	19	14
Pb	40	20	40	50	90	440	210
Sc	<5	6	13	6	26	24	15
Sr	620	1800	830	1000	1700	1200	2700
V	34	85	160	100	150	160	150
Y	41	21	52	32	49	50	40
Zn	57	61	120	78	330	530	140
				Radioactive elements			
Th	155	31.3	221	58.3	63.9	94.7	68.7
U	37.7	7.91	23.3	7.41	14.1	18.2	17.6
				Rare-earth elements			
La	169	70.5	131	77.9	143	158	129
Ce	245	142	279	163	252	282	229
Pr	22.4	16.9	34.2	19.9	29.2	32.6	25.5
Nd	65.2	58.0	121	69.4	102	114	85.4
Sm	11.3	11.4	24.2	14.2	20.0	21.6	16.8
Eu	2.42	2.50	5.17	3.20	4.59	4.45	3.68
Gd	8.81	8.11	18.2	10.4	14.7	16.3	12.3
Tb	1.31	1.08	2.52	1.47	2.05	2.20	1.83
Dy	7.31	5.28	12.1	7.22	10.1	10.4	9.28
Ho	1.37	.86	1.96	1.18	1.73	1.77	1.60
Er	3.86	2.18	4.86	2.77	4.32	4.27	4.24
Tm	.59	.33	.71	.41	.64	.60	.57
Yb	3.58	2.22	4.68	2.41	4.02	3.61	3.78
REE	542.15	321.36	639.60	373.46	588.35	651.80	522.98
$(La/Yb)_{CN}$	31.9	21.4	18.9	21.8	24.0	29.5	23.0
Eu/Sm	.21	.22	.21	.23	.23	.21	.22

Table 2. (continued)

	Y30C, 555	Y30C, 983	Y30C, 986-995	Y30C, 1144-1150	Y30C, 1434	Y30C, 1437
			Minor elements			
Ba	3400	1900	3700	2200	3000	2700
Be	12	11	9	10	6	6
Co	10	4	5	7	15	12
Cr	38	13	26	11	140	120
Cu	61	53	21	45	65	52
Ga	20	20	<10	20	10	10
Li	110	22	17	14	86	63
Mn	1200	1300	980	860	1100	1000
Ni	13	6	7	<5	33	31
Pb	90	790	50	140	20	50
Sc	13	6	10	<5	23	19
Sr	1200	690	1200	850	1500	1100
V	140	96	120	99	160	120
Y	32	38	26	23	37	37
Zn	140	220	81	83	120	140
			Radioactive elements			
Th	95.8	169	34.7	43.0	22.2	40.7
U	19.6	61.9	8.83	16.6	2.54	11.6
			Rare-earth elements			
La	138	135	91.0	56.7	127	151
Ce	239	252	188	131	224	254
Pr	26.1	28.3	23.0	16.7	26.0	28.4
Nd	85.0	92.5	81.0	60.0	91.4	95.8
Sm	15.6	17.5	16.2	12.8	18.3	18.2
Eu	3.42	3.72	3.54	2.78	3.84	3.98
Gd	11.7	12.6	11.4	9.41	13.8	13.7
Tb	1.54	1.80	1.60	1.34	1.87	1.82
Dy	8.00	8.24	7.85	6.71	8.87	8.76
Ho	1.37	1.31	1.28	1.06	1.43	1.42
Er	3.47	3.36	3.10	2.68	3.48	3.69
Tm	.52	.51	.47	.39	.46	.51
Yb	3.23	3.72	3.16	2.88	2.75	3.39
REE	536.95	560.56	431.60	304.45	523.20	584.67
$(La/Yb)_{CN}$	28.7	24.4	19.5	13.3	31.1	30.1
Eu/Sm	.22	.21	.22	.22	.21	.22