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K-FELDSPATHIZATION, ALBITIZATION AND GOLD MINERALIZATION IN GRANITOID ROCKS: THE RATTLING BROOK ALTERATION SYSTEM WESTERN WHITE BAY, NEWFOUNDLAND

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ABSTRACT

Auriferous fracture stockworks, veins and shear zones are developed in Proterozoic granitoid rocks of the Rattling Brook area. Alteration of the precursor foliated tonalite–granodiorite occurred during the Paleozoic in at least two main stages. Stage 1 alteration (K-feldspathization) is variably developed over an area of about 2 km², and consists of microcline and sericite formed by reaction of plagioclase and mafic minerals with hydrothermal fluids. Stage 2 alteration (albitization) is restricted to stockwork fractures, veins and vein selvages, and overprints both stage 1 alteration and unaltered rock. It consists of microcrystalline to fine grained albite, with lesser amounts of quartz, ankerite and sericite. Both alteration episodes are considered to be part of the same mineralization process, which resulted in precipitation of pyrite, arsenopyrite and gold. Fluids with high K+ activity initially permeated along grain boundaries and converted the host to granite. Subsequent hydraulic fracturing was accompanied by an increase in the activity of Na+, resulting in albitization and deposition of sulphides and gold.

INTRODUCTION

Auriferous fracture stockworks, veins and shear zones are developed in K-feldspathized granitoid rocks over an area of approximately 2 km² near Rattling Brook (Figure 1) in the Jackson's Arm area of western White Bay. Descriptions of the gold mineralization have been presented by Bruneau (1984) and McKenzie (1987). Field descriptions of the geology and geological setting have been presented by Tuach and French (1986) and Tuach (1987).

Mineralization is predominantly hosted by a Proterozoic, megacrystic, foliated granitoid rock from which zircon separates have been dated at around 1042 Ma (Erdmer, 1986). Recent work by BP-Selco geologists has shown that gold mineralization also occurs in Eocambrian to Early Cambrian quartzites that unconformably overly the granitoid-hosted mineralization, and in limestones overlying the quartzites (McKenzie, 1987).

The name 'Apsy pluton' (after Apsy Pond, Figure 1) is tentatively proposed for these Proterozoic granitoid rocks. Sample locations and general geology are shown in Figure 1.

The hydrothermally altered and mineralized rocks around Rattling Brook (Figure 2) are here referred to as the Rattling Brook alteration zone. In the northern part of the alteration zone, the host rock has been converted from a tonalite–granodiorite to a granite *(sensu stricto)* by reaction of hydrothermal fluids with plagioclase and mafic minerals to form microcline and sericite. Subsequent fracture stockworks, veins and local areas of hydrothermal breccia contain albite and lesser amounts of quartz, ankerite and sericite. This report documents the observed petrographic and geochemical characteristics of the Rattling Brook alteration zone.

PETROGRAPHY

Host Rocks

The Apsy pluton is composed of plagioclase and K-feldspar megacrysts set in a groundmass of biotite, and local hornblende, intergrown with abundant sphene, ilmenite, apatite and lesser zircon. Deformation of the pluton has resulted in a planar S-fabric and an augen texture.

Saussuritized plagioclase commonly forms anhedral grains of less than 0.5 cm in diameter, but locally it forms megacrysts up to 2 cm long. K-feldspar forms finely perthitic megacrysts up to 3 cm long that locally exhibit fine-scale microcline twinning.

Hornblende is present in several samples from the western part of the area (Figure 1). It is partly replaced by biotite, which in turn is partly replaced by chlorite and epidote. The distribution of the mafic mineral assemblages indicates increasing retrogressive metamorphism toward the east, in agreement with regional metamorphic patterns described by Erdmer (1986).

Small, pink, microcline-rich, granitic bodies cut the above lithologies, and are interpreted to be late differentiated phases of the Apsy pluton.

This project is a contribution to the Canada–Newfoundland Mineral Development Agreement, 1984–1989

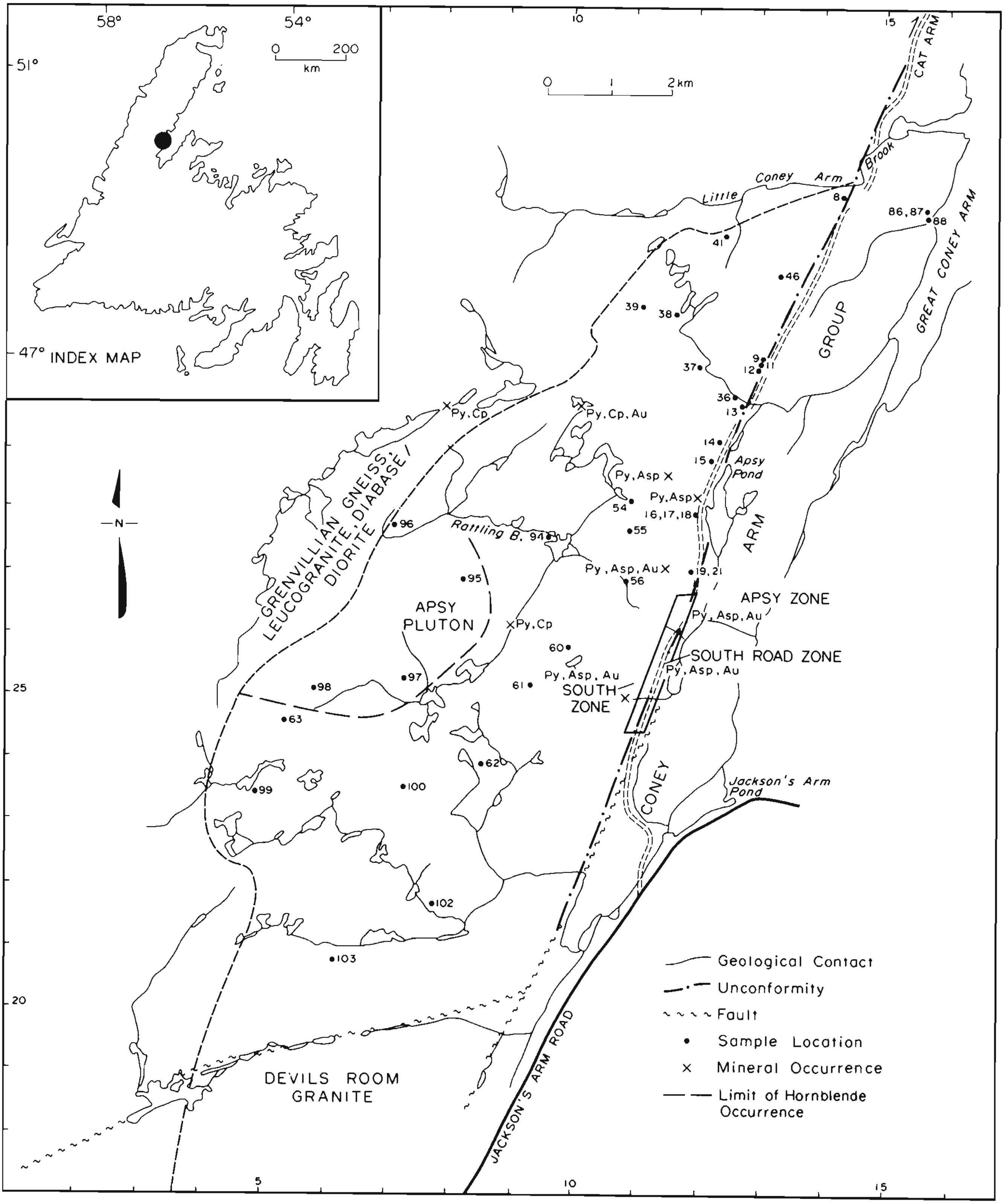

Figure 1. *General geology and sample locations in the Rattling Brook area. The area shown in the box is enlarged in Figure 2. Numbers along map border are UTM co-ordinates. Py—pyrite; Cp—chalcopyrite; Asp—arsenopyrite; Au—gold.*

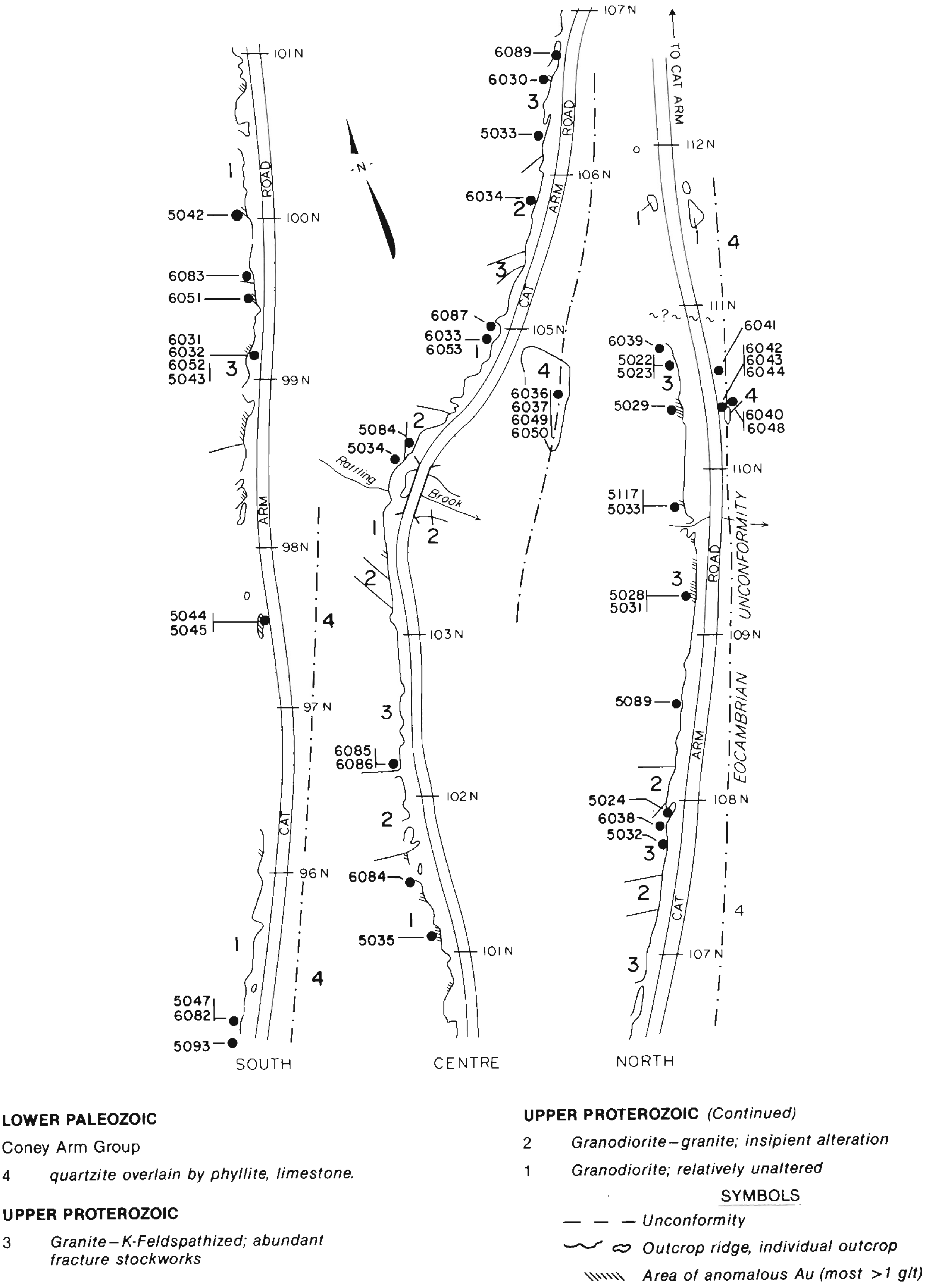

Figure 2. *Geological sketch of the Rattling Brook alteration zone along the Cat Arm Road (modified from Bruneau, 1984) showing area of detailed sampling. Grid is marked in 100-m intervals.*

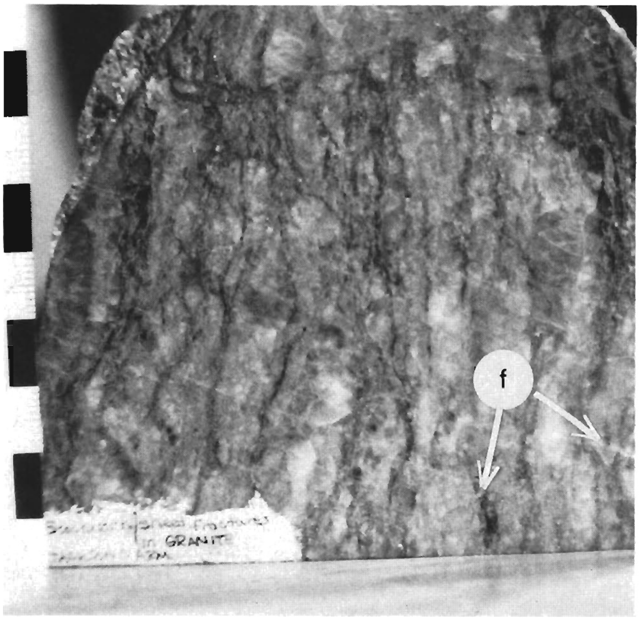

Plate 1. *Slab of typical stage 1 microcline-rich granite. Rock is cut by sheeted microfractures (f). Dark rectangles on scale are 1 cm long.*

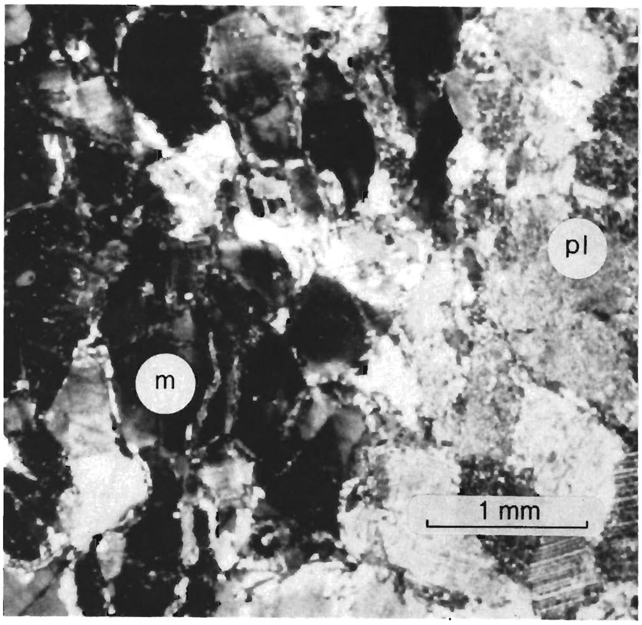

Plate 2. *Polygonal texture of plagioclase (pl) and microcline (m) in stage 1 altered granite. Crossed-nicols photomicrograph of sample 7045024.*

Microcline Alteration Zone

In the vicinity of mineralization, the host rock has been altered to a foliated, bright pink, leucocratic granite (Plate 1) that grades imperceptably into more typical unaltered tonalite–granodiorite of the Apsy pluton.

The alteration assemblage consists mostly of K-feldspar and quartz, with subordinate amounts of albitic plagioclase and sericite. Commonly, feldspar megacrysts are internally recrystallized, and are composed of uniform subgrains characterized by sharp boundaries and well-developed triple-point junctions (Plate 2). Generally, the K-feldspar has poorly developed to well-developed, fine-scale microcline twinning and is commonly perthitic. Locally, albite rims surround individual microcline grains. The groundmass to the megacrysts is composed of sericite, rutile, carbonate, zircon and apatite. Biotite, chlorite and epidote are minor or absent, and up to 10 percent pyrite and arsenopyrite are locally intergrown with the matrix assemblage.

Albite Veins and Alteration

The foliated pink granite is locally cut by fracture and veinlet stockworks that contain fine grained to microcrystalline albite, quartz, carbonate and sericite (Plate 3). This assemblage also occurs in the matrix of small areas of mineralized hydrothermal breccia (Plate 4). Albite partly replaces wall-rock microcline and plagioclase over a width of less than 3 cm marginal to fractures (Plate 5). Swarms of sheeted microcrystalline albite veins occur locally over widths ranging from 10 to 20 cm (Plate 3) to 12 m; the intervening country rock is pervasively replaced by albite. On the basis of field observations, Tuach and French (1986) misidentified the microcrystalline albite and quartz assemblage as fine grained silica.

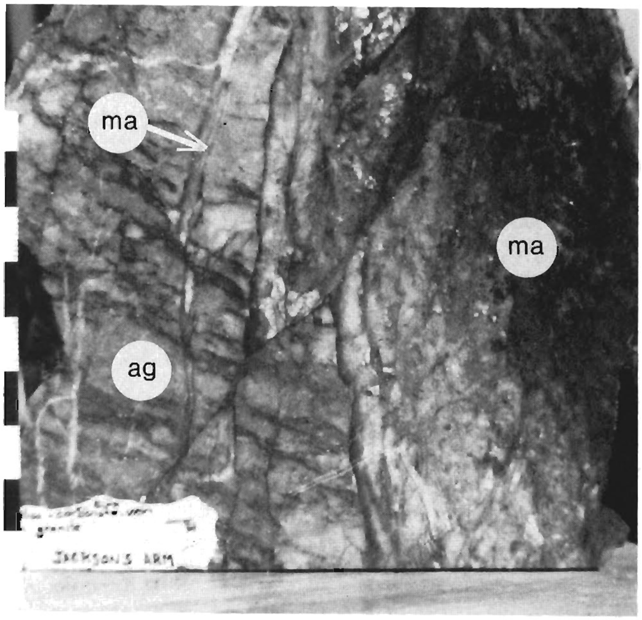

Plate 3. *Slab of albitized granite (ag) cut by microcrystalline albite (ma) veins (stage 2). Dark rectangles on scale are 1 cm long.*

Carbonate is also found locally in veins and in the matrix of hydrothermal breccias. Electron-microprobe analyses show that the composition of the carbonate varies from ferroan dolomite to ankerite; the latter is most common. Coarse grained siderite and ankerite have been identified in a sample from a 10-cm-wide gold and sulphide-bearing carbonate–sericite vein. Rare euhedral quartz crystals in this vein contain trails of secondary or pseudosecondary aqueous-CO_2 inclusions.

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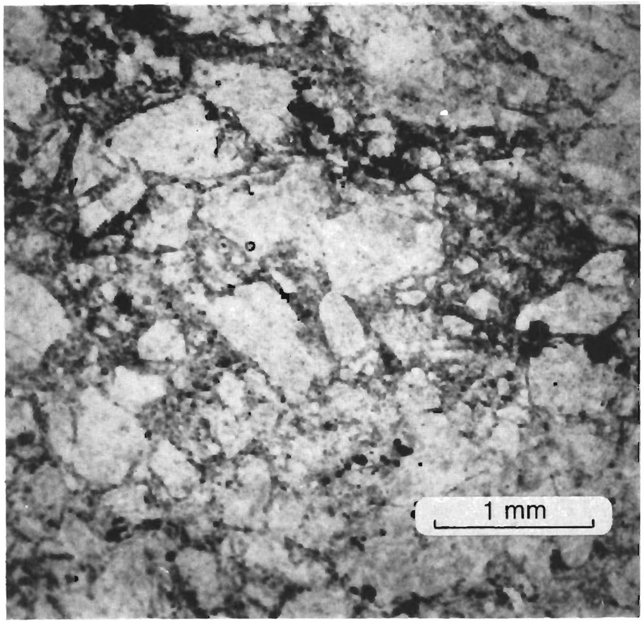

Plate 4. *Hydrothermal breccia consisting of microcline and albite fragments in a matrix of crushed rock fragments and microcrystalline albite, carbonate and pyrite (stage 2). Opaque material is partly pyrite and partly intergrown rutile and leucoxene. Plane light photomicrograph of sample 7046112.*

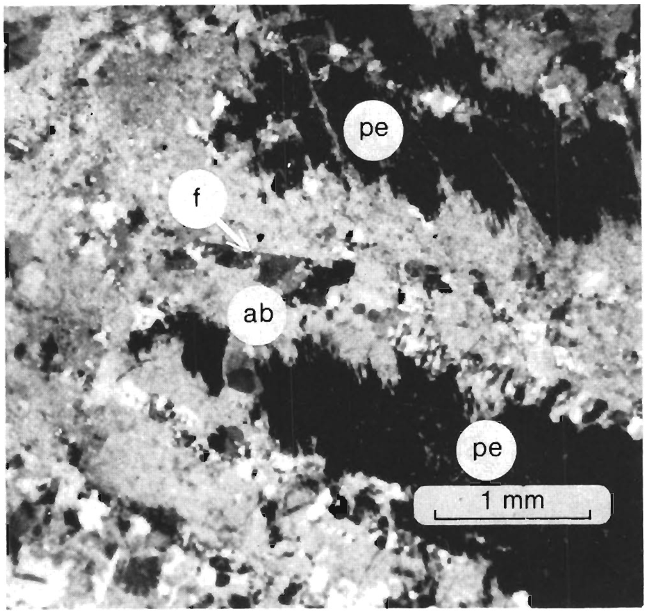

Plate 5. *Stage 2 untwinned hydrothermal albite (ab) replaces perthite (pe) marginal to fractures (f). The fractures are lined by fine grained, twinned albite. Crossed-nichols photomicrograph of sample 7045029.*

Sulphide Minerals

The K-feldspathized and albitized granites locally contain up to 10 percent disseminated sulphides. Pyrite and arsenopyrite crystals are commonly arranged along the foliation of the granite, but are completely undeformed. The sulphides are intergrown with biotite and/or sericite and other accessory minerals. An assemblage of finely intergrown pyrite (± arsenopyrite), carbonate, rutile (intergrown with leucoxene), apatite and zircon is present in the most altered samples.

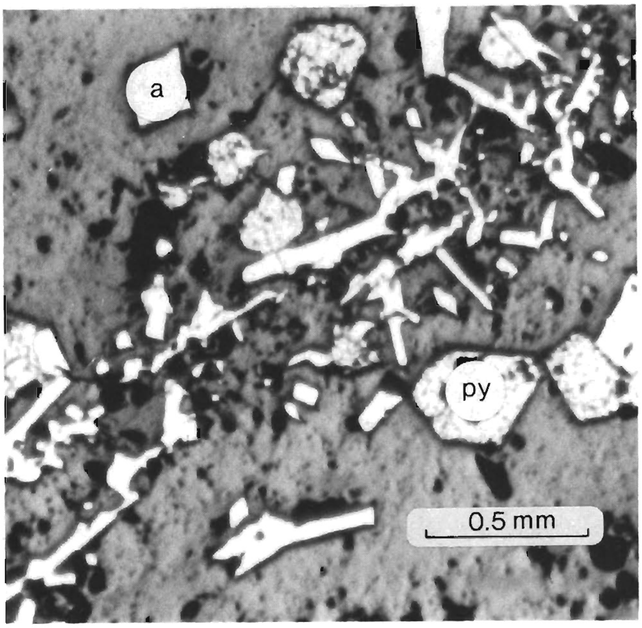

Plate 6. *Euhedral arsenopyrite (a) and pyrite (py) line fractures in siderite–ankerite vein. Reflected-light photomicrograph of sample 7046034.*

The albite–quartz–ankerite–sericite veins contain up to 10 percent sulphides; the sulphides consist mainly of pyrite and arsenopyrite, but there are rare occurrences of chalcopyrite (Plate 6). Arsenopyrite occurs as delicate, euhedral undeformed crystals that commonly have hollow cores. Pyrrhotite and galena occur as inclusions in pyrite and arsenopyrite. Gold has been observed in two thin sections from samples that are cut by swarms of microcrystalline albite veins. The gold occurs as clusters of less than one to greater than fifteen micrometre inclusions in pyrite (Plate 7). SEM analyses indicate only traces of silver in the gold. Rare, extremely fine grained (less than one micrometre) Au-Ag telluride, Pb-Au telluride and Pb telluride were observed as inclusions in pyrite in one sample.

PARAGENESIS

Alteration related to the mineralizing system appears to have occurred in two main stages. Stage 1 alteration (K-feldspathization) involved conversion of the precursor foliated tonalite–granodiorite to a granite *(sensu stricto)* by metasomatic reaction of hydrothermal fluids with plagioclase and mafic minerals. Much of the plagioclase and the mafic minerals were converted to K-feldspar and sericite. Analysis of remnant plagioclase by electron microprobe shows that it is albite. Sericite replaced biotite, chlorite and epidote. Ilmenite was replaced by rutile, and sphene was converted

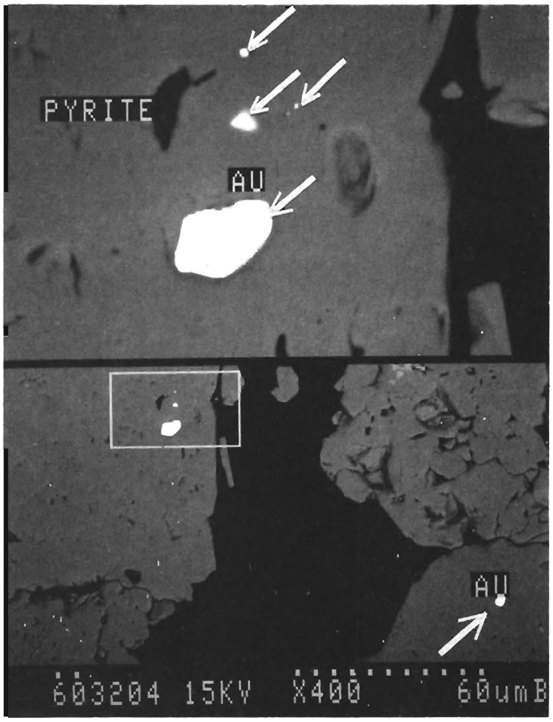

Plate 7. *Scanning-electron photomicrograph showing gold (arrows) included in pyrite (grey). Scale bar (length represents 60 micrometres) applies to lower half of photo. The top half (area in box) is enlarged by a factor of 5 with respect to the bottom half. The largest gold grain is 6 micrometres across. Sample 7046032.*

to rutile and calcite. The zircon and apatite are apparently unaltered.

Stage 2 alteration (albitization) is restricted to stockwork fractures, veins and vein selvages, and overprints both microcline-rich stage 1 alteration and the unaltered rock. Microcrystalline to fine grained albite, and lesser amounts of quartz, ankerite and sericite were deposited as veins that partly replaced the wall rock. Precipitation of pyrite, arsenopyrite and gold accompanied this alteration event.

The sulphides are concentrated along the foliation of the host granite, but are themselves undeformed, indicating that mineralization postdated deformation. Pyrite, and to a lesser extent arsenopyrite, are intergrown with and partly replace ilmenite, sphene and rutile. The titanium oxides, which are concentrated along the foliation of the host granite, may have acted as preferential nucleation sites for the formation of the sulphides.

GEOCHEMISTRY

Introduction

The rock samples can be separated into altered and unaltered groups, although there is a continuum between the two. Unaltered rocks are those in which distinct chemical and petrological features related to the mineralizing event are minor or absent; they have, however, been affected by regional retrogressive metamorphic events. Most samples of unaltered rock are from the tonalite–granodiorite, but three are from small granitic bodies interpreted to be late differentiated phases of the Apsy pluton.

The altered rocks can be separated into two groups dominated by either stage 1 alteration (microcline-rich granites) or stage 2 alteration (albite-rich rocks). The albitic samples contain vein material and albitized granite wall rock (Plate 3) in varying proportions. The microcline-rich granites that are enriched in Au (greater than 100 ppb) are separated from those containing less than 10 ppb (Figures 3 to 6). All the albite-rich samples are enriched in gold.

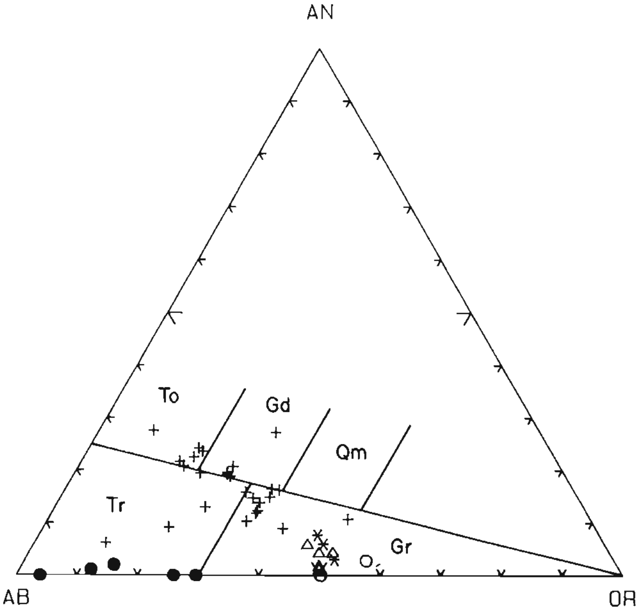

Figure 3. *Plot of normative albite-anorthite-orthoclase showing classification fields of O'Connor (1965). Qm–quartz monzonite; Gd–granodiorite; Tr–trondhjemite; To–tonalite; Gr–granite. Crosses–unaltered granitoid; asterisks–differentiated phases of unaltered granitoid; open circles–microcline-rich metasomatic granite with greater than 100 ppb Au; triangles–microcline-rich metasomatic granite with less than 10 ppb Au; filled circles–albite-rich samples (all have greater than 30 ppb Au) consisting of vein-material and albitized granite wall rock.*

Results

Unaltered rocks from the Apsy pluton have compositions that straddle the tonalite, trondhjemite, granodiorite and granite fields on O'Connor's (1965) normative Ab-An-Or classification diagram (Figure 3). The variation may be a result of fractionation processes and regional alteration, but coarse grained granites present geochemical sampling problems that could explain part of the variation. Late phases of the pluton plot in the granite field. Average compositions of samples from the Apsy pluton are given in Table 1.

Table 1. Average analyses of samples from the Apsy pluton and the Rattling Brook alteration zone

	HOST GRANITOID				ALTERED ± MINERALIZED ROCKS					MISCELLANEOUS						
	Mafic to Intermediate		Granite Differentiate		Microcline Granite		Albitic Granite and Veins		Sulphide Carbonate Vein	Biotite Schlieren	Amphibolite Xenocryst	Amphibolite Xenocryst	Long Range Dyke	Diabase Dyke	Diabase Dyke	Felsite Dyke
	$\bar{x}$	$\bar{s}$	$\bar{x}$	$\bar{s}$	$\bar{x}$	$\bar{s}$	$\bar{x}$	$\bar{s}$								
	n = 26*		n = 3*		n = 11*		n = 5*		n = 1	n = 1	n = 1	n = 1	n = 1	n = 1	n = 1	n = 1
Oxide (wt.%)																
SiO_2	63.06	3.96	71.65	0.91	70.27	4.17	65.46	3.21	35.15	40.90	59.85	59.00	45.80	46.80	43.85	74.60
TiO_2	1.13	0.39	0.35	0.02	0.36	0.10	0.97	0.21	0.22	4.88	1.64	1.47	1.38	1.47	1.38	0.11
Al_2O_3	14.87	0.71	13.79	0.23	13.58	1.29	13.73	0.97	8.23	9.30	13.92	12.89	16.54	16.27	16.18	13.01
FeO(T)	5.51	1.59	1.48	0.31	2.27	0.79	4.71	0.87	11.63	19.16	8.42	6.49	8.69	8.49	8.04	0.42
MnO	0.09	0.03	0.03	0.01	0.03	0.02	0.04	0.02	0.28	0.42	0.10	0.14	0.17	0.17	0.15	0.01
MgO	1.43	0.43	0.35	0.10	0.39	0.15	0.57	0.33	6.09	4.99	1.31	2.27	9.20	7.84	7.21	0.03
CaO	3.31	1.04	1.07	0.19	0.72	0.38	0.95	0.45	9.77	6.16	3.83	3.73	10.83	8.92	8.62	0.09
Na_2O	3.83	0.61	3.51	0.22	3.23	0.22	5.84	0.89	0.14	0.03	3.05	3.87	2.13	2.77	2.10	2.99
K_2O	3.80	0.72	5.85	0.46	6.32	1.38	2.59	1.17	4.00	5.15	3.65	4.62	0.88	1.61	1.63	7.04
P_2O_5	0.39	0.17	0.08	0.03	0.10	0.06	0.32	0.12	0.14	1.91	0.77	0.53	0.06	0.20	0.13	0.02
LOI	1.36	0.50	1.15	0.01	1.84	0.84	3.42	0.94	14.02	3.02	1.49	3.93	3.38	3.75	10.01	0.72
Element (g/t)																
Li	22	7	11	2	14	4	19	11	18	106	25	32	30	n.d.	51	8
F	792	229	235	94	246	64	304	328	n.d.	2121	887	n.d.	117	415	141	26
V	66	22	30	4	16	5	44	12	17	258	69	51	201	n.d.	216	8
Cr	7	3	4	1	5	5	4	1	4	20	4	5	206	n.d.	161	4
Ni	4	8	2	1	2	4	1	0	5	4	1	1	83	n.d.	56	4
Cu	6	3	4	3	15	28	12	8	17	22	7	6	62	n.d.	49	3
Zn	102	39	27	5	22	7	45	23	13	423	147	190	73	n.d.	76	9
Ga	23	5	15	2	15	4	20	1	21	40	27	19	18	19	18	13
Rb	90	22	88	17	172	41	51	28	119	221	85	84	28	n.d.	73	149
Sr	365	95	196	52	113	36	119	38	73	102	400	310	236	n.d.	402	70
Y	47	10	12	5	18	6	17	6	22	183	78	52	26	30	23	2
Zr	129	36	98	36	170	30	81	17	124	272	46	91	113	160	102	84
Nb	20	5	5	3	12	3	16	5	3	86	29	30	1	4	2	1
Mo	3	1	2	0	3	2	4	2	12	8	5	4	4	n.d.	4	3
Ag	0.1	0.0	0.1	0.0	0.4	0.8	0.6	0.6	1.1	0.1	1.0	0.1	0.1	n.d.	0.1	0.1
Ba	1305	314	1754	730	873	367	851	409	492	441	1170	1400	355	n.d.	506	398
La	71	19	87	106	87	39	75	42	105	233	88	113	5	15	9	9
Ce	143	36	139	171	171	72	152	85	197	549	192	234	15	43	21	6
Pb	13	3	12	1	29	52	19	24	13	1	9	8	1	n.d.	6	10
Th	4	2	12	14	14	7	6	11	5	3	2	1	1	3	1	4
Element (mg/t)																
Au	1	2	1	0	480	794	1819	805	4550	3	1	183	1	57	1	1

* For FeO(T) n (number of samples) = 26, 3, 8, and 5 respectively; for F, n = 24, 3, 9 and 3 respectively; n.d. = not determined; x = mean; s = standard deviation.

The microcline-rich samples (stage 1) plot in the granite field as expected (Figure 3). The albite-rich samples (stage 2) plot in the trondhjemite field. Average compositions of both groups are given in Table 1.

The two groups of altered granites differ from each other mainly in their K_2O, Na_2O and SiO_2 contents (Table 1 and Figure 4). When compared to the unaltered rocks, both groups show lower average contents of CaO, MgO, MnO, Al_2O_3, Sr and to a lesser extent Zn (Table 1 and Figure 4).

The microcline-rich granites have generally high Rb, La, Ce, Th and Zr (Table 1 and Figure 4) compared to the albite-rich samples, which generally have low levels of these elements. Late differentiates of the Apsy pluton can be separated from the microcline-rich altered granites by significantly lower Rb and slightly higher Sr. Two of the late differentiates have low La, Th and Ce but one sample has anomalously higher concentrations of these elements. The microcline-rich granites do not differ significantly from the differentiates in concentrations of elements such as Li, F, Mo, and Cu. The albite-rich samples have slightly higher concentrations of Cu and variable, but not significantly different, concentrations of Li, F, and Mo.

Microcline-rich granites have significantly lower Ba/K_2O ratios than either unaltered granitoid or albite-rich granite (Figure 5). Electron-microprobe analyses of perthitic and microcline-twinned K-feldspar from a variety of samples reveal that K-feldspar in the unaltered rocks and the albite-rich granites contain an average of 0.66 percent BaO (Table 2). In the microcline-rich granites, K-feldspar contains an average of 0.16 percent BaO.

Gold is anomalously high in the albite-rich samples and in many of the microcline-rich samples (Figure 4). The highest gold value was obtained from a 10-cm-wide pyrite–arsenopyrite-bearing siderite–ankerite–sericite vein. An

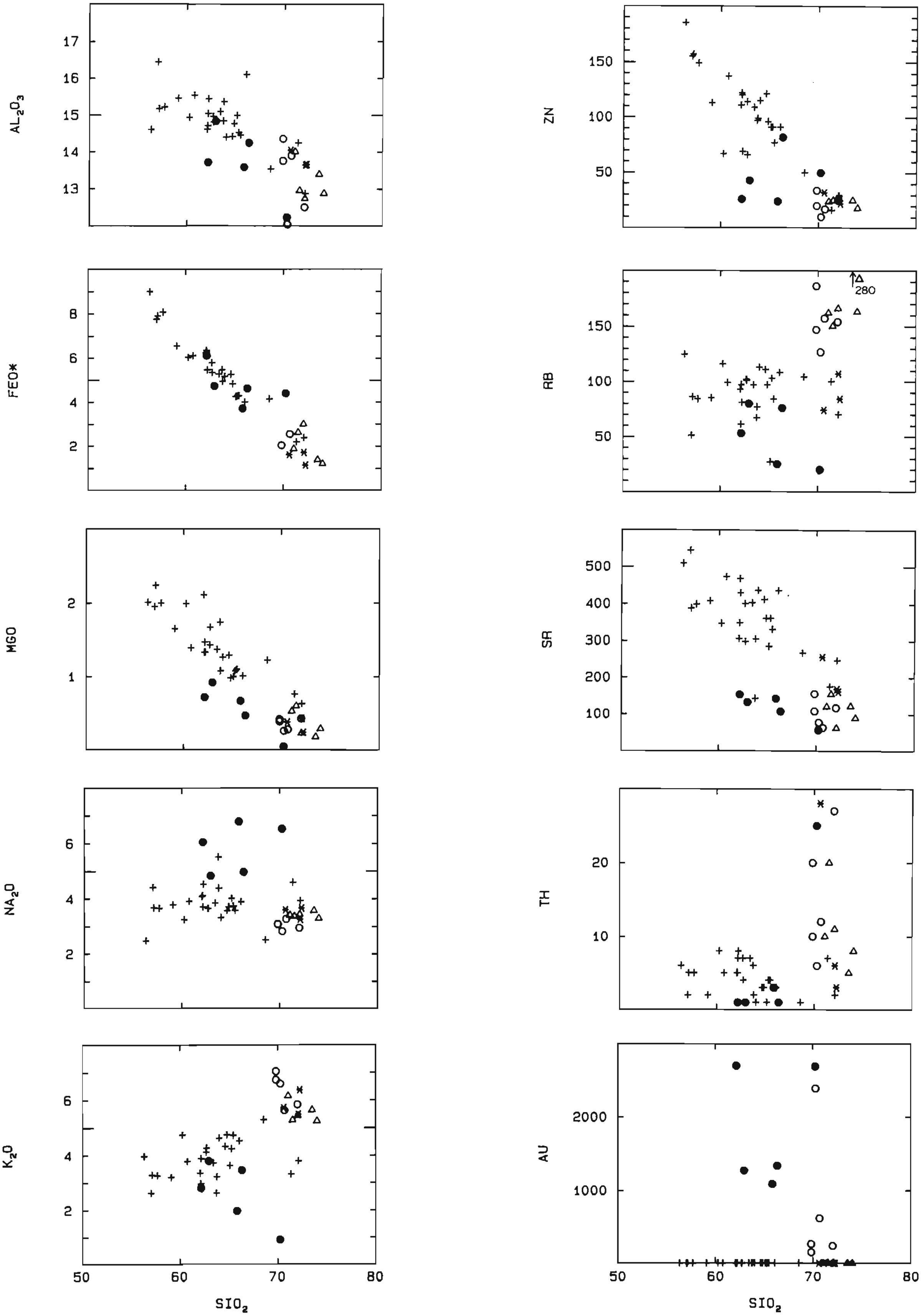

Figure 4. *Harker diagrams showing variation of selected major and trace elements. Symbols as for Figure 1. Oxides in percent, trace elements in ppm, gold in mg/t. Explanation given in text.*

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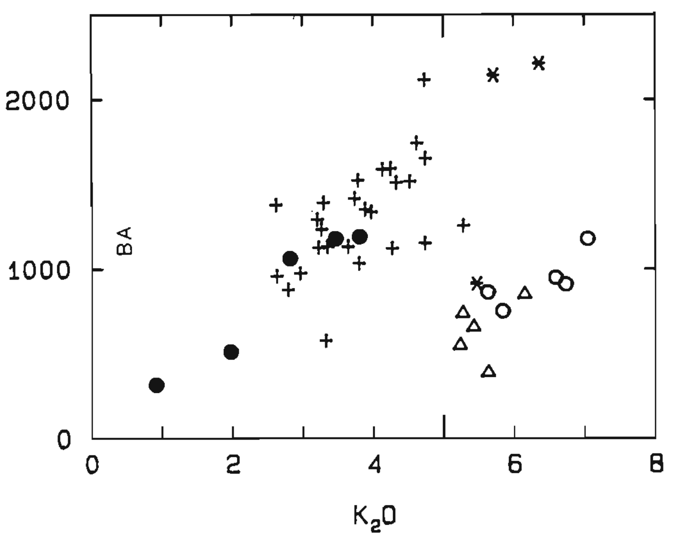

Figure 5. *Plot of Ba against K_2O. Note lower Ba/K_2O ratios of microcline-rich metasomatic granites. Symbols as for Figure 1.*

Table 2. BaO content of K-feldspar

Rock Type	% BaO	No. Points	No. Samples
Unaltered	0.67	13	3
Differentiates	0.35	6	2
Albite-rich	0.66	13	4
Microcline-rich	0.16	19	5

amphibolite inclusion and a cross-cutting diabase dyke also contain anomalous gold (Table 1).

Interpretation

The chemical composition of the altered samples reflects their mineralogy. Microcline-rich granites are enriched in K_2O and Rb and albite-rich samples are enriched in Na_2O. The net loss of CaO, Sr and Zn from both the albite-rich and microcline-rich granites results from replacement of plagioclase. In addition, MgO and MnO have been removed from the rocks during formation of sericite and carbonate from mafic minerals.

Although the altered samples are pyritic, there has been little net addition of iron (Figures 4 and 6). This suggests that sulphur and arsenic reacted with iron from ilmenite, biotite, chlorite and epidote in the host rock to form pyrite and arsenopyrite in the altered rock.

Microcline-rich granites have lower Ba/K_2O ratios than the unaltered rocks or albite-rich granites. This results from the significantly lower Ba content of the metasomatic microcline. The presence of Ba-rich microcline in the albite-rich granites indicates that albitization overprints unaltered granite as well as granite that was affected by stage 1 (low-Ba microcline) alteration.

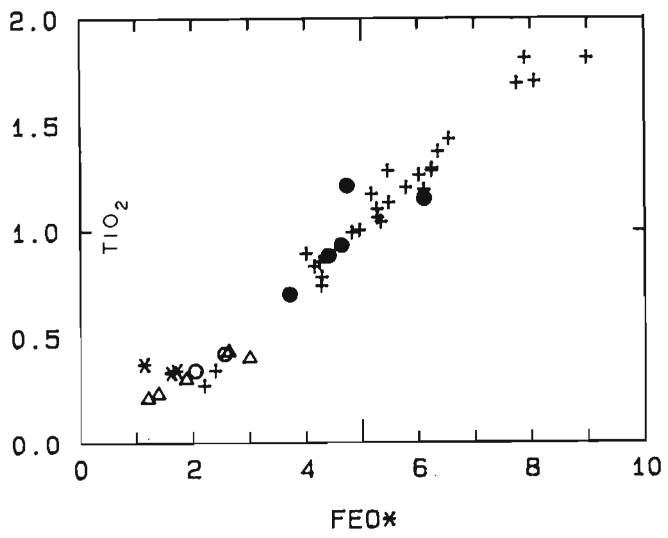

Figure 6. *Plot of TiO_2 against FeO(total). Note that there has been little net addition of iron to the mineralized and altered samples. Symbols as for Figure 1.*

DISCUSSION

K-feldspathization of the granitoid rocks in the Rattling Brook area clearly predated the formation of albite veins and mineralization. It is possible that stage 1 alteration accompanied or predated Grenvillian deformation (ca. 1000 Ma), and is unrelated to the mineralized albite stockworks. However, the spatial association of stage 1 and stage 2 alteration assemblages, and the implication that two different alteration systems of different ages were superimposed argues against such an interpretation.

Gold mineralization and alteration extend up into Lower Cambrian rocks (McKenzie, 1987) demonstrating that the hydrothermal system was Lower Cambrian or younger. Euhedral outlines of silicate and sulphide crystals in stockworks indicate that growth of these phases postdated major deformation in the area and, in turn, suggests that the stockwork system is Late Silurian or younger.

It is probable that the alteration is related to a single hydrothermal system and that variations observed are due to temporal and spatial changes in fluid composition and ion activity in response to changing physical parameters (cf. Beane, 1982). Initially, fluids with high K+ activity permeated along grain boundaries and crystal dislocations. Rupturing of the system, perhaps in response to increasing fluid pressure, led to local hydraulic fracturing, and was accompanied by an increase in Na+ activity and the formation of albite, sulphides and gold in and around fractures.

Hydrothermal K-feldspar and albite have been documented at other gold deposits (cf. Berger and Eimon, 1983; Colvine *et al.*, 1984), and also in association with many of the major granite-related stockwork (porphyry) deposits (White *et al.*, 1981; Beane, 1982). In Newfoundland, pervasive albite alteration occurs at the Windowglass Hill gold prospect at Cape Ray (Wilton, 1984; Tuach, 1986), and the presence of sodium-rich rocks in the Baggs Hill granite near gold occurrences at Big Pond suggests albitization accompanied gold mineralization (Tuach, 1986).

The Siluro-Devonian Devils Room granite, which is in fault contact with the Apsy pluton (Figure 1), may have provided a heat source and/or a source of fluids to the mineralizing system. However, a marked lack of enrichment of elements such as F, Li, Cu and Mo in rocks of the Rattling Brook alteration zone argues against a granitic source of fluids. It is also possible that cross-cutting mafic dykes provided a heat source for hydrothermal activity.

The fluids appear to have been enriched in CO_2, S, As, Na, K and Au. Buisson and Leblanc (1986) suggest Cl-bearing fluids of similar composition were responsible for enrichment of gold associated with carbonatized ultramafic rocks (listwaenites). Such fluids are assumed to be seawater derived and related to serpentinization of underlying ultramafic rocks. The gold is assumed to have been leached from the ultramafic rocks. The similarity of fluid compositions could mean a similar origin for gold mineralization in the Rattling Brook area. The slight enrichment of Rb, La, Ce and Th in the microcline-rich granites may be the result of local remobilization of these elements.

CONCLUSIONS

Alteration related to gold mineralization in the Rattling Brook hydrothermal system developed in two main stages. Stage 1 involved large-scale conversion of the precursor foliated tonalite–granodiorite to granite *(sensu stricto)* via potassium metasomatism. Plagioclase and the mafic silicates were converted to K-feldspar and sericite. Ilmenite was replaced by rutile, and sphene was converted to rutile and calcite.

Stage 2 alteration is restricted to stockwork fractures, veins and vein selvages, and overprints both microline-rich, stage 1 alteration and unaltered granitoid rocks. Deposition of albite, quartz, ankerite and sericite was accompanied by pyrite, arsenopyrite and gold mineralization.

Samples affected dominantly by stage 1 alteration are enriched in K_2O, slightly enriched in Rb, La, Ce and Th and depleted in CaO, Al_2O_3, MgO, MnO, Sr and Zn. Those affected dominantly by stage 2 alteration are depleted in all the above elements and are strongly enriched in Na_2O.

The presence of similar mineralization in Lower Cambrian quartzites and limestones above the granitoid rocks (McKenzie, 1987) indicates that mineralization is Lower Cambrian or later. Lack of deformation of alteration and ore assemblages in fractures suggests that the bulk of the mineralization post-dated the Acadian deformation in the area and is Late Silurian or younger.

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