PETROGRAPHIC STUDY OF THE BIOTITE SCHIST-RICH MIGMATITE QUETICO BELT, SUPERIOR PROVINCE ONTARIO,CANADA

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INTRODUCTION

There were two rock units in my mapping area southeast of the fault, around Nest Lake, Point Lake and Lost Bay: a biotite schist-rich migmatite and a hornblende tonalite gneiss (Mb and Hg respectively). I will present a detailed petrographic study of the Mb unit, comparing samples from the contact zone to samples collected by my field partner, Mary Horvath, from the central region of the Mb, away from the contact (See Fig. 1). I sampled across the contact in two locations: at the Swamp Portage contact near Nest Lake and in Lost Bay near the nose of the major anticline where the Mb plunges beneath the Hg. The study is based on analysis of thin sections including mineralogies, textures, and reactions observed. I will use point counts and estimations of mineral percentages from thin sections as a means of comparison.

FIELD OBSERVATIONS

The biotite schist-rich migmatite (Mb) is a heterogeneous unit. It consists of four components: (1) 50-80% biotite schist, (2) 10-30% leucogranite with a low proportion of biotite and/or hornblende, ranging from thin bands intermixed with biotite schist to more massive outcrops, (3) 5-10% mafic rock, generally amphibolite, that exhibits a high degree of variation with respect to relative proportion of mafic crystals, as well as grain size, (4) 5-10% early plutionic rocks ranging from tonalite to, granodiorite (Day and Weiblen, 1986). These are found throughout the biotite schist unit as concordant and discordant intrusions, often pegmatitic. Some of these intrusions have been faulted and/or folded, while others apparently have not been deformed at all.

The biotite schist-rich migmatite is folded and has a strong foliation. There is a major anticline oriented N55E, plunging about 12-15 to the NE. There are parallel parasitic folds on both sides of the hinge of the fold. Faults of various sizes, as well as joint sets, slickensides, mullions and boudinage structures were also present in the field area. Clearly, there are both compressional and tensional structural features. The folds and the foliation are probably the results of an early phase of ductile deformation. Some of the other features, diagnostic of more brittle deformation, are probably due to later deformational events that occurred after the environmental conditions had changed, specifically, the Burntside Lake and associated faults.

The hornblende tonalite gneiss (Hg) is a more homogeneous unit than the biotite schist migmatite (Mb), and may be a sill that has intruded the Mb. It contains quartz, plagioclase, secondary alkali feldspar, and hornblende. The relative abundances of the hornblende and its grain size are both variable. There is both primary and secondary gneissosity. Kinking of grains is apparent in some localities, especially in more mafic and coarser-grained rock. It has not been deformed as much as the Mb unit, but the dominant foliation in both is similar.

PETROGRAPHY

The primary minerals of the biotite schist-rich migmatite are quartz, feldspar, hornblende, and biotite. These minerals crystallized during amphibolite facies metamorphism. Other minerals developed during a later greenschist facies overprint.

Primary Minerals

Quartz is present in all specimens. The grains are generally anhedral and stretched parallel to the dominant foliation and wrapping around feldspar porphyroblasts. All specimens show polygonization of grains to some degree; some are extremely subgrained. Many grains exhibit undulose extinction. Quartz is distinguishable in plane polarized light because it does not display alteration patches of clay minerals.

Plagioclase feldspar is present in all specimens. The most common twinning is of the Carlsbad type, though there are a few samples that display albite twinning and a few that display pericline twinning. Most of the feldspar grains have twinning visible, primarily around the edges of the grains. The alteration of the feldspar to clay minerals tends to be concentrated in the centers of the grains, presumably because the grains are zoned with more calcic cores, which are more easily altered than the sodic rims. Platelets of muscovite are visible in the altered portions of the grains. Dislocations are visible in some grains, evidenced by the offset of twins. Exsolution patterns are present in a number of specimens, typically micropegmatite in the plagioclase. Alkali feldspar is also present, though in very small quantities. The alkali feldspar grains resemble quartz grains except that they are biaxial porphyroblasts, often surrounded by granulated quartz. Twins are not visible in most grains. Some of the alkali feldspars display strain lamellae as blebs and/or wavy lines.

There are two amphiboles present: hornblende and secondary actinolite. Hornblende is present in all specimens collected from the two contact zones. It has high relief and moderate birefringence. It is strongly pleochroic, ranging from pale green to brown. Twinned hornblende is present in some specimens, with the twin plane at a small angle to the long axis of the grains. Two cleavage planes are visible in many grains, intersecting at the characteristic 120 .

Biotite is present in most samples. It occurs as flakes and aggregates and is the best mineral for defining the foliation. The aggregates of biotite grains wrap around larger feldspar porphyroblasts in many samples. It is strongly pleochroic, ranging from colorless to brown in plane polarized light. There are a few examples of biotite twinning. It is distinguished from hornblende by its one good cleavage direction, birds-eye extinction and higher birefringence.

Secondary Minerals

All sppecimens studied showed some degree of retrograde alteration, much of which was probably hydrothermal in origin. Among the products of this alteration were: actinolite,chlorite, epidote and hematite. A number of mineral reactions were observed in the analysis of thin sections (See Fig.2). Five specimens from the contact zone showed a retrograde reaction from hornblende to actinolite. The actinolite is lighter in color than the hornblende under plane polarized light, and it is strongly pleochroic, ranging from pale green to deep blue-green. The actinolite tends to grow parallel to the long axis of the hornblende grains as narrow prismatic needles. Hornblende alters to biotite, though it is rare. Hornblende also alters to chlorite and epidote. The epidote forms inclusions in the larger chlorite flakes, but it is also found as larger individual grains. Epidote is colorless to pale yellow under plane polarized light, and has bright 2nd-3rd order interference colors. The chlorite tends to be intergrown with the biotite if the two are coexistent. The biotite also alters to chlorite and epidote. Plagioclase is at varying stages of alteration to clay minerals, particularly muscovite. Many specimens, especially the more altered ones, contain small amounts of carbonate material, in most cases, in the interstices between grains.

Accessory Minerals

The accessory minerals present are typical of metamorphic rocks comparable to those that I studied. Euhedral apatite, and zircons of high relief are present as inclusions in porphyroblasts. Some garnet is present. Titanite was present in all specimens. Many of the titanite grains were diamond-shaped, but a few samples had larger, more irregularly-shaped grains. They have very high relief and range in color from dark yellow to brown.

CONCLUSIONS

There are a number of differences between the biotite schist-rich migmatite of the contact zones and that from the central region of the unit. The biggest difference is in the proportion of hornblende (See Fig. 3 and 4). Hornblende was present in all samples from the two contact zones, averaging 23%, but it was only present in one of the specimens from the central region, and only at 4%. I suggest that the presence of the hornblende in the biotite schist-rich migmatite is due to mixing with the hornblende tonalite gneiss. Indeed, in mapping the contact, it was difficult to pinpoint the exact location of the contact. There appeared to be a fair amount of mixing. There is also more chlorite present in the contact zone samples. This is at least partially due to the fact that there is more alteration of the rocks near the contact, and the fact that there was more hornblende there initially to be altered.

Further differentiations can be made between the two contact zone sample areas. The rocks from the Lost Bay contact seem to more mixed on the outcrop scale, as well as on the microscopic scale. There is an average of 31% hornblende in the Lost Bay specimens, while there is an average of 20% in the samples from the Swamp Portage contact. Again, in line with the more general comparison, there is more alteration in the specimens from the Lost Bay. As the proximity to the contact increases, and as the degree of mixing increases, the degree of alteration increases, as well as the amount of hornblende.

REFERENCES CITED

Day, Warren C. and Weiblen, P.W. (1986) Origin of Late Archean granite: geochemical evidence from the Vermillion Granitic Complex of northern Minnesota. Contributions to Mineralogy and Petrology, v.93, pp. 283-296.

Percival, John A., (1989) A regional perspective of the Quetico belt, Superior Province, Canada. Canadian Journal of Earth Sciences, v.26, pp.677-693.

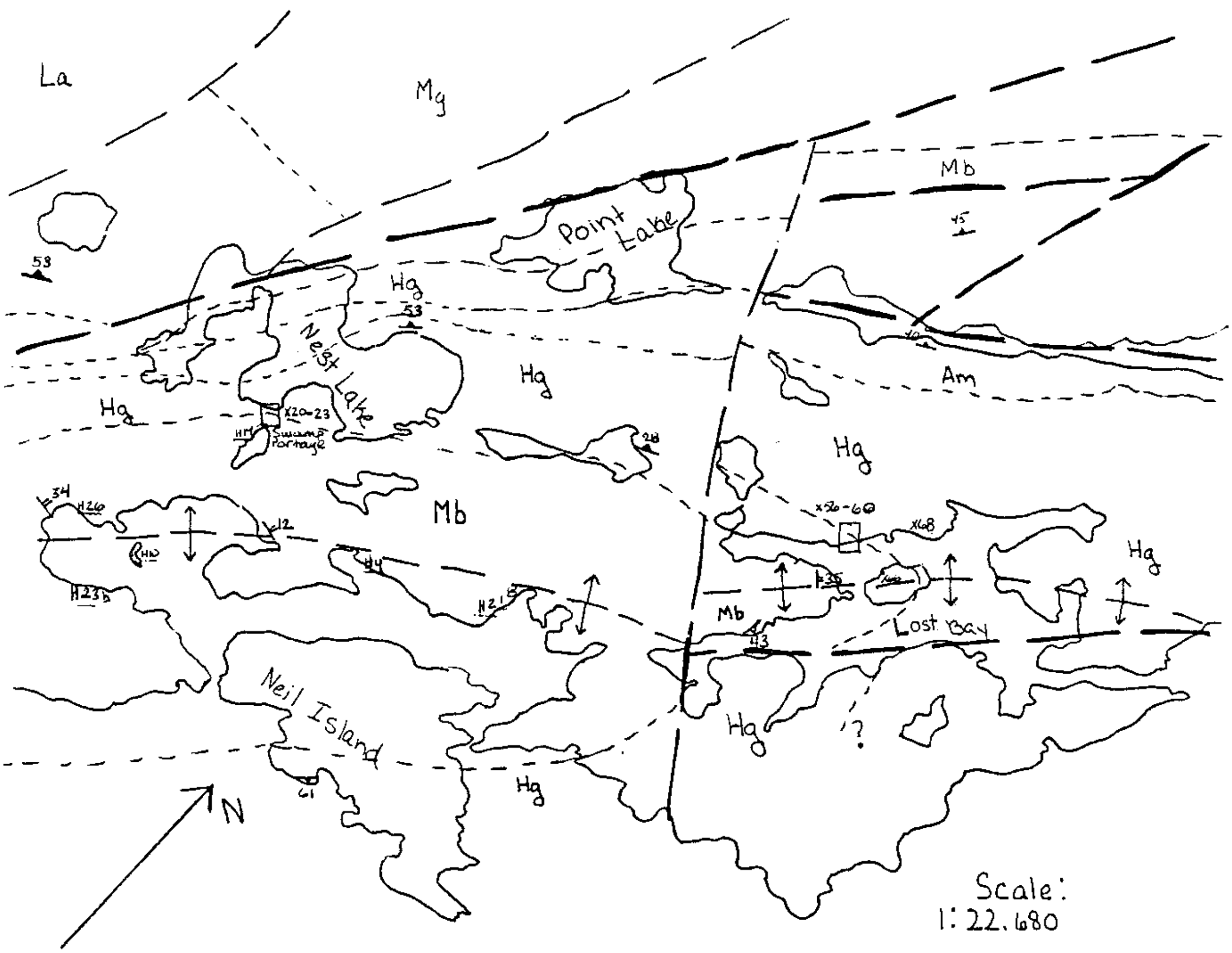

Figure 1 Geologic Map of Field Area (Drafted by H. Woodard, 1989)

Figure 2 Reactions observed in thin sections

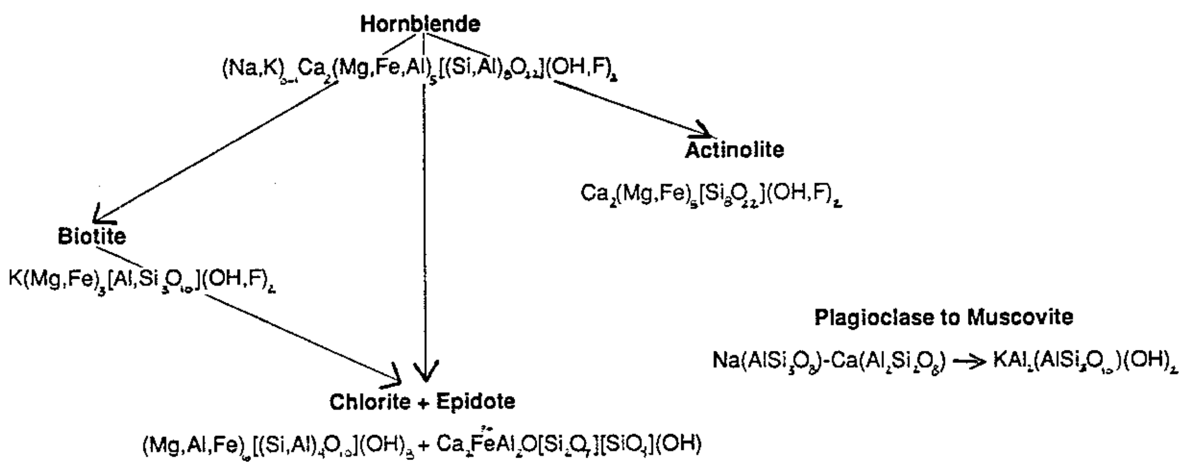

Figure 4 Modal Extremes and Averages (in %)

S P E C I M E N S

Central	Qtz	Plag	Hb	Bio	Chl	Musc
H1	25	40		15	<1	20
H4 *	32	57	4	10	0.3	0.1
H8 *	38	39			4	15
H18	60	40		<1	<1	<1
H10	18	40		28	1	<1
H23b	20	65		10	<1	<1
H26	18	60		20	<1	<1
Contact						
X20 *	24	35	19	8	6	0.6
H6 *	27	42	21	2	27	0.8
X56	7	49	37		7	1
X59	10	40	25		3	5
X60	18	48	31		3	<1
X66	45	30	4	18	2	<1

* Data based on 1000 points/thin section

Figure 3 Modal Data of Biotite schist-rich migmatite (in %)

	High	Low	Central Avg	Contact Avg	Total Avg.
Quartz	60	7	30.1	21.8	23.2
Plagioclase	65	30	48.7	40.7	40
Hornblende	37	0	0.6	22.8	10.9
Biotite	28	0	11.9	4.6	8.6
Muscovite	20	0	5.2	1.3	3.4
Chlorite	27	<1	1	8	4.3