POTASSIUM ALTERATION OF TONALITES IN CENTRAL KAWNIPI LAKE, ONTARIO, CANADA

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INTRODUCTION

The Kawnipi Lake region of the Quetico Provincial Park, Ontario, Canada is positioned astride the Quetico-Wawa subprovince junction with Archean geology consisting of intensely deformed and metamorphosed migmatites, ultramafic bands associated with fault action, and igneous sequences including sill-like tonalite intrusions. This project focused on the tonalite units and the associated trondhjemite dikes found within the Wawa belt, with an emphasis on the possible potassium alteration of the plagioclase feldspars of these rocks (figure 1).

Methods. Because the research area was located in Quetico Provincial Park, transportation was limited to canoeing and traversing on foot. Mapping was done on both aerial photographs and topographic maps. Brunton compasses were used to make structural measurements which were plotted on aerial photographs. Specimens were carefully selected in order to reduce portaging of unnecessary rock material. They were analyzed in the laboratory by staining slabs with sodium cobaltinitrite to reveal the presence and distribution of potassium feldspar and through observation of partially stained thin sections using Zeiss petrographic microscopes. Classification of different rock units is based on original mineral compositions rather than on mineral compositions resulting from secondary alteration, which were often difficult to determine in hand specimen while in the field. Our classification therefore placed emphasis on the original genesis of the rocks.

GEOLOGY OF THE CENTRAL KAWNIPI LAKE REGION

Lithologies. Five main lithologic units were mapped in the central Kawnipi Lake region. The biotite schist-rich migmatite (Ap), granitic-rich migmatite (Agx), hornblende tonalite gneiss (At), and amphibolite migmatite (Av) units are consistent with those previously discovered in other portions of the Wawa belt (Woodard, 1992). A new lithology discovered in the mapped area, biotite-rich blastoporphyritic schist (Ao), cross-cuts the other units. This cross-cutting relationship indicates an igneous origin. The migmatitic units contain sills and dikes of the tonalite and all are intensely folded. Trondhjemite is commonly found as dikes cutting all of the major lithologies and consists of plagioclase feldspar, quartz, and less than 10% biotite.

Structures. The major structural features found in the central Kawnipi Lake region range from N 20-50 E and are aligned along strike of the regional S1 foliation . These features include: 1) a large ductile shear zone located in McVicar and Kawa Bays, 2) a possible continuation of the Silence Lake Fault which cuts through North Bay (figure 1), 3) late stage small scale brittle faulting in Murdoch and McKenzie Bays, 4) northeast-trending and -plunging synclines and anticlines possibly related to the shearing events seen in the eastern portion of the map area near Atkins Bay and in North Bay, and 5) highly folded portions of the Ap unit near North and McKenzie Bays (figure 1). Smaller-scale structures include an unexplained subhorizontal fracturing pattern present in the tonalites found in several areas and a complex joint system also studied by Kinner and Morgan (1994).

POTASSIUM ALTERATION OF TONALITES

Tonalite is a granitic rock composed chiefly of plagioclase, quartz, and mafic minerals, usually hornblende (figure 2). The most likely source of tonalite is as a partial melt derivative of an amphibolite or tholeiitic basalt (Barker, 1981). In the Wawa Belt this genesis is supported by the presence of amphibolite pods throughout the tonalite as well as amphibole-rich mafic varieties of tonalite (Krugh, 1990), which was also seen in our area. Tonalite was especially important in early crustal evolution during the Archean, since it was the main felsic component of continental crust (Barker, 1981).

Intrusive bodies such as tonalite compose much of the Wawa belt (Card and Ciesielski, 1986). In the Central Kawnipi Lake region, tonalites are the main intrusive rock, injected as thick sills into the greywacke-type sediments that were later partially melted to form migmatites of biotite schist-rich or granitic-rich character. These tonalite injections have been recognized as a potential source of the heat necessary to produce the partial melting. Tonalites compose the entire eastern portion of the mapped area, and underlie Murdoch Bay, and parts of McKenzie, Kawa, and McVicar Bays. Much of the tonalite mapped is sheared, especially in the locality of Kawa and McVicar Bays (figure 1), where several shear zones have been discovered. Another interesting feature present in some tonalite outcrops is a sub-horizontal fracturing, found predominantly in the eastern portion of the area mapped and in Murdoch Bay.

Figure 1. Geology of the Central Kawnipi Lake Region, Quetico Provincial Park, Ontario, Canada.

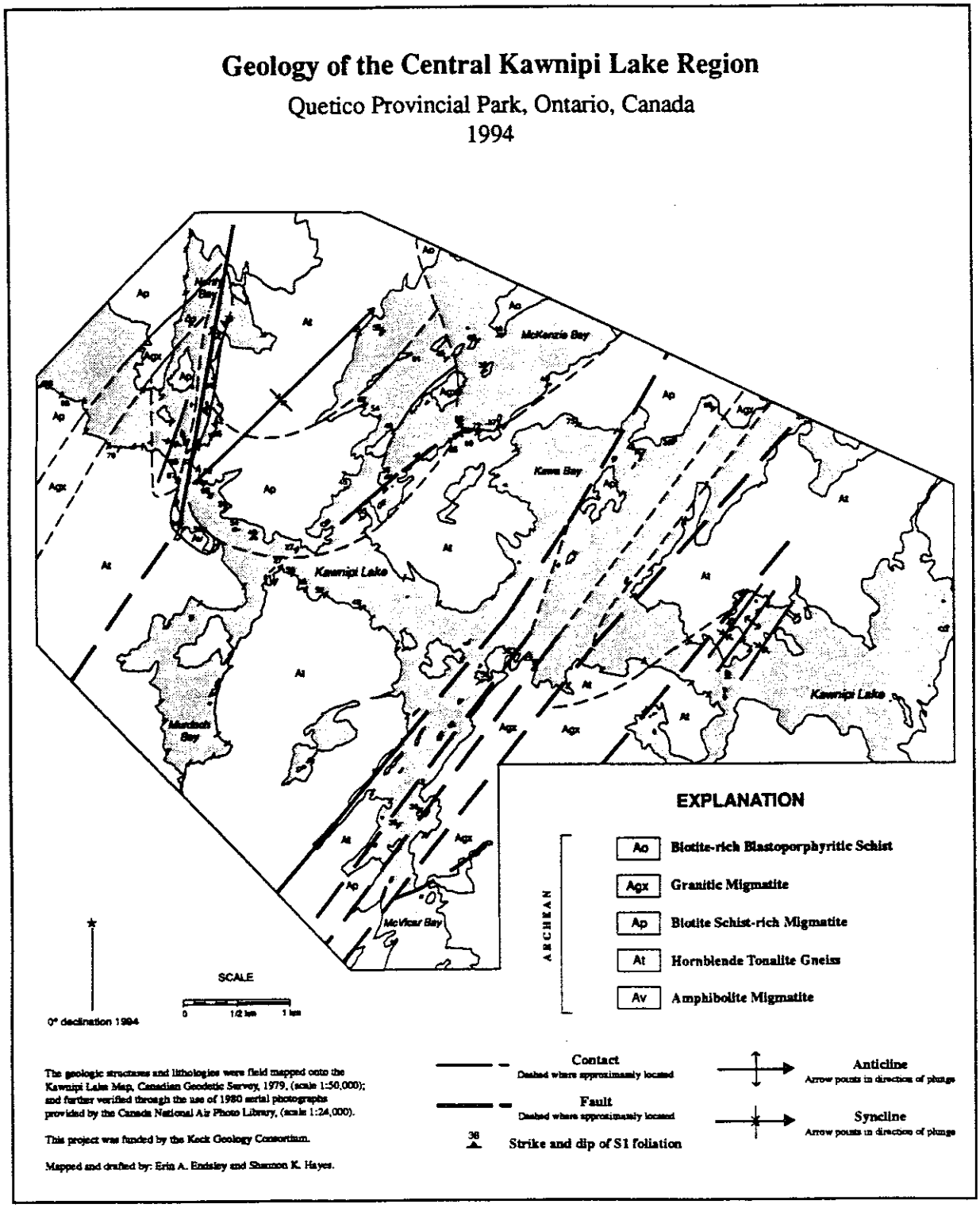
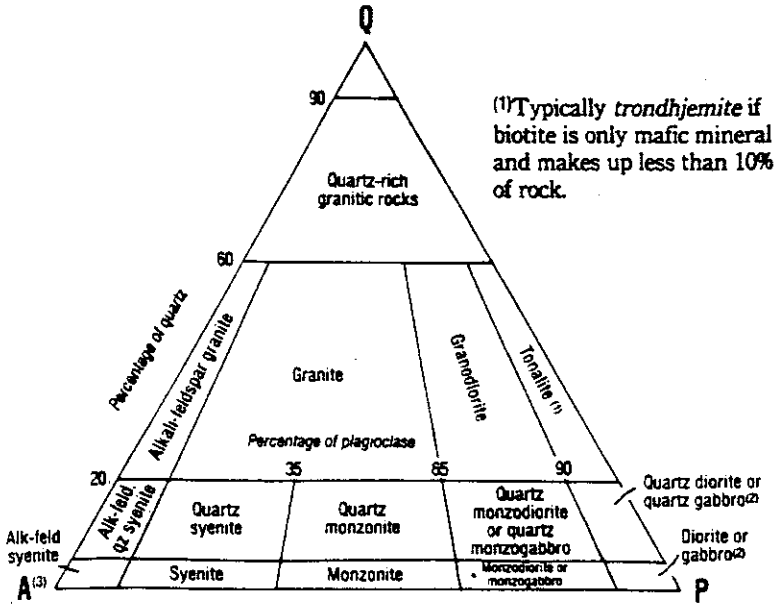


Figure 2. Streckeisen classification of tonalite (Compton, 1985).



(1)Typically *trondhjemite* if biotite is only mafic mineral and makes up less than 10% of rock.

Data. In order to analyze our field data, the specimens collected were grouped into ten series based on location. They were then slabbed, etched with hydrofluoric acid, and stained with sodium colbaltinitrite. Sodium cobaltinitrite stains potassium-bearing minerals bright yellow, which allowed us to differentiate between potassium feldspar and plagioclase. Altogether, thirty-eight slabs of tonalite and trondhjemite were stained, and partially stained thin sections were made from fourteen of these slabs. Specimens containing granitic dikes as well as specimens located far away from dikes were collected to help determine the role the granitic dike magmas play in the distribution of potassium feldspar in the tonalites.

In general, the stained tonalites from the south shore of Kawnipi Lake east of Kawa and McVicar Bays contained about 3% potassium feldspar. All of this appeared to be secondary and often was seen in abundance along tiny fractures within the specimen. These tonalites are located adjacent to a granitic-rich migmatite (Agx) unit.

The tonalites in the small bay east of the entrance to Kawa Bay are highly sheared and contain 3-15% potassium feldspar. This potassium feldspar is found between grains along foliation planes, filling in microfractures, and rimming quartz and plagioclase grains. In some specimens with higher potassium feldspar content, the potassium feldspar partially replaces the plagioclase. These textural relationships indicate that the potassium feldspar is secondary.

The highly sheared tonalite on the eastern shore of Kawa Bay also contains a large amount of potassium feldspar. The average percentage of potassium feldspar found was 15% and was distributed interstitially. The specimens were taken from the shear zone near the contact with a granitic-rich migmatite (Agx) unit.

Although a large shear zone is located in McVicar Bay, none of the specimens studied from this locality were highly sheared. The tonalite slabs contained 1-7% potassium feldspar. Several specimens contained granitic dikes with 40-60% potassium feldspar which did not appear to increase the potassium feldspar percentage in the tonalite adjacent to the dikes. A few dikes were zoned, containing only 1% potassium feldspar in the outer edges and up to 60% in the middle. Again, potassium feldspar is found concentrated in fractures in the rock or interstitially. Also, the presence of myrmekite and sericitization of the plagioclase feldspars indicates hydrothermal alteration.

A small amount of potassium feldspar is contained in the tonalite specimens taken from the shore of Kawnipi Lake between Murdoch and McVicar Bays. There is about 5% potassium feldspar in these specimens and it is distributed unevenly. One dike originally believed to be trondhjemite in the field was found upon staining to contain up to 40% potassium feldspar; the dike, however, does not affect potassium feldspar concentration of the surrounding tonalite.

Both the tonalite and trondhjemite of McKenzie Bay contain about 3% potassium feldspar, found interstitially and distributed unevenly thoughout the rock. One specimen contains approximately 15% potassium feldspar along with biotite. Its map location indicates it may simply be a finer-grained portion of the Ao intrusive stock.

Potassium feldspar ranges from 2-15% in the tonalite of Murdoch Bay. All potassium feldspar appears to be secondary and is predominantly interstitial, although one case of possible metasomatism of tonalite by potassium around a granitic dike was found. The porphyritic varieties of tonalite in Murdoch Bay contain a much higher percent of potassium feldspar (8-15%) than the non-porphyritic tonalite. In one specimen of porphyritic tonalite, the potassium feldspar appears to replace plagioclase phenocrysts. Epidote and sericitization of the plagioclase, which indicate hydrothermal activity, are also present.

The tonalites found in North Bay and along the shore of Kawnipi Lake west of Murdoch Bay and northwest of the entrance to North Bay contain a moderate amount (3-10%) of potassium feldspar. It is distributed unevenly and concentrated along cracks and in the spaces between grains. Granitic dikes and the adjacent granitic-rich migmatite (Agx) in the area do not affect the concentration of potassium feldspar in these specimens. In addition to potassium feldspar, a small amount of biotite is also found in the tonalite, sometimes intergrown with the amphibole, and sericitization of the plagioclase, myrmekite, and epidote are present. A trondhjemite dike found within the biotite schist-rich migmatite (Ap) contains a high amount of potassium feldspar. Amphibolite lenses within the tonalite also show potassium feldspar in cracks.

CONCLUSIONS

Several generalizations can be made regarding the presence of potassium feldspar in the tonalites of the central Kawnipi Lake region. Tonalites, by definition, should not contain any more than 3% potassium feldspar (figure 2). 1) The potassium feldspar found in the tonalites is predominantly interstitial or located along microfractures in the rock, often altering the plagioclase. 2) Granite dikes cutting the tonalite and granitic migmatites found near tonalite do not appear to affect the concentration or distribution of potassium feldspar in the tonalite. 3) Porphyritic tonalite generally contains more potassium feldspar than the non-porphyritic varieties. 4) More secondary potassium feldspar is present in the sheared tonalites than the non-sheared tonalites, most likely because the rock was weakened during the shearing process, allowing more potassium-rich fluids to enter and alter the tonalite. This supports the idea that hydrothermal differentiation is associated with cataclasis (Collins, 1988). 5) There were at least two major hydrothermal events affecting the tonalite: an earlier event consisting of potassium alteration marked by the generation of myrmekite, replacement of plagioclase by potassium feldspar, and emplacement of interstitial microcline; and a later lower temperature event characterized by sericitization and the development of epidote. 6) The source of potassium feldspar is most likely external. Although primary potassium feldspar could have been mobilized in hydrothermal fluids and then crystallized interstitially, the high percentage of potassium feldspar found in many tonalite specimens suggests an outside source (Krugh, 1990).

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