A Study of the Burntside Lake Fault At The Quetico-Wawa Junction Kawnipi Lake, Quetico Provincial Park, Ontario, Canada

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Introduction

In the Kawnipi Lake area, the Quetico belt is generally characterized by migmatite composed of biotite schist, granitic intrusions and quartz monzonite sills. Age determinations of the igneous rocks in the Quetico range from 2.65 to 2.70 Ga (Williams, 1992). The Wawa belt is composed of greenstone, biotite schist-rich migmatite, foliated tonalite, granodiorite, and granite and is 2.70 to 2.75 Ga (Williams et. al., 1992). Convergence of these two belts resulted in a junction characterized by complex structures and lithologic melanges.

Following the development of the junction, the Burntside Lake episode of strike-slip faulting occurs in the Quetico and Wawa belts trending northeast, subparallel to the junction. The Burntside Lake Fault and the Quetico-Wawa junction intersect in Kawnipi Lake just east of Rose Island (Fig. 1). Previous research on the fault to the southwest indicates an initial period of ductile deformation followed by a later period of brittle deformation (Kambhu and Russin, 1992). Previous work on the Burntside Lake Fault indicates right lateral motion (Kambhu and Russin, 1992). No age for the Burntside Lake Fault has been determined, although relative age dating restricts it to before the Vermilion fault system (Kambhu and Russin, 1992).

As part of our research in the Kawnipi Lake area, we mapped the geology associated with the Burntside Lake fault lineament and the trace of the Quetico-Wawa junction. We also collected data on the direction and extent of displacement in the area and determined the point of intersection of the fault and the junction. We also examined the mineralogy of the Quetico and Wawa belt rocks altered by the Burntside Lake hydrothermal event.

Methods

We collected data along the shoreline by canoe and made some inland traverses to locate outcrops. At each outcrop we determined the predominant rock type and measured the foliation, strike and dip of fault surfaces, plunge of slickenlines, and the sense of motion whenever possible. We recorded the relative amount of hematite staining. All information was plotted on aerial photos of the region. Thin sections of each rock type were made to determine the effects of the hematite staining on the mineralogy of the rocks.

Lithologies along the Quetico-Wawa Junction

Within the region studied in 1994, the Quetico belt consists of granitic-rich migmatite, biotite schist-rich migmatite, small isolated units of hornblende gabbro, and Williams Lake hornblende quartz monzonite. The granitic-rich migmatite trends southwest-northeast into Keewatin Lake (Fig. 1). Biotite schist-rich migmatite is located along the channel west of Rose Island and northeast of Rose Island. Biotite schist rafts are dispersed in the granitic-rich migmatite in the area southwest of Rose Island. There are three isolated outcrops of hornblende gabbro: one along the junction northeast of Rose Island, one on a small island southwest of Rose Island, and another along the fault southwest of Rose Island. There is a peninsula of Williams Lake hornblende quartz monzonite within the belt of granitic migmatite.

The Wawa belt in this region contains granitic-rich migmatite, tonalite, and biotite-hornblende schist-rich migmatite. The granitic-rich migmatite trends northeast from Keewatin Lake along the junction. The tonalite units are found within 300 meters of the junction in areas east of Keewatin Lake, east of the portage into Kawnipi Lake, and east of the peninsula south of Rose Island. Areas of biotite-hornblende schist-rich migmatite are found east of Rose Island (Fig. 1).

southwestward. This process of "backshoving" caused intense rotation and dismemberment of previously formed F_1 anticlines and synclines within the Wawa belt in the central and eastern portions of Kawnipi Lake) (see Fig. 1), and a complex sequence of F_2 fold axes can be recognized. The central portion of Kawnipi Lake trends west and northwest across the regional structural trends, and is eroded along the crests and flanks of several of these rotated F_1 folds.

Within the Quetico belt, the more northerly-trending portion of Kawnipi Lake is fault controlled. This is demonstrated by several displaced rock units (see Fig. 1). No work has been done in the far southeastern portion of Kawnipi Lake and the reason for its orientation is still unknown. Given the extremely complex structural relationships illustrated throughout the Kawnipi Lake area, it is perhaps not surprising that the orientation of fracture sets in these rocks as measured by Kinner and Morgan (this volume) could not be easily related to the mapped geology.

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Structural Geology Related to the Burntside Lake Fault

We traced the Burntside Lake Fault from the southwest corner of Kawnipi Lake to its intersection with the Quetico-Wawa junction east of Rose Island. The Burntside Lake Fault trends N30E (Fig. 2), dips subvertically, and shows right lateral movement. The Quetico-Wawa junction trends N20E and also shows right lateral movement (Fig. 2).

The intersection of the Burntside Lake Fault with the Quetico-Wawa junction is characterized by brecciation, foliation, and slickensided surfaces. The outcrops of biotite-hornblende schist-rich migmatite at the intersection are brecciated and fractured along the foliation. In contrast to the N20E foliation typical of the junction, foliation and slickenline measurements at the intersection range from N60E to N80W. The slickenlines found on sheared surfaces indicate right lateral movement along the Burntside Lake Fault and the reactivated junction.

Burntside Lake Hydrothermal Event

Hematite staining varies from being concentrated along fractures to being pervasive throughout the rock. The staining is very intense in outcrops along the fault trace. The intensity decreases away from the fault trace until it completely vanishes, usually within 500 meters. Areas of heavy staining occur in the bay southwest of Rose Island and continue northeast along the fault. Medium staining is present along the Quetico-Wawa junction in Keewatin Lake and becomes heavier to the north where the Burntside Lake Fault intersects the junction. Beyond this the staining becomes lighter.

Thin sections were prepared of each of the dominant rock types in the Quetico and Wawa belts in order to examine the effects of the hydrothermal alteration.

Specimen 1 of coarse-grained granitic-rich migmatite was taken from a moderately stained outcrop located on a small island just south of Rose Island. The thin section contains quartz, plagioclase, perthite, and less than 5% biotite altering to chlorite. Albite twinning identifies the stained feldspar as plagioclase. The remaining unstained feldspar is perthite.

The heavy staining of the rock type on the peninsula south of Rose Island made identification difficult, but it most closely resembles Williams Lake hornblende quartz monzonite. Specimen 2 is composed of quartz, plagioclase, potassium feldspar phenocrysts, and 5 to 10% hornblende. Again the plagioclase is heavily stained with hematite and the potassium feldspar phenocrysts are not. Examination of the thin section reveals an alteration process of hornblende to biotite to chlorite.

Specimen 3, a fine-grained biotite-hornblende schist-rich migmatite, was taken from the mouth of the small bay to the east of Rose Island. This specimen is lightly stained, although the degree of staining is more visible in the cross-cutting leucosomes within the specimen. The mineralogy consists of both biotite and hornblende as well as minor amounts of quartz and stained plagioclase.

Specimen 4, an unstained, course-grained tonalite, comes from the small bay on the east side of Keewatin Lake and contains quartz, plagioclase, and about 20% hornblende altering to biotite. The small flakes of biotite surrounding the larger grains of hornblende observed in thin section illustrate the alteration. This alteration of hornblende to biotite within the tonalite unit becomes much more pronounced in areas to the north along the junction. In some outcrops near the intersection of the Burntside Lake Fault there is more than 50% biotite preserving the original amphibole shape.

Hydrothermal alteration was more intense in the felsic rock types containing plagioclase than in the mafic rock types. At the intersection of the Burntside Lake Fault and the Quetico-Wawa junction, the lithologies were predominantly biotite-hornblende schist-rich migmatite and tonalite. In the Wawa belt close to the intersection is a rare outcrop of heavily stained schist. The tonalite just south of the heavily stained schist, however, is unstained. There is no fracture system in the tonalite unit to allow staining. Moderately stained tonalite occurs along the east shore of Keewatin Lake where hydrothermal alteration occurred along the Quetico-Wawa junction.

Interpretation

The combination of intermingled biotite-hornblende schist-rich migmatite, granitic-rich migmatite, and tonalite along the Quetico-Wawa junction defines a melange zone. The presence of hornblende gabbro possibly indicates an earlier ophiolite sequence in which fragments of the ocean floor were accreted to the Quetico belt. This melange zone has been sheared and stained at its intersection with the Burntside Lake Fault. This hematite staining is characteristic of the fault and is caused by a simultaneous hydrothermal event. The staining may be due to oxidation of inclusions of iron-rich magnetite in the plagioclase.

Evidence that the Quetico-Wawa junction has been reactivated was found in both the Keewatin and Kawnipi Lake areas. Research by McCormick and Ford (1993) on Keewatin Lake indicates very similar strikes between the slickenlines and foliations. Their interpretation of this relationship is a preferential faulting along the foliation direction in this area. The slickenlines from Keewatin Lake, the brecciated rocks, and hematite staining along the junction indicate fault activity related to the Burntside Lake Fault.

Stained Williams Lake quartz monzonite is located on the peninsula south of Rose Island and trends northeast. Wegmann and Allen (1994) mapped the eastern boundary of the Williams Lake pluton along the southeast extension of Williams Lake, northeast across the Burntside Lake Fault, and due north about 1 km. The southern boundary of the pluton is unknown. Extrapolation of the boundary south would place the pluton close to the Quetico-Wawa junction between the north end of Reid Lake and the north portage out of Agnes Lake. The right lateral reactivation could have displaced a piece of the Williams Lake 4 to 6 miles north to the peninsula south of Rose Island. This segment of Kawnipi Lake is evidence that the Williams Lake pluton continues to the junction in Reid Lake.

Conclusions

We consider the Quetico-Wawa junction as a melange zone which has been intersected by the Burntside Lake Fault. The fault is associated with a concurrent hydrothermal event resulting in extensive hematite staining. We believe the right lateral displacement of the Burntside Lake Fault was transferred to the junction boundaryn. These conclusions correlate with previous studies on the Burntside Lake Fault and the Quetico-Wawa junction.

Acknowledgments

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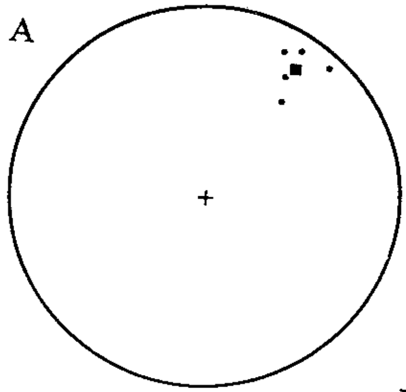
Figure 2

A. Stereonet of the Burntside Lake Fault slickenline data. The box indicates the mean vector for this plot. The mean vector is N32E, 18.4 degrees.

B. Stereonet of the Quetico-Wawa junction slickenline data. The mean vector for this plot is N21E, 16.4 degrees.

A



B

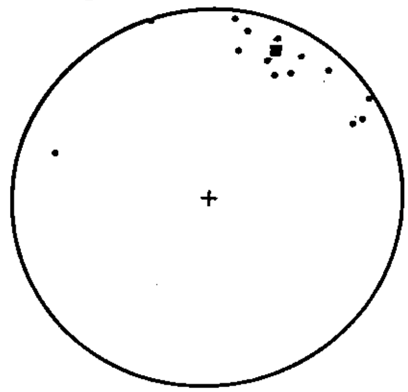
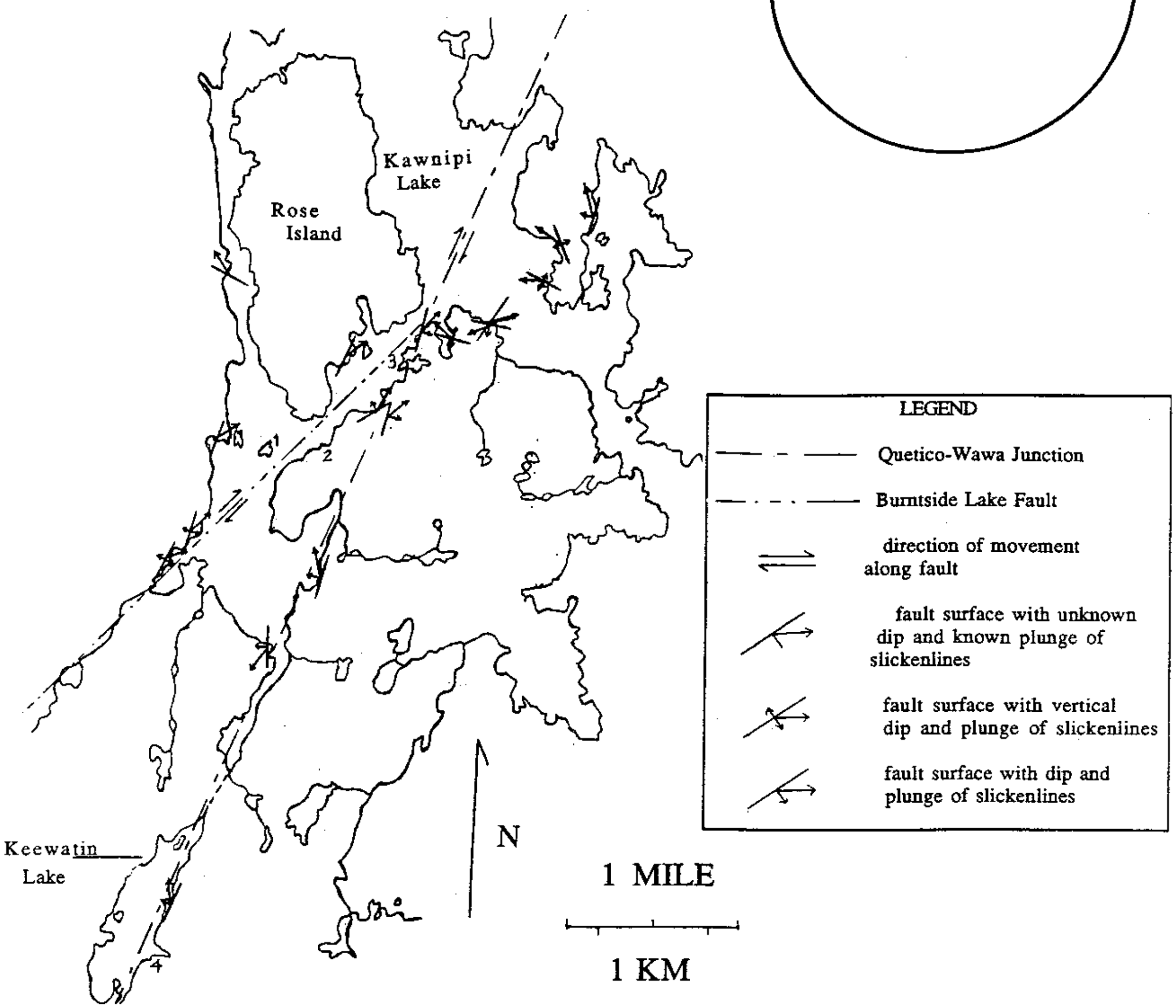


Figure 1



COMPOSITION GRADIENTS IN TONALITES OF THE WAWA SUBPROVINCE, SUPERIOR GEOLOGIC PROVINCE, CANADA

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INTRODUCTION

The research was conducted on tonalite samples collected from within the Wawa Subprovince of the Superior Province, Quetico Provincial Park (see Woodward, et al., this volume). A series of tonalites of similar age displays a variety of contact relationships with several other lithologies of various ages (e.g. granitic intrusions, basaltic dikes and amphibolites). The focus of the research was to document composition gradients between tonalites and adjacent lithologies and to determine if mobilization of material has taken place between these rocks during intrusion and subsequent metamorphism.

METHODS

Through petrographic study of thirty samples, modal analyses were approximated. Chemical staining of the samples with Na-cobaltinitrite was used to determine distribution and quantity of alkali feldspar present. Based upon mineral assemblages and distinct intrusive contacts, three samples were selected for electron microscopic analysis and backscatter electron imaging on a JEOL microprobe at the University of Georgia. Using the microprobe chemical compositions of selected feldspar and amphibole grains were determined. Secondary backscatter imaging proved useful in visualizing and interpreting textures of the sample fabrics.

RESULTS

The rocks of this study are chiefly medium- to fine-grained tonalites. The tonalitic samples demonstrate one of three distinctly different petrographic characteristics: tonalites with hypidimorphic-granular textures (Group A), tonalites intruded by granitic dikes (Group B), and tonalitic-appearing samples which have granitic mineralogies (Group C).

Group A samples display hypidiomorphic-granular textures, which is generated by early unrestrained growth of certain crystals (Best, 1982). The mineralogies of these samples are: 30-40% quartz, 25-35% biotite, 25-35% plagioclase, 10-20% amphibole, <5% sphene and <1% alkali feldspar. These modal abundances classify the samples as tonalite (Hyndman, 1972). Confirmed by staining with Na-cobaltinitrite, Group A samples are deplete in alkali feldspars.

Samples in Group B are tonalites cross-cut by centimeter-wide granitic intrusions. The modal mineralogies of the tonalites in these samples are similar to those of Group A: 25-35% plagioclase (compositions from albite to bytownite; fig. 2, QT10 & QT6), 30-40% quartz, 15-20% amphibole (edenitic hornblende; fig. 3), 25-35% biotite, and <5 sphene. The granitic intrusions are more rich in alkali feldspar (<90% Or). The granitic rocks contain medium- to coarse- grained minerals which coarsen away from contacts. The tonalite-granitic dike contacts show some gradation into one another; this overlap area, where alkali feldspar is present, ranges from millimeters to centimeters. The minerals in these granitic rocks are mostly alkali feldspar, quartz and minor biotite. This contact was one of the foci of the study. The tonalites are also in contact with amphibolites and basalt. The tonalite-basalt and the tonalite-amphibolite contacts are sharp and do not demonstrate any gradation.