STRUCTURE OF THE QUETICO-WAWA SUBPROVINCE JUNCTION ALONG THE REID-KEEWATIN LINEAMENT, QUETICO PROVINCIAL PARK, ONTARIO, CANADA.

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INTRODUCTION

As part of the continuing research in the Quetico-Boundary Waters region in the Quetico Provincial Park, the 1993 Keck Quetico research group focused on the area along the northern Agnes Lake region, extending north into Keewatin Lake. Under the guidance of faculty advisors, researchers worked in pairs on projects in the general area of Reid Lake.

This research focused on mapping lithologies and examining structural features to establish the existence of a fault along the Quetico-Wawa subprovince junction and to define its boundaries and displacement along the Reid Lake-Keewatin Lake lineament (a topographic lineament from southern Reid Lake to northern Keewatin Lake which lies along the junction between the Quetico and Wawa subprovinces within the Superior Province of the Canadian Shield). We also attempted to determine the relationship, if any, to the Burntside Lake fault which occurs approximately ten kilometers to the northwest and extends almost parallel to the Reid-Keewatin lineament.

METHODS

Much of our data was collected along lake shore outcrops from canoe. We made lithologic observations and took measurements of the foliation, fault surfaces, and slickensides and slickenlines, noting the sense of shear when possible. We also looked for hydrothermal alteration (e.g., epidote, hematite staining) and evidence of brecciation. Traverses were made to determine the width of the fault. Foliation measurements, lithologies and contacts, strikes and dips of fault surfaces, and the bearing and plunge of slickenlines were plotted on aerial photographs while in the field.

GEOLOGIC DATA

Four units were mapped in the research area (fig. 1). On the northwest side of the Reid-Keewatin Lake lineament, within the Quetico subprovince, two previously mapped lithologic units are present. The first unit, a biotite schist-rich migmatite (map unit Mb, fig. 1), contains more than 50 percent biotite schist rafts, displaying S_1 foliation in alignment of biotite, and locally containing boudins. The second unit, a granitic migmatite (map unit Mg, fig. 1), contains less than 50 percent biotite schist rafts within tronjdhjemite, and displaying S1 foliation in the orientation of hornblende crystals (Woodard, 1993, personal communication).

On the southeast side of the Reid-Keewatin lineament, within the Wawa subprovince, two units are present. The first, a hornblende tonalite gneiss (map unit Hg, fig. 1), is composed of quartz, plagioclase, secondary alkali feldspar, and hornblende (Woodard, 1993, personal communication). This unit has been previously mapped south of Reid Lake. Foliation within the tonalite is defined by elongation of hornblende. The second unit is a thin zone of tectonically assembled lithologies made up of Mb and Hg (map unit Mb-Hg, fig. 1). Outcrops in this zone show intermixing of Mb and Hg. This unit has not been previously mapped within the Wawa subprovince.

Ultramafic and amphibolite inclusions are present in the Hg unit. These inclusions are present along northeastern Agnes Lake and southeastern and northern Keewatin Lake (map unit U, fig. 1).

STRUCTURAL DATA

S_1 foliation in the region represents early ductile deformation that preceded the brittle faulting of the Reid Lake shear zone. Using an equal area lower hemisphere scatter stereonet plot the S_1 foliation was represented by plotting the poles to the foliation planes (fig. 1a). There are two fields of data points, one in the NW quadrant and another in the SE quadrant. A single line can be drawn connecting these two fields. This relationship suggests a general strike foliation of N 45° E. Both fields of data points indicate that foliation along the Reid-Keewatin

Conclusions:

The foliation data suggests the presence of a large complex first order fold in the study area (Fig.2). The fold is traceable on aerial photographs of northern Agnes Lake and Dack Lake. The stereonet indicates that the fold is isoclinal in character. If a fold is present, the orientations of the foliations indicate a synformal structure in the central area studied. The tonalite (At) seems to represent the hinge of the fold while the schist (Apq) reflects the location and the orientation of the fold limbs. Alternatively, the lithologic contacts may represent a highly folded thrust terrane. The foliation is associated with an early event of ductile deformation that involved compression from the southeast and northwest.

The fault plane data, after being entered into a tensor program, indicates that the orientation of the principal stress or maximum compression vector (σ_1) is oriented in the northeast. The faulting associated with the brittle deformation event is younger than the ductile deformation that created the foliation. The stress fields were reoriented during this deformation process.

The rose diagram for the joints indicate that there are four main groups of joint orientations (Fig. 4). The set of joints orientated between 110-120° is parallel to the N60W fault planes. This joint set could very well be directly linked to the brittle faulting event related to the faulting. The set of joints oriented 040-050° is very close to being orthogonal to the set parallel to the fault planes (110-120°) and also may be related to the brittle faulting event. This set of joints is also more or less parallel to σ_1 indicating that a genetic relationship between these joints and the faults exists. The two sets of joints oriented between 0-010° and 090-100° are orthogonal and are probably genetically related to each other, but they are not associated with the brittle deformation that caused the faulting. Importantly, the joints are associated with brittle deformation events that are younger in age than the ductile deformation that caused the foliation.

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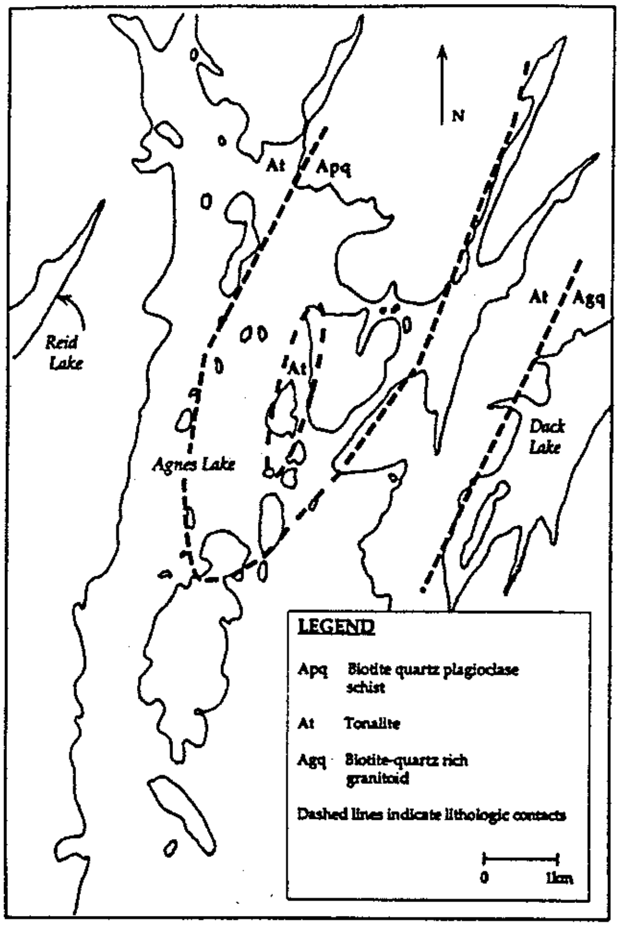

Figure 1: Map of northern Agnes lake and Dack Lake showing lithologic contacts.

lineament dips steeply from 70° to subvertical (within five degrees of vertical). Work done to the west (Humm & Saks, 1993) and to the east (Farthing & Stewart, 1993) of the Reid-Keewatin lineament suggests that the dip of the foliation becomes more shallow to the west and east away from the fault. Foliation dips are steeper (increasing to subvertical) at locations closer to the Reid-Keewatin fault (fig. 1a).

An equal area scatter stereonet plot of slickensided surfaces represents poles to the slickenside surfaces (fig. 1b). Slickenside orientations along the Reid-Keewatin lineament generally strike N 45° E and dip steeply at 70° to subvertical.

The steep, near vertical nature of the slickenside fault surfaces extends from the southern end of Reid Lake to at least the northern shore of Keewatin Lake. Reconnaissance work done by Sam Root suggests the subvertical slickenside fault surfaces continue several kilometers north into Kawnipi Lake (Root, personal communication). These subvertical fault surfaces occur along a zone at least as wide as the west and east shores of Reid and Keewatin Lakes.

The trend and plunge of the slickenlines are plotted on a equal area lower hemisphere scatter stereonet plot (fig. 1c). The data points on the plot can be separated into at least one orientation, N 40°E (indicated by lines on fig. 1c). This group of data may indicate a relationship between S_1 foliation, which has an average strike of N 45° E, and these slickenside fault surfaces. The plunge is generally subhorizontal to the north and rarely to the south.

Based on the presence of steps associated with the development of secondary mineral fibers, a sense of movement for ten of the slickensides was determined. Five of the measurements show left-lateral movement while the other five measurements show right-lateral movement. Therefore, no coherent displacement sense can be determined from this data.

Hematite occurs in the rocks along the entire Reid-Keewatin lineament and results in coloration of rocks ranging from a light pink to a deep red. The red coloration becomes less apparent further from the fault to the east and west and eventually dies out. No secondary epidote or chlorite was found along the lineament.

Brecciation also occurs along the length of the Reid-Keewatin lineament. The brecciated material is typically pegmatitic dikes with high concentrations of feldspar that have been greatly fractured. The fractured feldspar grains range from 1 cm to 3 cm in size. Generally the brecciated rock occurs in a zone 1/2 m to 1 m in width.

Within the Hg unit there are inclusions of ultramafic material at three locations. In all three locations the ultramafic material is coarse grained amphibole. At two of the locations the ultramafics appear as 1-2 m bands that extend several meters along the exposed outcrop.

DISCUSSION AND CONCLUSIONS

Ultramafic rocks, like those found along northern Agnes Lake to Keewatin Lake, likely originate from a source at great depth. Since they are not associated with strike-slip, brittle deformation, vertical displacement, or obduction, may have been required to move these ultramafics from their source. This type of deformation is consistent with the docking of the Quetico and Wawa subprovinces. The brittle deformation along the Reid-Keewatin lineament may have been superimposed along a previously existing fault related to the Quetico-Wawa docking event and contemporaneous obduction of ultramafics. Some time after the docking event the fault was reactivated along the Reid-Keewatin lineament. This later Reid-Keewatin faulting event (the Reid-Keewatin fault) is characterized by brittle deformation in the form of slickensides and brecciation, strike-slip displacement along a steeply dipping fault surface, and hematite staining.

A comparison of work done to the west (Humm & Saks, 1993) and to the east (Farthing & Stewart, 1993) of the Reid-Keewatin lineament suggests that the dip of the S_1 foliation is shallow to the east and west away from the fault. Closer to the lineament, the dip of the foliation becomes subvertical, a relationship consistent with a compressional event. The S_1 foliation may be associated with the docking of the Quetico and Wawa subprovinces, whose junction extends along the length of the Reid-Keewatin fault.

A comparison of the slickenside fault surface orientation plot (fig. 1b) to the S_1 foliation plot (fig. 1a) reveals that the two are similar. The slickenside plot shows an average strike of N 45° E and steep, 70° to subvertical, dips. S_1 foliation has a general strike foliation of N45°E. The similarity between strike and dip measurements and S_1 foliation measurements suggests that brittle deformation developed along the earlier S_1 foliation, implying that the later Ried-Keewatin fault was influenced by the S_1 foliation structure.

The trend and plunge measurements of fault surfaces exhibiting a lateral sense of motion illustrates a fifty-fifty split between left- and right-lateral movement for both north and south plunging slickenlines. The even distribution of left- and right-lateral movement from only 10 out of 57 measured slickensided surfaces along the Reid-Keewatin fault yields nothing definite about the overall sense of the subhorizontal movement. The presence of left- and right-lateral movement in near proximity along the fault may be the result of conjugate fractures or braided faults. Our data taken from small scale structures are possibly measurements on such conjugate fracturing.

Deformation along the Reid-Keewatin fault resembles the type of deformation related to the Burntside Lake fault located 10 kilometers NW of Reid Lake. The Burntside Lake fault has an average strike of N 10° E and an average dip of 70° (Kambhu and Russin, 1993). Evidence suggests that the Burntside Lake fault displays brittle deformation superimposed on an earlier zone of ductile deformation that may be associated with the Quetico-Wawa docking event (Woodard and Weaver, 1990). Along the Burntside Lake fault trace there is evidence of hematite staining giving rocks close to the fault trace a pink color (Gerber, 1990). Several factors suggest that the two faults are genetically related: strike-slip displacement, NE striking fault surfaces that dip steeply, brittle deformation superimposed on earlier ductile deformation, and hematite staining. The Reid-Keewatin fault may be a subsidiary fault of the Burntside Lake fault.

ACKNOWLEDGMENTS

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FIGURE 1. Lithologic Map of Reid Lake-Keewatin Lake Area Showing S_1 Foliation, Slickenside, and Slickenline Measurements Along the Reid Lake-Keewatin Lake Lineament.

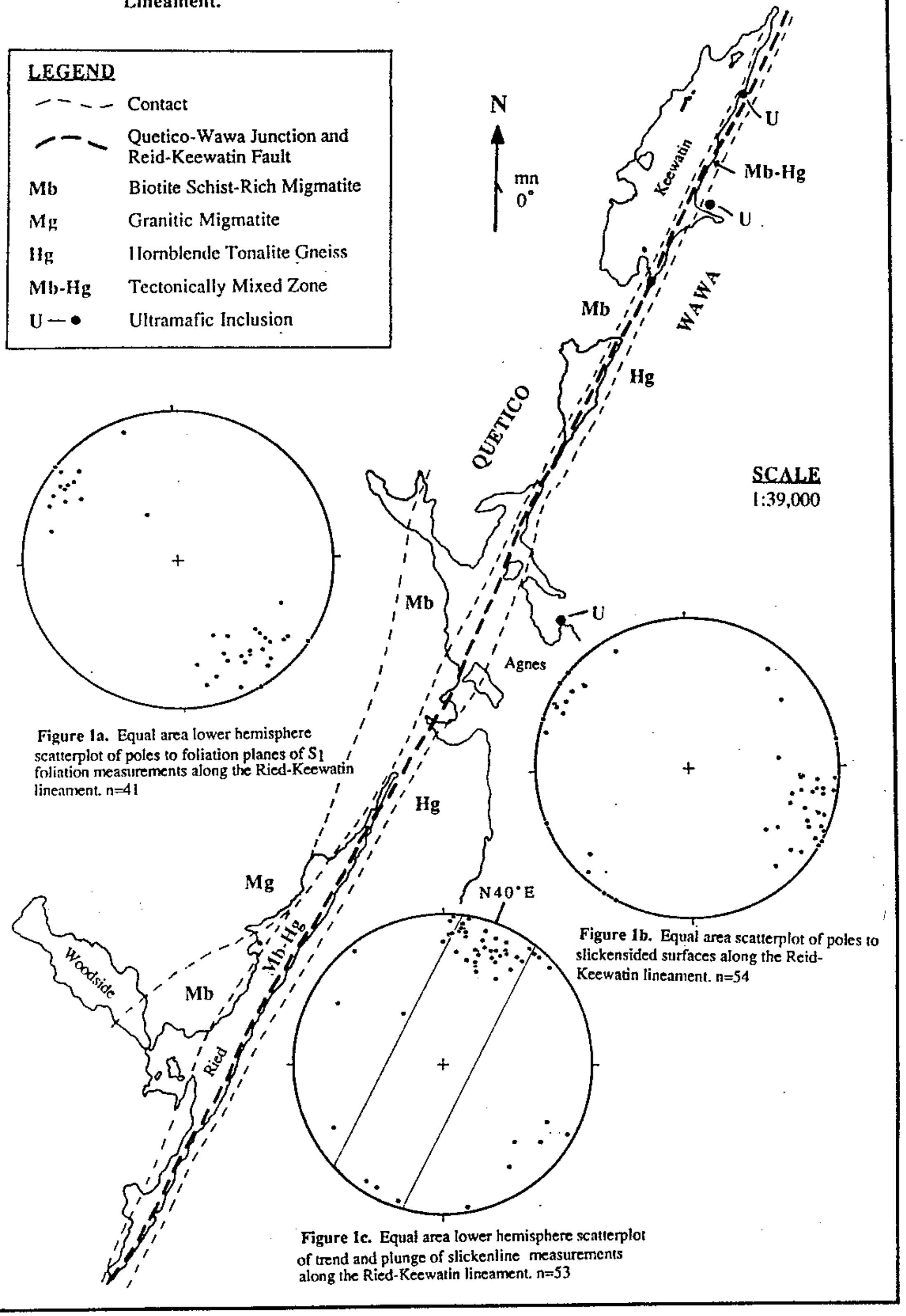

Figure 1a. Equal area lower hemisphere scatterplot of poles to foliation planes of S_1 foliation measurements along the Ried-Keewatin lineament. n=41

Figure 1b. Equal area scatterplot of poles to slickensided surfaces along the Reid-Keewatin lineament. n=54

Figure 1c. Equal area lower hemisphere scatterplot of trend and plunge of slickenline measurements along the Ried-Keewatin lineament. n=53

Deformational History of the Silence Lake Lineament, Quetico-Wawa Structural Junction, Quetico Provincial Park, Ontario Canada

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INTRODUCTION: The Silence Lake Lineament is a previously unstudied N35E trending lineament southeast of the Quetico-Wawa subprovince junction. Due to evidence of motion along the lineament in the form of slickenlines and breccias, the lineament was determined to be a fault. The newly named Silence Lake Fault runs subparallel to the Reid Lake Lineament and is a dextral fault. The amount of offset is undetermined. The Silence Lake Fault shows evidence of multiple deformational events. Early ductile deformation along the fault was overprinted by brittle deformaiton Three tectonic models have been developed to explain the relationship between the amphibolite and tonalite units along the fault.

GEOLOGIC SETTING: The Superior Province of the Canadian Shield is comprised of various subprovinces which have been defined based on structural and lithologic characteristics (Card and Ciesielski, 1986). These subprovinces include metasedimentary, metavolcanic, plutonic, and high grade gneiss terranes (Figure 1). The Quetico subprovince consists of a 2694±1Ma tonalite unit and a 2678±6 Ma hornblende quartz monzonite (Woodard and others, this volume). In addition to igneous intrusions, the Quetico belt also contains metasediments and metavolcanics such as those comprising the Wawa subprovince. Percival and Williams (1989) suggest that the Quetico subprovince developed as a prism between accreting arcs now represented by the metavolcanic Wawa subprovince to the southeast and the metavolcanic Wabigoon subprovince to the northwest.

The area which includes the Wawa-Quetico belt boundary (Figure 1) has been affected by a minimum of two deformational events. At least one event was predominantly ductile; and at least one was mainly, if not exclusively, brittle. Intrusions within the Quetico subprovince both predate and postdate ductile deformation. A series of complex minor folds resulting from plastic deformation deform the boundary between the Quetico and Wawa subprovinces. Evidence of late stage brittle deformation is extensively preserved in the form of pervasive slickenlines, and at least two well- developed sets of fractures. A N60W-striking joint set is common throughout the entire study area. A N35E-striking fault zone runs subparallel to both the Reid Lake Lineament and Silence Lake Lineament. The fault zone displays hydrothermal alteration, brecciation, and slickenlines. The structures produced by brittle deformation truncate the pre-existing ductile features.

The Silence Lake Lineament (SLL) is located 1 km southeast of the Reid Lake Lineament (RLL) (Figure 1). The SLL is a geomorphological feature which roughly parallels the regional lithologic contacts. The SLL region consists of tonalite surrounding a central region of amphibolite (Figure 1).

GOALS:
- To construct a geologic map of the Silence Lake Fault and surrounding region based on surficial mapping.
- To determine the deformational history of the Silence Lake Fault.
- To construct a series of tectonic models constrained by surrounding structural and lithologic field relationships.

DEFORMATION: The studied area has been affected by multiple deformational events. Cross-cutting relations indicate that the ductile deformation pre-dates the brittle deformation. Brittle deformation cuts and sometimes offsets (on a mm to cm scale) earlier ductile deformation features. Fractures and associated epidote veins along the SLF within the jointed amphibolite cross-cut schistosity and display right-lateral micro-offset.