GEOLOGIC CHARACTER OF THE BOUNDARY ZONE BETWEEN THE QUETICO AND WAWA ARCHEAN STRUCTURAL BELTS, QUETICO PROVINCIAL PARK, ONTARIO

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ROCK UNITS AND DEFORMATIONAL STRUCTURES RELATED TO THE JUNCTION OF THE QUETICO AND WAWA SUBPROVINCES, BASSWOOD LAKE TO YUM YUM LAKE, QUETICO PROVINCIAL PARK, ONTARIO

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Detailed geological mapping during the 1989 and 1991 field seasons has delineated the rock units and their secondary structures near the junction of the Quetico and Wawa structural subprovinces in a zone extending from Basswood Lake on the southwest, northeastward to the unnamed lake lying northeast from Yum Yum Lake. In the Quetico belt three mappable units are delineated on Fig. 1 SW-half and NE-half. These are, from oldest to youngest: 1) Mb - biotite schist-rich migmatite where < 50% of granitic leucosome is present, and may contain conformable units and pods of amphibolite. The granitic material is chiefly trondhjemite which has been very selectively replaced by K-feldspar. 2) Mg - granitic-rich migmatite where > 50% of granitic leucosome is present. Biotite-rich rafts are oriented and define fold structures within the supracrustal rocks. 3) Ha - hornblende quartz monzonite gneiss which is typically composed of 42% microcline phenocrysts up to 3 cm in length, 29% interstitial plagioclase, 10% quartz, 9% hornblende, and 7% biotite and chlorite. Magnetite, allanite, monazite, zircon, pyrite, and apatite are all present as accessory minerals. Igneous-type zoning in microcline phenocrysts is common. Secondary gneissosity is well developed but primary flow banding can sometimes be recognized. 4) Lg - leucocratic sugary to pegmatitic granite typically composed of 45% microcline, 30% plagioclase, 23% quartz, and less than 5% biotite. Occurs as late dikes and sills in the supracrustal sequence, and may grade into (Mg) with increasing biotite content and biotite schist rafts.

Also delineated on Fig. 1 SW-half and NE-half are four mappable units within the Wawa belt. These units from oldest to youngest are: 1) Mb - biotite schist-rich migmatite where < 50% of granitic leucosome is present, and may contain conformable units and pods of amphibolite. The granitic material is chiefly trondhjemite which has been very selectively replaced by K-feldspar. 2) Av - A strongly bedded sequence of fine- to coarse-grained mafic pyroclastic meta-volcanics, interfingering with or passing upward into meta-pillow basalts. 3) Hg - Hornblende tonalite gneiss containing quartz, plagioclase, hornblende, and erratically distributed secondary K-feldspar. Some plagioclase feldspar crystals show igneous zoning. Both primary and secondary gneissosity can be recognized, although primary alignment, deformed by folding, appears to be most common. Some bodies have a high concentration of mafic to ultra-mafic inclusions, and these have been mapped separately as unit (Am).

All the rocks, except the leucogranite (Lg), which is post metamorphism, are of amphibolite grade and all are irregularly impregnated with secondary perthitic feldspar and probably quartz. The Wawa belt rocks are cut by numerous dikes and Ho and Small (this volume) have established an age sequence for their emplacement. Within the Quetico belt, dikes are noticeably less numerous, but where present they appear to resemble those in the Wawa belt. As stated by Woodard and Weaver (1990) it may be that the late "soaking" by potassium of the rocks of both belts plus the emplacement of late leucogranite pegmatitic dikes in both belts denotes that the juxtaposition of the two belts preceded the intrusion of the Vermilion Batholith into the Quetico supracrustal sequence to the southwest of this area. It may be that this intrusive complex could be described as a "stitching pluton," emplaced along the Quetico-Wawa junction. In fact, Godfrey and Jennings (this volume) describe the field relationships of a large leucogranite dike (not shown on Fig. 1) near the southwest end of Yum Yum Lake which appears to transect the belt junction.

Woodard and Weaver (1990) reported a U-Pb date from zircon from the hornblende quartz monzonite (Ha) of the Quetico belt as 2656±1 Ma. Dating of several of these rocks is currently underway by Dr. John Aleinikoff of the U.S. Geological Survey. Although we expect to report final data in the future, we can report that a tentative U-Pb date on zircon from the hornblende tonalite gneiss (Hg) of the Wawa belt is 2694±1 Ma. This is significantly older than the dated (Ha) unit of the Quetico belt. Both of these units (Ha and Hg) were intruded as sills into their respective supracrustal sequences before the major folding. Thus, tentatively, it would seem that a maximum age can be assigned to the period of folding in each belt. Further dating of the leucogranite (Lg) of the Vermilion Batholith is also in progress and we plan to report in the future these results and their implications for the Archean history of the area.

The location of the belt junction as denoted on Fig. 1 SW-half and NE-half is taken to be somewhere within the thin continuous unit of biotite schist-rich migmatite (Mb). Although the topographic expression of the junction forms a strong lineament and can be easily traced on both topographic maps and aerial photos for a distance of at least 73 km, on the ground, when observing critically located outcrops, it is impossible to recognize the junction other than as a rather typical contact between the two units mapped as hornblende tonalite (Hg) and biotite

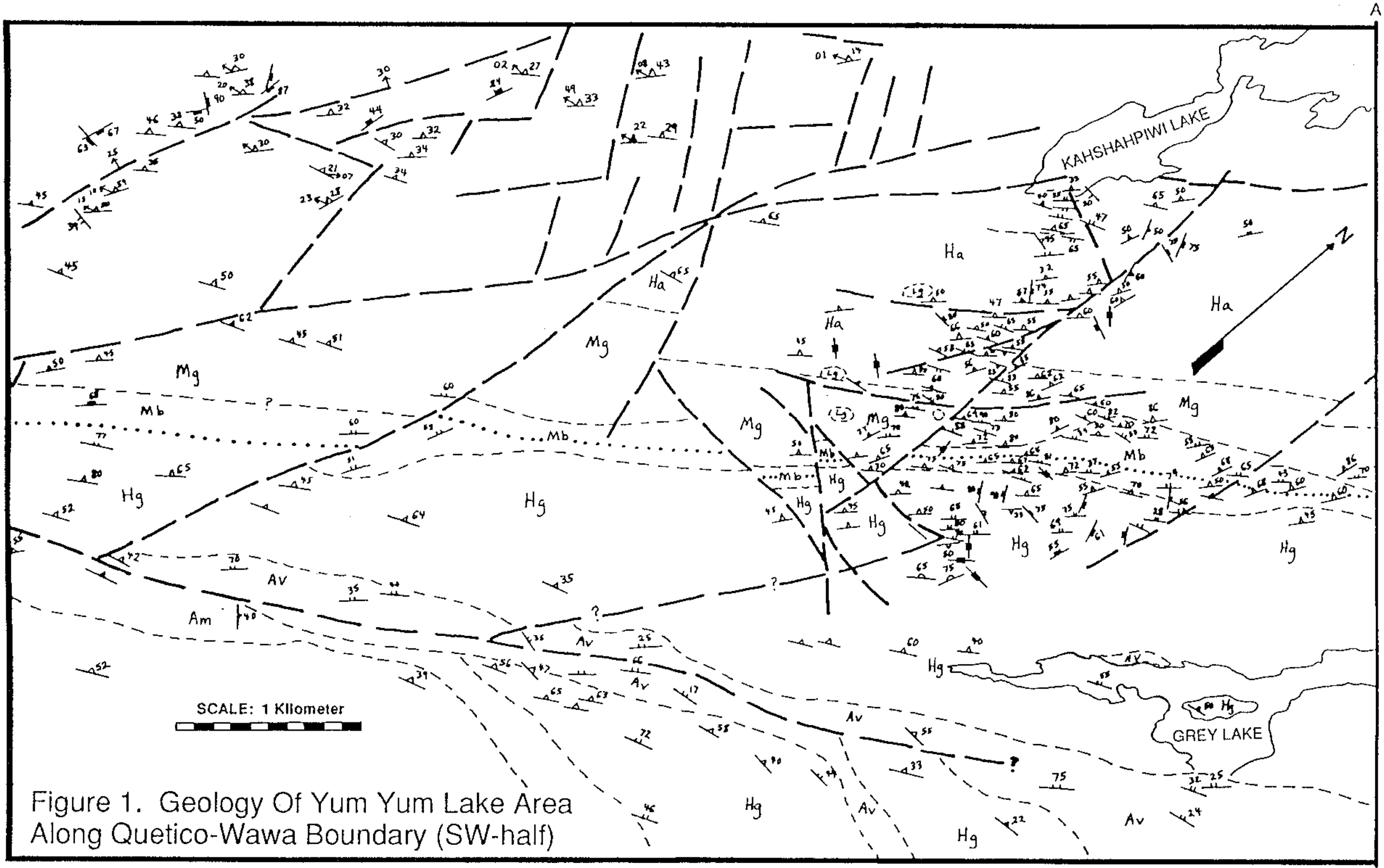

Figure 1. Geology Of Yum Yum Lake Area
Along Quetico-Wawa Boundary (SW-half)

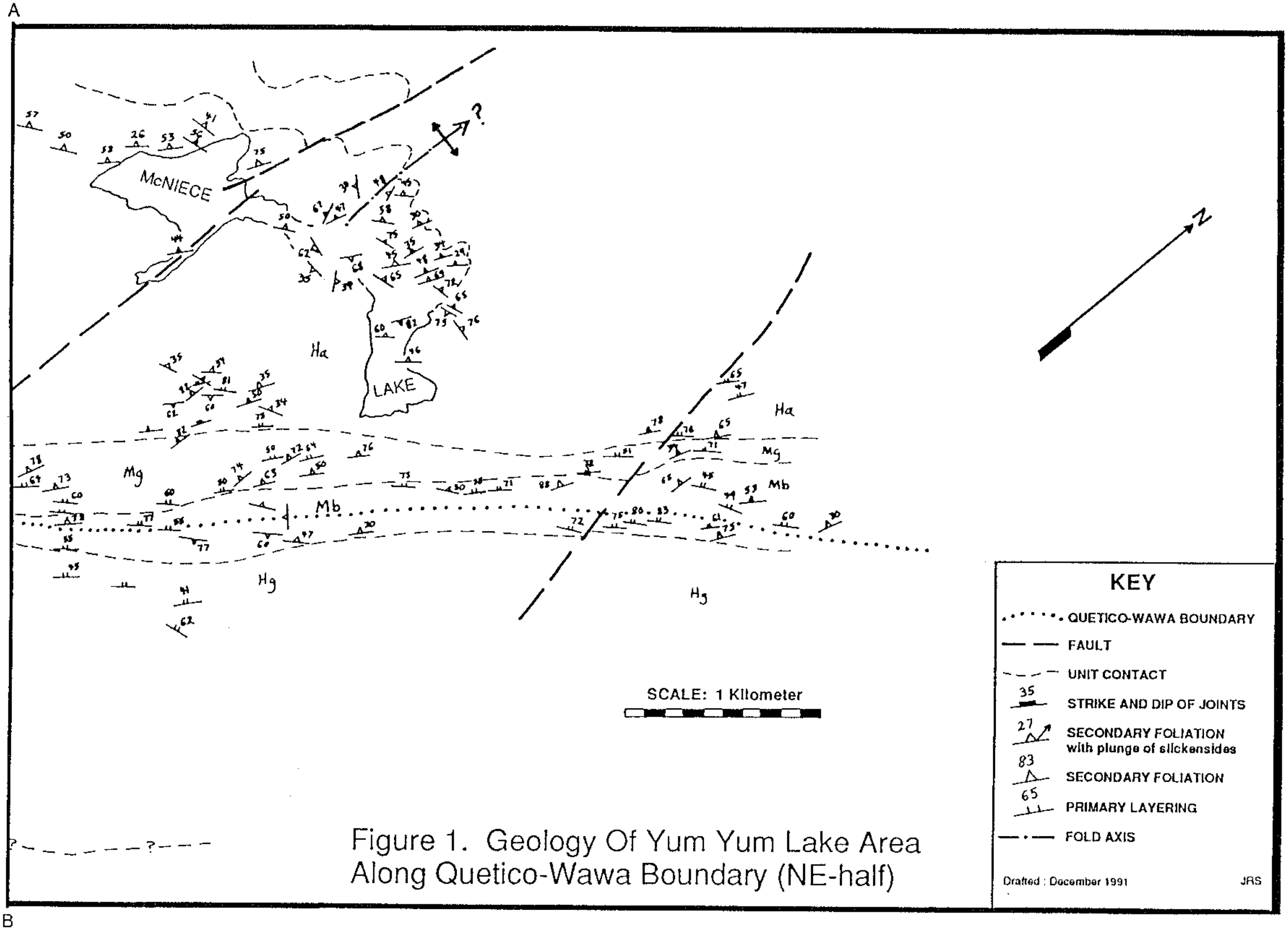

Figure 1. Geology Of Yum Yum Lake Area Along Quetico-Wawa Boundary (NE-half)

schist-rich migmatite (Mb). The belt junction located on Fig. 1 SW-half and NE-half is taken to be within the (Mb) rock unit because the unit has relatively low ductility and is mapped continuously as a narrow band along the junction for a distance of at least 53 km. On Fig. 1 SW-half and NE-half the outcrop width along a strike distance of 12 km averages only 300 meters and throughout the entire 53 km length which has been mapped to date, this narrow outcrop belt is typical. It appears then that the (Mb) rock unit exposed continuously along the junction acted as a ductile slip unit when the belts were structurally juxtaposed. Whether this narrow (Mb) rock unit is related to the biotite schist-rich migmatite of the Wawa belt or the same type rock present within the supracrustal rocks of the Quetico belt is unknown. If this narrow (Mb) unit did act as a ductile slip unit, then we should expect the unit to show strain and shear sense within the biotite schists. Two previous studies recognized S-C type shear within this (Mb) rock unit in the area along Basswood Lake (Font, 1989 and Booth, 1989). Both of these studies were confused by the then unrecognized superposition of the younger Burntside Lake fault zone upon the Quetico-Wawa junction. Chastain and Kolinski (this volume) measured many secondary foliations within the (Mb) and (Mg) units shown on Fig. 1 SW-half and NE-half, and they note that secondary foliation almost always strikes more northerly than either the local primary layering (bedding) or the contacts of the mapped units.

Fig. 2 is a representation of the distribution of (Mb) and (Mg) units and their contained foliation measurements taken from Fig. 1 SW-half and NE-half. It appears that the entire (Mg) - (Mb) zone, including the Quetico-Wawa junction, could be considered a giant S-C type structure as is indicated by the directional arrows and strain ellipsoid shown on Fig. 2. If this interpretation is correct, then the sense of shearing recorded in the (Mb) - (Mg) zone is dominantly right lateral. Presumably, this ductile shear developed during the event which structurally juxtaposed the two belts.

Working in the McNiece Lake area, approximately 2.5 km northwest from the (Mb) - (Mg) zone (see Fig. 1 NE-half), Gupta and Weng (this volume) studied deformed K-feldspar phenocrysts in the unit mapped as hornblende quartz monzonite gneiss (Ha). Of 1350 observations, they found most feldspar augen to show flattening in the plane of the major northeast-striking foliation. Only 84 augen showed left lateral sense of shear, while just 10 showed right lateral sense.

The thick igneous sills injected into supracrustal rocks of both belts prior to folding (hornblende tonalite - Wawa belt; hornblende quartz monzonite - Quetico belt) make it difficult to recognize major fold structures in the limited area studied near Yum Yum Lake during the 1991 field season. Using graded bedding within the mafic volcanics which crop out southwest from Grey Lake, the portion of the Wawa belt mapped during 1991 appears to be on the northwest limb of the "Queen's Lake" anticline (Johnson, 1989). Southwestward, along strike in the Wawa belt, the perpendicular distance between the major syncline on Canadian and United States Points and the "Queen's Lake" anticline on King Point is approximately 9 km. This trough to crest distance also permits the Wawa rocks in the Yum Yum Lake area to lie structurally on the west limb of the "Queen's Lake" anticline.

The bedding in the (Mb) and (Mg) units of the Quetico belt which are exposed west of Yum Yum Lake, shows several examples of textural grading and tops are always indicated to the southeast (i.e., the sequence is overturned). Northwest from McNiece Lake (Fig. 1 NE-half), strike and dip data, and topographic expression (Gupta and Weng, this volume), and aerial photo interpretation (Fig. 1 NE-half) all suggest a complex major antiformal axis with a northerly plunge. If further work confirms the existence of such a structure, its southeast limb would be overturned as required by the known easterly younging direction demonstrated by the graded beds within the (Mb) and (Mg) units.

Ishimatsu and Parkin (this volume) studied the orientation of joint sets on both sides of the Quetico-Wawa junction in an attempt to relate the joints to major recognizable lineaments. Throughout the Yum Yum Lake area they showed that the dominant joint set has a near vertical dip and a N40° - 50°W strike. This direction forms a right angle to the N45°E trend of the Quetico-Wawa junction, but the origin of the joint set is not clear. Although several other joint sets are more local in development, and some speculations can be made as to their relationships to surface lineaments, no definitive correlations could be firmly established.

Acknowledgements

I would like to thank Dr. Samuel Root of Wooster College for his enthusiastic participation in the 1991 field research project. Although I accept all responsibility for the material contained within this paper, he contributed a great deal to both the data collection and interpretation phases of the project. Dr. Walter Coppinger of Trinity University spent ten days with the project in the field. His cheerful and professional help, sometimes under adverse and stressful field conditions, made all of the student research projects more productive. Dr. John Aleinikoff of the U.S. Geological Survey has supplied preliminary U-Pb dates on zircon. To the four support persons, I owe particular thanks, and also I take considerable pride. All were originally introduced to the Quetico wilderness as undergraduate students of mine at Beloit College. Peter Parham is now an accomplished wilderness guide and student of natural environments. Miquette Gerber and Frank Kaszuba are both former student researchers on earlier Keck research projects. They took time from their graduate studies to participate in this project. Dan Costello was

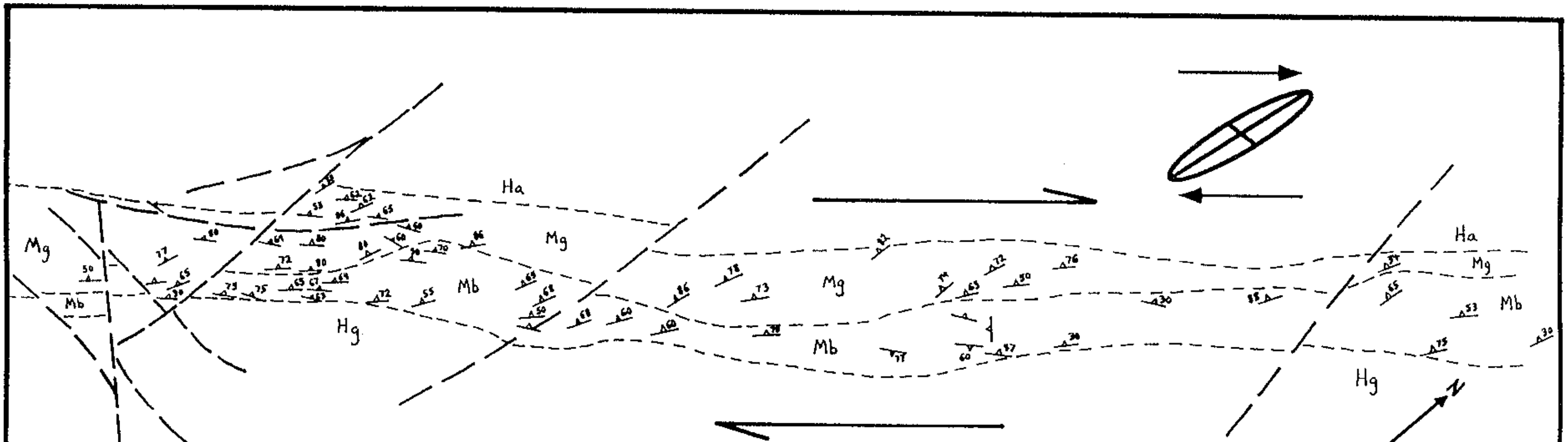

Figure 2. Rock Units Mb & Mg Showing More Northerly Strike Of Foliation Compared To Contacts, And Inferred Shear Directions

inspired to write the lead paper for the Quetico Project (this volume) illustrating some aspects of Quetico wilderness living other than studying geology. Lastly, I would like to congratulate the ten student researchers who participated in the 1991 research. They proved that undergraduate sophomores can do excellent field research!

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CHARACTER OF MEGASCOPIC DUCTILE STRUCTURES AT THE WAWA SUBPROVINCE AND QUETICO SUBPROVINCE JUNCTION IN QUETICO PROVINCIAL PARK, ONTARIO, CANADA

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INTRODUCTION

Southern Ontario Archean rocks of the Canadian shield have been interpreted by Percival (1989) as being composed of several linear subprovinces of differing composition and origin. He also suggested that these subprovinces have accreted together to create the southern part of the Canadian Shield. The study of such junctions between the subprovinces helps geologists better understand the process of accretion during Archean time. The purpose of this paper will be to examine the ductile structures near the junction between the Wawa and Quetico subprovinces within the Canadian Shield and hypothesize the ''docking" mechanism which brought these subprovinces together.

A portion of the junction of these two subprovinces lies in Quetico Provincial Park, Ontario, Canada; the Wawa subprovince is to the southeast of the Quetico subprovince. The data for this study were collected near the junction, along Yum Yum Lake and the unnamed lake directly northeast of Yum Yum Lake (hereafter called "NoName Lake") in the southern part of the park (figure 1). The junction trends approximately N40E and parallels the trend of many of the major lineaments in the area.

OBSERVATIONS

Rock types

Near Yum Yum Lake and "NoName Lake" these two subprovinces are defined by four rock types that run roughly parallel to the N40E junction. In the Wawa subprovince, the predominant rock type observed is a white, coarse-grained, foliated hornblende tonalite (Hg). Between the two subprovinces there is a zone of biotite-rich migmatite (Mb) that is about 500m wide as seen in outcrop. Two types of rocks characterize the Quetico subprovince. One is a pink, medium grained granitoid rock with occasional rafts of biotite schist material and the other is a unit of foliated, porphyritic gneiss.

The minerals within the tonalite (Hg) are quartz, plagioclase, alkali feldspar, and hornblende (Woodard 1991, unpublished data). The hornblende crystals in the tonalite range in size from 5mm to less than 1mm. Because of the presence of potassium feldspar, this rock unit appears to be a hornblende granite, hence the symbol Hg on maps. However, the distribution of the potassium feldspar suggests that the potassium within this tonalite was subsequently introduced to the rock, possibly related to the emplacement of the Vermilion Batholith (Woodard, 1991).

The hornblende quartz monzonite (Ha) consists of microcline, plagioclase, quartz, hornblende, biotite, and chlorite (Woodard, 1991). It is pink, medium-grained, and is foliated parallel to the dominant S1 foliation. There are very few biotite schist rafts caught within this unit.

The granitic migmatite (Mg) contains less that 50% biotite schist rafts whereas the biotite-rich migmatite contains more than 50% biotite schist rafts. The predominant minerals in these units are microcline, plagioclase, quartz, and biotite (Woodard 1991, unpublished data). This granitic material is predominantly trondhjemite. Rafts are oriented within this material parallel to the dominant foliation.

Structural characteristics

Structures of ductile deformation present in the biotite-rich migmatite include folds and foliations. Foliations cutting across both limbs of earlier phase folds give evidence that the migmatite has experienced at least two periods of ductile deformation (figure 2). Also within both subprovinces dikes, slickensides, faults, and other forms of late stage brittle deformation are found . Joints are also prevalent in the study area.

Foliations and folds were measured in the Yum Yum Lake - "NoName Lake" area. This study area was around 7 kilometers in length. Most of the data were collected from the various biotite schist rafts of the units Mg and Mb as the platy minerals within the rafts best preserved the structures. The majority of the biotite schist rafts were preserved in the migmatite units, therefore most of the folds measured were found in the rafts of these units.

The strike and dip of axial planes and bearing and plunge of fold hinges of the F1 folds were recorded. The orientation of the axial planes was comparable to that of the dominant foliation. The general strike and dip of the dominant S1 foliations ranged from approximately N70E/65NW to N50E/75NW (figures 3 and 4).

The variation in the orientation of the axial plane of F1 folds is similar to that of the S1 foliations. The plunge of the F1 fold varies from 10NE near the southern part of Yum Yum Lake to 20SW near the northern part of