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

Lynne Marie Chastain, Colorado College
Amy Kolinski, The College of Wooster

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The minerals within the tonalite (Hg) are quartz, plagioclase, alkali feldspar, and hornblende (Woodard 1991, unpublished data).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 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!

References Cited

Booth, Kristina, 1989, Petrology and structure along the Basswood trace of the Burntside Lake Fault, northeast Minnesota: in Woodard, H. H., ed., Second Keck Research Symposium in Geology, Beloit, Wisconsin, p. 153-155.

Chastain, Lynne Marie and Kolinski, Amy, 1992, Character of megascopic ductile structures at the Wawa subprovince and Quetico subprovince junction in Quetico Provincial Park, Ontario, Canada: in Wilson, M., ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio.

Costello, Daniel, 1992, Yum Yum: in Wilson, M., ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio.

Font, K. R., 1989, The Burntside Lake fault zone: A study of two faults in Basswood Lake: in Woodard, H. H., ed., Second Keck Research Symposium in Geology, Beloit, Wisconsin, p. 156-160.

Godfrey, John and Jennings, Susan, 1992, The relationship of lithological structures to the Quetico-Wawa juncture, area of southwestern Yum Yum Lake in the Quetico Provincial Park, Ontario, Canada: in Wilson, M., ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio.

Gupta, Anupma and Weng, Kevin, 1992, Docking mechanism of the Quetico-Wawa junction as indicated by structural mapping and analysis of augen zones in Quetico Provincial Park, Canada: in Wilson, M., ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio.

Ho, Anita and Small, Eric, 1992, Sequence of intrusive events in the Grey Lake region of the Wawa subprovince, Quetico Provincial Park, Ontario, Canada: in Wilson, M., ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio.

Ishimatsu, Josh and Parkin, Elise, 1992, Joint analysis along the junction of the Quetico and Wawa structural belts, Quetico Provincial Park, Canada: in Wilson, M., ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio.

Johnson, Gerald W., 1989, Petrographic and structural interpretations of displacement along the Burntside Lake fault zone, Basswood Lake area, northern Minnesota: in Woodard, H. H., ed., Second Keck Research Symposium in Geology, Beloit, Wisconsin, p. 161-164.

Woodard, H. H. and Weaver S. G., 1990, The nature of the boundary between the Wawa and Quetico belts, Basswood Lake area, Minnesota-Ontario: in Woodard, H. H., ed., Third Keck Research Symposium in Geology, Beloit, Wisconsin, p. 82-85.

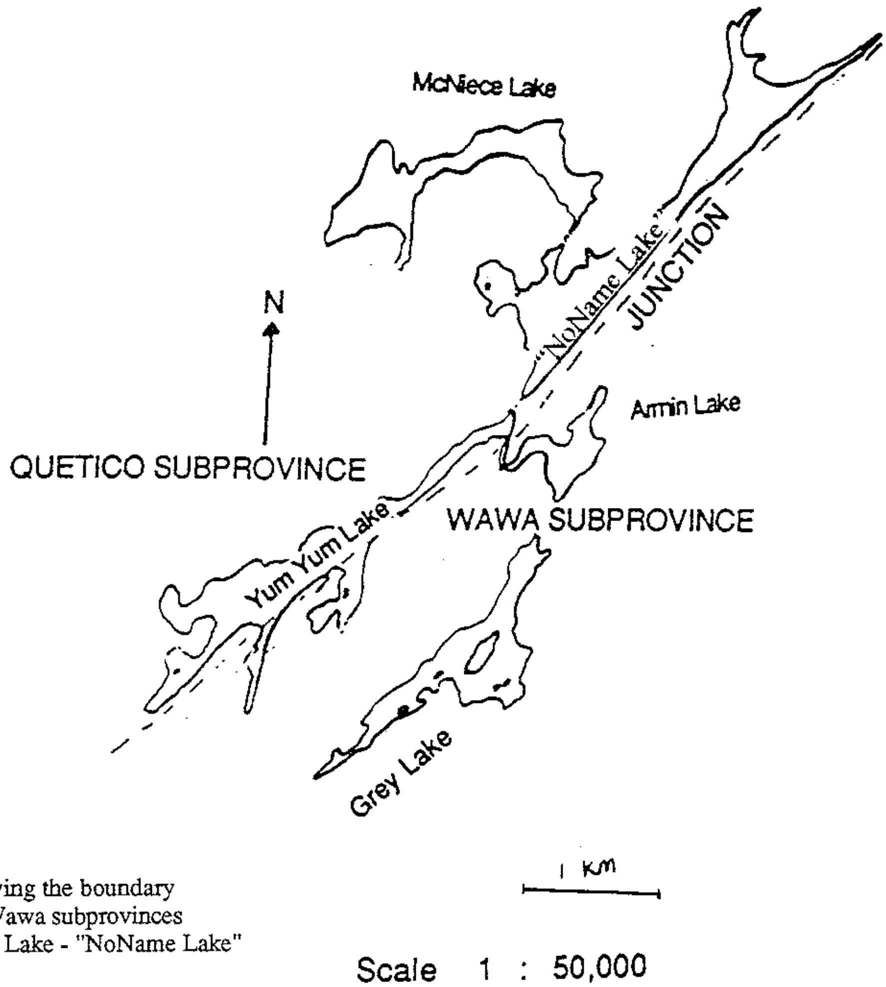

Figure 1: Map showing the boundary of the Quetico and Wawa subprovinces along the Yum Yum Lake - "NoName Lake" study area.

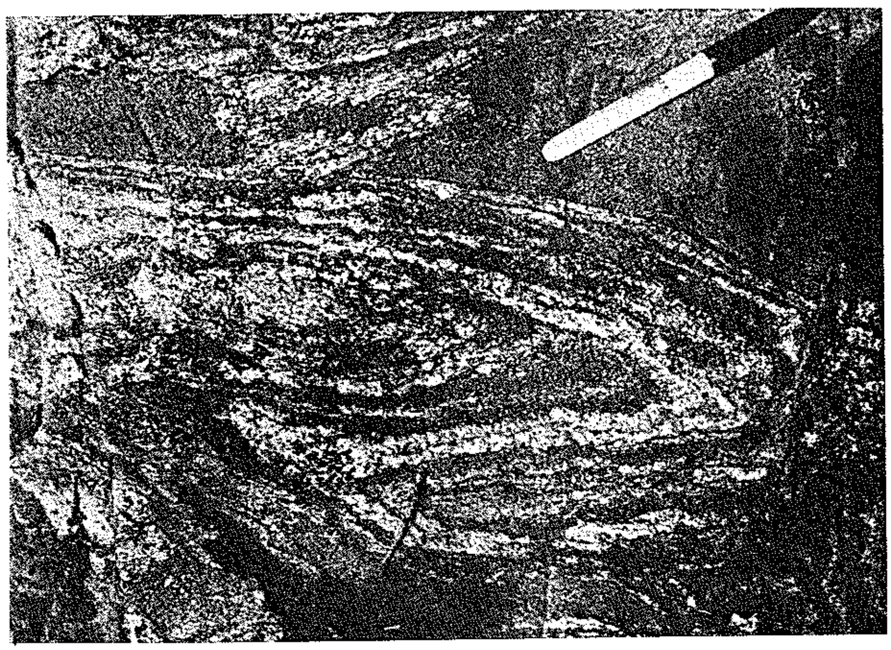

Figure 2: Picture of lesser S2 foliation cross-cutting both limbs of a fold whose axis is parallel to the S1 foliation. The S2 foliation is parallel to the pen.

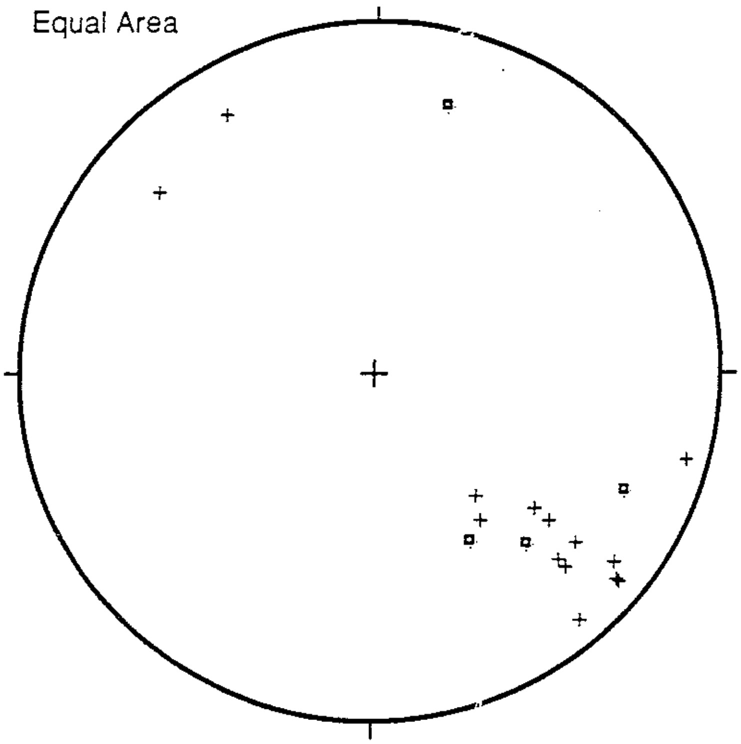

Figure 3: □ S1 Foliations; Wawa Subprovince
+ S2 Foliations; Wawa Subprovince

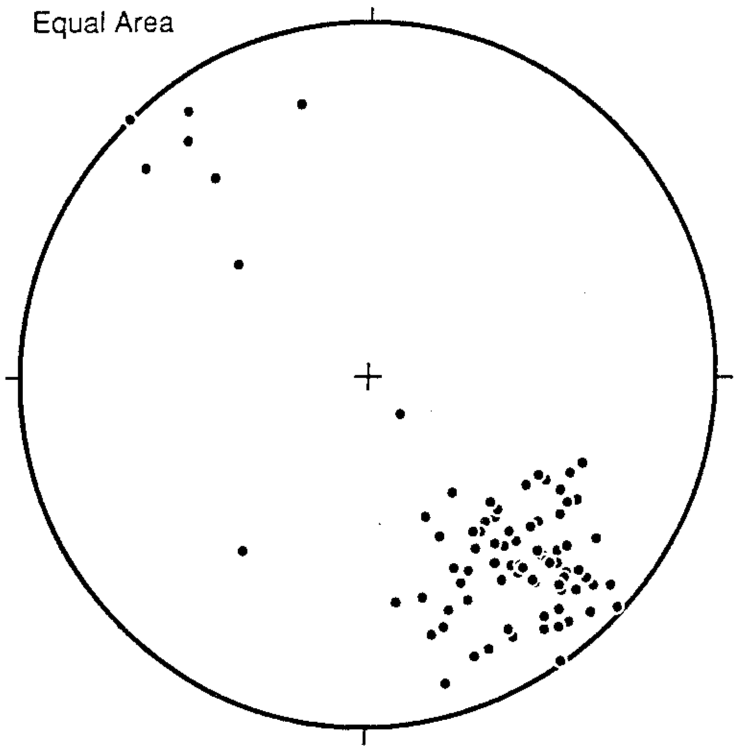

Figure 4: S2 Foliations; Quetico Subprovince

"NoName Lake". The S2 foliation did not create folds that could be measured on an outcrop or megascopic scale. The orientations of these F2 folds could not be measured in the field because of their microscopic nature.

S1 foliations in the migmatite units range from an average of N75E/70NW near the south end of Yum Yum Lake to an average of N50E/55NW near the north end of "NoName Lake" (figure 3). S2 foliations remain relatively constant over the area. However, these foliations are much more difficult to measure than the S1 foliations and therefore there may be more measurement error.

There were very few biotite schist rafts within the tonalite. Developed within these few rafts, folds could be seen with structural orientations similar to those rafts caught within the biotite-rich migmatite and the pink granitoid of the Quetico subprovince.

The pink granitic migmatite Mg in the Quetico has more rafts allowing the S1 and S2 structures to be preserved. These too had the same structural orientations as those in the biotite-rich migmatite. The strong S1 foliation is usually the only visible foliation outside of the biotite schist rafts.

CONCLUSIONS

There are at least two periods of deformation in this area. The relative ages of these two deformations are established by observing the weaker foliation cross-cutting two limbs of a fold whose axial plane is parallel to the dominant S1 foliation (figure 2). Our study also indicates that the S1 foliation varies whereas the S2 remains relatively constant over the study area.

Both foliations are consistently at an angle to the junction of the subprovinces. This large scale relationship between the junction and the strikes of the foliations could resemble a large scale S-C fabric from the time that these two subprovinces were "docked". The angular relationship suggests dextral shear sense along the entire junction because foliations form perpendicular to the maximum stress in a rock.

REFERENCES CITED

Percival, John A., and Williams, Howard R., 1989. Late Archean Quetico Accretionary Complex, Superior Province, Canada: Geology, v. 17, p. 23-25.

Woodard, H.H., and Weaver, S. G.. 1990. The nature of the boundary between the Wawa and Quetico belts, Basswood Lake area, Minnesota-Ontario. Third Keck Research Symposium in Geology, Northhampton, Massachusetts, p. 82-85.

DOCKING MECHANISM OF THE QUETICO-WAWA JUNCTION AS INDICATED BY STRUCTURAL MAPPING AND ANALYSIS OF AUGEN ZONES IN QUETICO PROVINCIAL PARK, CANADA

Anupma Gupta
Carleton College
Northfield, MN 55057

Kevin Weng
Williams College
Williamstown, MA 01267

Introduction

The Quetico Provincial Park in southwestern Ontario is a picturesque region of small lakes and coniferous/deciduous forest. Slopes are often steep but the amplitude of relief is very small; soils tend to be very thin. There is outcrop along much of the lake shore and frequently inland, although often lichen- and moss-coated. The bedrock is composed of intensely deformed Archean rock with a number of significant structural boundaries. The lineament of Yum Yum and "No Name" Lakes is the junction between two structural belts, the Quetico belt lying to the northwest and the Wawa belt to the southeast (Woodard and Weaver, 1990). [See section preface].

We spent three weeks investigating the structural geology of an area about 3 km by 6 km northwest of the junction encompassing two lakes, "No Name" and McNiece. We attempted to determine the style of deformation at the Quetico-Wawa belt junction by taking structural data. The Quetico belt contains a large body of quartz monzonite with many feldspar phenocrysts, whereas the Wawa belt rocks are predominantly fine grained. The lithology of the Quetico belt was thus more conducive to the formation of macroscopic augen structures than the lithology of the Wawa belt. Since augen can indicate the nature of deformational events, our research was focused mainly in the Quetico belt. We took a lot of data in the vicinity of McNiece Lake; it is the only major lake in the area which does not follow the dominant northeast lineament, and so we investigated the possibility of structural control over this.

Methods

Travelling by canoe or on foot, and using pace and compass mapping, we measured the trend and plunge of fold axes, the strike and dip of S1 (the dominant foliation in the region) and examined macroscopic augen structures. Augen analysis was done by finding outcrops with recognizable augen development and counting the number of grains in a measured area (about $1m^2$), noting their shear-sense. In the lab, augen were studied in three planes at right angles since these views showed whether the grains were sigmoid or disc-shaped. Sigmoid cross-sections indicate a shearing force during formation, whereas a uniform disc indicates a coaxial sigma-1 force, i.e. flattening. (Fig. 1) The structural data, primarily strike and dip values for the dominant foliation (S1), axial planes of folds, and strike and dip of fault surfaces, were plotted on mylar overlays of aerial photographs. Stereoscopic lineament analysis of the photographs aided in data interpretation.

Results

Structural data are plotted in Figure 2. The orientation of the dominant foliation (S1) parallels the topographic lineament of the belt junction. However, McNiece Lake does not follow the N50°E lineament. The augen analysis showed that there is a predominance of flattened phenocrysts with a slight left-lateral shear sense. The augen are generally oriented parallel to S1 and contained within its planes. The shear-sense of the augen we counted were: left-lateral, 84, right-lateral, 10, flattened (no shear-sense), 1256. The total is 1350.

Stereoscopic lineament analysis revealed several arcuate lineaments north of McNiece Lake.

Discussion

Since the dominant foliation parallels the belt junction and the augen are contained within the dominant foliation, the three features were likely produced by the same event. Furthermore, no evidence was found of an older deformational event occurring in both belts. This leads us to hypothesize that the S1 foliation was formed during