Petrology and Structure of the Wawa Belt, Northern Agnes Lake and Dack Lake

Dori Farthing
The Department of Geology
The College of Wooster
Wooster, Ohio 44691

Brooke Stewart
Department of Geological Sciences
University of Washington
Seattle, Washington 98195

Introduction:

The Wawa geologic subprovince of the Superior province is located in southern Ontario, Canada. This area is characterized as a classic high-grade gneissic terrane with metamorphic facies which range from amphibolite to granulite. The main lithologies are often intruded by tonalite, granodiorite, and syenite. (Card and Percival, 1985)

This research specifically took place in the Quetico Provincial Park of southern Ontario. Petrologic and structural data was collected in an area centered about Agnes and Dack Lakes (Fig. 1). The northwestern extent of this research was adjacent to the Quetico subprovince and the Wawa subprovince boundary.

Methods:

This research project centers on the lithologic and structural aspects of northern Agnes Lake and Dack Lake. To begin with, lineations and possible folds were sketched out on air photographs. The next step involved exploring the outcrops observed on the air photos. The most informative sites were easily accessible on foot or by canoe, reasonably clean from lichen growth or cleanable with a wire brush, and also had clear measurable foliation directions. Outcrops that were examined were found both along the shoreline as well as more inland. Some of the best outcrops were found inland when moss was peeled away from the rock face. These inland outcrops were less weathered and lichen free.

At each outcrop the lithology and the structural aspects of the rocks were noted and measured. Structural measurements were taken with a Brunton compass, and often to obtain an accurate reading several measurements were collected at each outcrop. To aid in the understanding of the geologic character of the area, the structural and petrologic data was plotted on 1:24000 scale air photographs. The foliation, joint, and fault plane data were plotted on rose diagrams as well as on equal area stereonets.

Petrologic Observations:

Three main lithologic units were mapped within the research area. The units were distributed in linear belts which trend to the northeast within the research area. These units are a tonalite (At), a biotite quartz plagioclase schist (Apq), and a biotite-quartz rich granitoid (Agq).

The most widespread unit in the studied area was a tonalite or hornblende tonalite gneiss (At). It was observed in outcrops along the western shore of Agnes Lake, in the middle of Agnes Lake, and on the eastern shore before entering the Agnes River Channel. This unit is described by Woodard (1993) as an intrusive sill containing quartz, plagioclase, secondary alkali feldspar, and hornblende. The crystals range in size from approximately 1-2 mm in width to sizes less than .25 mm in width. Some of the units labeled as At had biotite as a component (5-10% of the composition).

The newly recognized biotite quartz plagioclase schist (Apq) was observed in outcrops to the east and west of the central Agnes Lake tonalite. It is composed of fine crystals of biotite quartz and plagioclase. The individual crystal sizes are less than .25 millimeters in width. It was common for this unit to have small amounts (less than 20%) of hornblende and epidote. There were also accessory amounts of pyrite and chalcopyrite. This unit also tended to grade from being biotite rich (greater than 70%) in the farthest northern sites to being biotite poor (less than 30%) in the southern sites.

The unit mapped as biotite-quartz rich granitoid (Agq) is another newly recognized unit. It was only observed in the outcrops studied along the western coast of Dack Lake. It is characterized by elongated and oriented quartz crystals and has very few mafics except for biotite (which also seems to be elongated and oriented). The other main component aside from quartz and biotite is plagioclase. In hand sample, the estimated the percentages of the components are: 50% quartz, less than 5% alkali feldspar, 15% biotite and 30% plagioclase. It is important to note that this lithology is lineated but not foliated, classifying it as an L-tectonite.

Along with the three main lithologies that occur in the research area, there are many cross-cutting intrusives. These intrusives include quartz veins, leucocratic dikes, (specifically trondhjemite or other low mafic fine-grained units containing potassium feldspar) and coarse-grained pegmatite dikes. The pegmatite dikes usually contained coarse crystals of quartz, potassium feldspar, plagioclase and in rare cases, biotite books.

Structural Observations:

Within the three lithologic belts structural data was collected on foliation, fault surfaces, and joints. Foliation data concentrated on S_1 foliations which are the earliest set of foliations. Three domains of foliation measurements were noted. The western most domain is characterized by units with northeastern strikes which steeply dip to the northwest. The central domain is characterized by units that have northwestern strikes which dip moderately to the northeast, and the easternmost domain is characterized by units with northeastern strikes dipping gently to the northwest. Each of the foliation belts are lineated with a northeasterly bearing which is topographically seen in the elongated lakes and land masses of the area (Fig. 1).

Fault planes with quartz mineralized slickenlines indicate a movement sense are present in the research area. The fault planes are associated and caused by a period of brittle deformation. The majority of fault surfaces had strikes of N60°W with sub vertical dips (Fig. 3). Most of the slickensided surfaces indicate a left-lateral movement sense with slickenlines plunging in general to the northeast. This system of northwest trending faults is reflected in the topography of the area. Associated with the faulting is hydrothermal alteration of the lithologies. In all of the mapped units near the fault system, iron staining was common. The hydrothermal alterations caused a loss of mafics in the tonalites as well as mineralogic changes within the biotite quartz plagioclase schist. Alteration of the biotite into either chlorite or phlogopite was common.

Joints were also measured throughout the area. They are sub vertical in their orientation and often were stained red due to hydrothermal activity (Fig. 4). Joints are most common near to the faults; the farther east the sites, the less joints were present. The most common joint measurements fall between 0-010°, 040-050°, 090-100°, and 110-120°.

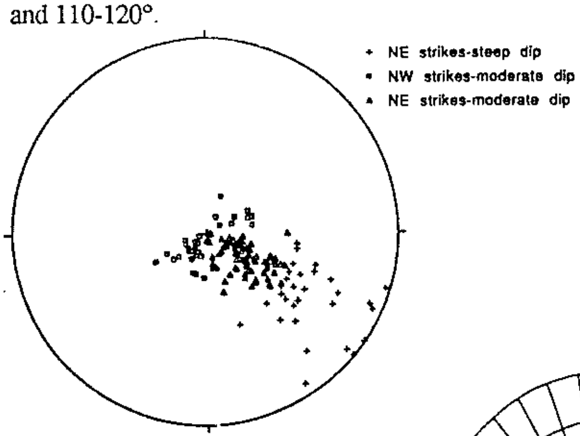

Figure 2: Equal area stereonet showing poles to foliation planes for the three domains. N=179

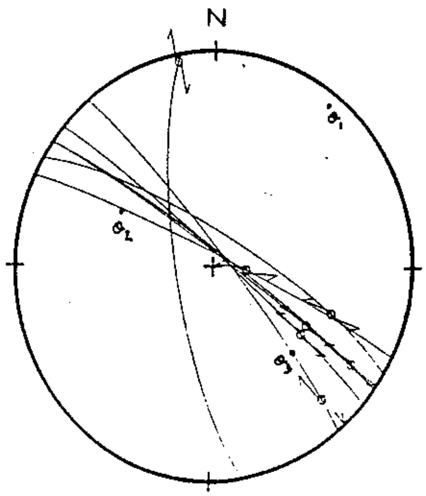

Figure 3: Equal area stereonet showing the great circles for fault planes, slickenline orientations, and movement senses. The location of σ_1, σ_2, and σ_3 are also shown. N=7

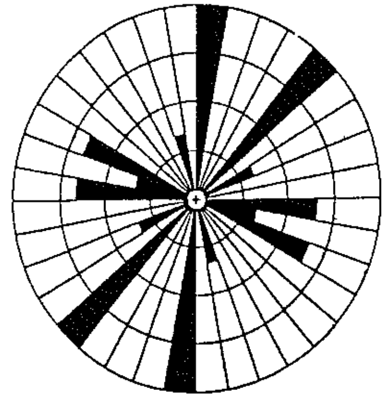

Figure 4: Rose diagram showing the joint orientations. Class interval=10°, N=13.

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.

References Cited:

Percival, J.A. and Card, K.D., 1985, Structure and Evolution of Archean Crust in Central Superior Province, Canada. Geological Association of Canada Special Paper #28, p.179-92.

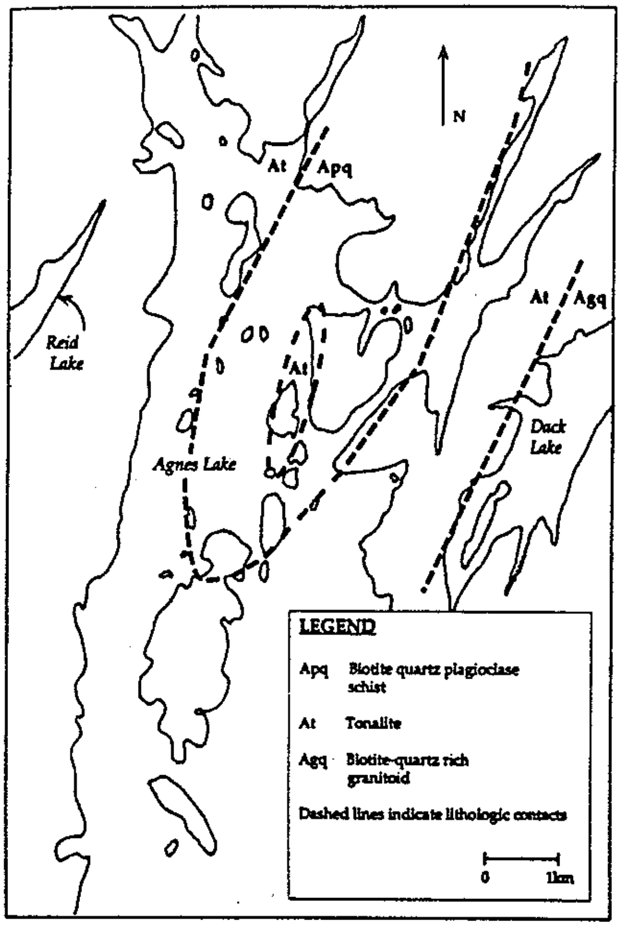

Figure 1: Map of northern Agnes lake and Dack Lake showing lithologic contacts.

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

Casey McCormick
Department of Geology, Beloit College
Beloit, Wisconsin 53511

Kirsten Ford
Department of Geology, Amherst College
Amherst, Massachusetts 01002

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