The Relationship of Lithological Structures to the Quetico-Wawa Juncture, Area of Southwestern Yum Yum Lake in the Quetico Provincial Park, Ontario Canada

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Introduction

Yum Yum Lake, located in Quetico Provincial Park, is transected by the Quetico-Wawa belt boundary. The Archean Quetico and Wawa metamorphic belts of the Superior province are in contact along an obvious northeast-southwest lineament, along which Yum Yum lake has developed. The Quetico -Wawa belt boundary may represent two docked terrains (Percival, 1989). Sills of quartz monzonite, dated at 2656 Ma, intruded into the sedimentary and volcanic rocks of the Quetico belt. About the same time, tonalite sills were intruded into the sedimentary and volcaniclastic rocks of the Wawa belt. Following this was a period of folding and migmatization in both belts, with development of trondhjemite leucosomes, folds and foliation. They may be synchronous with the docking of the two belts (Woodard and Weaver, 1990).

The Vermillion Batholith (a leucogranite which is post-folding and post-migmatization, and later than the above noted quartz monzonite sills) was intruded into the Quetico Belt (Woodard and Weaver, 1989). The rocks in both the Quetico and Wawa belts are potassium metasomatized along the boundary (Woodard and Weaver, 1990). The potassium metasomatism found in the Wawa belt rocks is also related to the batholith. The Quetico belt may have a slightly higher grade of metamorphism than the Wawa belt rocks. There is a disagreement over the time it took from the sedimentation to intrusion of the batholith; Woodard and Weaver (1990) time the events as taking 200 to 300 million years, while Percival (1989) concludes that it took 15 million years.

The Burntside Lake Fault system, a brittle deformational event, crosscuts both belts and the belt boundary (Woodard and Weaver, 1989 and 1990). At Yum Yum Lake, the main trace of the system lies 2.5 km to the northwest in the Kashahpiwi Lake area.

The purpose of this project was to map in detail the various lithologic units across the Quetico-Wawa belt boundary, as well as to delineate the faulting possibly attributed to the Burntside Lake Fault system. The distribution of these units relative to the belt boundary may lead to a better understanding of the tectonic nature of the boundary.

Methods

A beginning study of the area was done by canoe because of the easy access to lakeshore outcrops. This was to identify the varying rock units and to find problem areas such as brecciation zones and rock units in places where they were not expected. The next step was to look at these problem areas on an aerial photograph to see if there were lineaments in or near the areas. Then a pace and compass traverse was made perpendicular to the structural trends. Rocks on both sides of lineaments were studied and records of rock types, breccia, and fault surfaces (including slickensides), and other evidence, such as displacement to identify the lineament, were taken. Additional traverses by canoe and foot were made to follow contacts along strike and to follow at least one very large dike-like body of (**Sg**) located on the peninsula between the southernmost and middle bays on the southern part of Yum Yum lake. Stations were located on aerial photographs and information recorded in a notebook. At each station along traverses, as well as on lakeshores, the rock types were identified, and strikes and dips of the S1 and S2 foliations were measured. Also recorded were strikes and dips of the fault surfaces, joints, and closely spaced fracture sets, and bearing and plunge of slickensides. Descriptions of mineralogical change, grain size change, degree of migmatization, and amount and types of dikes were also included.

lineaments which are perpendicular to the boundary and that the lineaments do not seem to cross the boundary. Similar to our assertion about J2's relatioship to the belt boundary, our speculation about J3's genetic history rests on dubious evidence. In order to find a definitive answer, further research needs to be done.

Two of our geographic sub-areas, "No-Name Lake" and South Yum Yum Lake on the Quetico side, presented problems to our J1, J2, and J3 hypothesis. Both sub-areas gave stereonet contours which showed that J1, J2, and/or J3 were not the major joint sets within the particular sub-areas.

However, we believe that J1, J2, and J3 have a strong presence in the "No-Name" Lake area. Around the "No-Name" Lake's northeasternmost bay, there is a curved lineament which trends at approximately N60E. Without the measurements from northeast "No-Name" Lake, the stereonet contour plot derived from the measurements taken around the rest of the Quetico side of the lake clearly and only shows J1, J2, and J3. Across this lineament, the strikes of the joint sets change radically. Perhaps the lineament occurs along a fault.

The zone with the most diffuse stereonet contours is the one from the South Yum Yum Lake area, in the Quetico side. In this geographical zone, there are numerous, low-angle northeast-trending lineaments (possible splays of the Burntside Lake fault?) and a fault which is roughly parallel to the belt junction (Godfrey and Jennings, 1991). Furthermore, the zone is sandwiched between the two major lineaments. One might expect that the diverse stresses from the different generations of folding and faulting would produce chaotic jointing.

We have developed a relative chronology for the joint sets in this area based upon observations made around McNiece Lake. J1 and J3 are clearly the youngest of the joint sets, they cut J2 at numerous outcrops . We were not able to tell which of J1 or J3 was older, therefore we assume that they formed at approximately the same time. Our observation that J2 and J3 formed at different times seems to contradict the possibility that J2 and J3 are a conjugate set. Finally, we found a late-stage fault, which trends at N15W and cuts J1 and puts an upper boundary on the occurance of the area's jointing.

CONCLUSIONS

We chose a particularly difficult topic to research. Though joints are common and easy to locate in the field, they are near impossible to interpret. We only know a few things for certain-

The joints are relatively young.

The joints opened post-ductile deformation.

In McNiece Lake, J1 and J3 are younger than J2.

We can make a few assertions with some confidence-

J1, in McNiece Lake, is associated with the Burntside Lake Fault.

The N75W joint set in Grey Lake is the result of a minor fault.

The joint set orientations change when crossing a topographic lineament in northeast "No-Name" Lake in the Quetico belt.

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The information gathered was then transferred to a mylar overlay on aerial photographs. When a fault surface measurement matched a strong lineament on the aerial photo, the lineament was dashed in on the overlay. Contacts were also recorded on the overlay. Follow up traverses were made in areas called into question by the contacts and information already plotted on the overlay.

Rock Units

There are five main rock units that occur in the vicinity of the Quetico-Wawa belt boundary. All units are strongly foliated metamorphics, intruded by various types of sills and dikes. Four of these units were described by previous studies in the region southwest of Yum Yum area (Woodard and Weaver, 1990). Three of these units, hornblende quartz monzonite (**Ha**), granitic-rich migmatite (**Mg**), and Biotite schist-rich migmatite (**Mb**), are present in the Quetico belt. The only mappable unit of the Wawa belt in the Yum Yum are is tonalite gneiss (**Hg**).

A fifth unit, semi-aplitic granite (**Sg**), has not been previously mapped in the Quetico-Wawa boundary area. The unit occurs as an abundant intrusive dike-like body located in all rock units. Semi-aplitic granite contains 55% to 65% feldspar, 25% to 35% quartz, and 10% to 20% mafics (usually biotite). Grain size is equigranular and about 2 mm in diameter. Foliation is evident, sometimes in two directions, but neither is strongly developed.

Observations

Throughout the area, foliation trends N 40 E to N 65 E in all lithological units. This suggests that the units on both sides of the Quetico-Wawa boundary were effected by the same strain event. In most places, foliation readings are parallel to rock unit contacts. Occasionally, two sets of foliations were observed in the (**Mb**) and (**Sg**) units, with the stronger foliation remaining at N 40 E to N 65 E. The Yum Yum Lake lineament trends approximately N 50 E. Thus, the belt junction corresponds with the strikes of foliation (see figure 1).

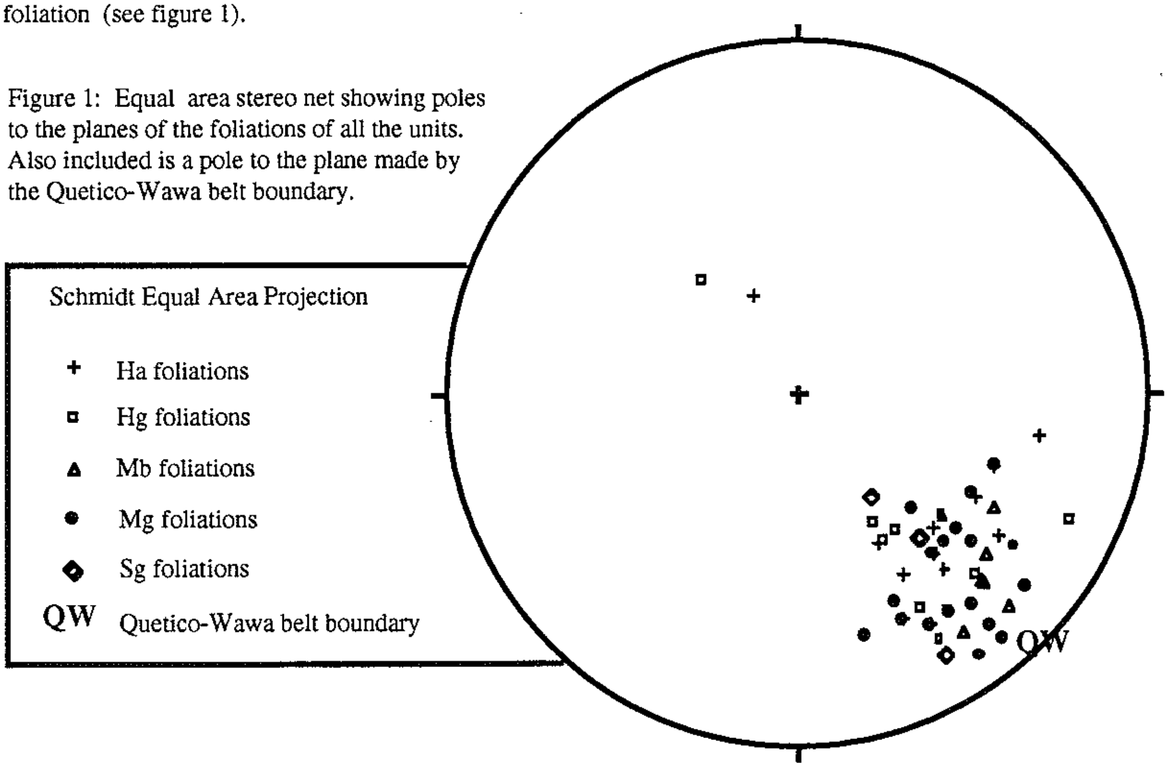

Figure 1: Equal area stereo net showing poles to the planes of the foliations of all the units. Also included is a pole to the plane made by the Quetico-Wawa belt boundary.

All of the rock unit contacts, except those of (**Sg**), are parallel to the belt boundary. This boundary is assumed to be located between rock units (**Mb**) in the Quetico belt and (**Hg**) in the Wawa. Also, all of the rock units, including (**Sg**), were cut by dikes of granite pegmatite. Trondhjemite dikes, less than 5 cm in width and 4 m in length, were also observed, cutting all units except (**Sg**). Foliated dikes of (**Sg**) cut through every unit and event the Quetico-Wawa belt boundary itself. In the latter example, the dike of (**Sg**) was observed for a length of 500 m trending N 35 E to N 40 E. Dikes of (**Sg**) were generally 5 to 20 meters in width, and up to 500 m long. In one observation (**Sg**) appeared to show folding.

Faults containing brittley deformed breccia affected both the Quetico and Wawa belts in the area. All faulting appears to be post-docking, since it cross cuts the belt boundary and moves blocks of both belts with no special preference (see figure 2). Fault breccia was very common in both the (**Mg**) and (**Ha**) units.

Four faults displace the Quetico-Wawa belt boundary to the southwest along the middle bay of southern Yum Yum Lake. The two oldest faults strike N 80 W and displace the belt boundary south of the end of the middle bay. The southernmost of these two faults shows right lateral movement. The third fault strikes approximately N 10 E bisecting the middle bay; displaces both of the two earlier faults and the belt boundary; and shows left lateral displacement. The fourth fault, also south of the middle bay, displaces the belt boundary and the three previous faults, and exhibits left lateral slip, which trends NW-SE.

Five additional faults occur in the Quetico belt but do not cross the belt boundary. These faults seem to form the outline of the dogleg shape of the northern bay of southern Yum Yum. Faults trend NE-SW, N-S, and E-W, and the majority show left lateral motion when shear sense can be determined. To the north, east of Kashahpiwi Lake, it is possible to determine at least one sequence in the faulting. The N-S striking fault displaces in a left lateral sense the NE-SW striking fault, that also has left lateral motion. Several lineaments on the air photo show no displacement.

Discussion and Comments

The units adjacent to the belt boundary give some information as to the sequence of events associated with the accretion of the Quetico-Wawa belts. The unit (**Sg**) is found in dike-like form trending N 35/40 E on both sides of the Quetico-Wawa belt boundary, and is foliated N 60 E 75 NW, which is proximal to the foliations in the rock units on either side of the boundary. The fact that this cross cutting dike is foliated, clearly indicates that the foliation formed after the bodies docked. Furthermore, the (**Sg**) unit is cross-cut by pegmatite dikes, related to the Vermillion Batholith, which means that (**Sg**) is pre-Vermillion Batholith.

The lineament that makes up Yum Yum Lake runs along the (**Mb**) unit, either on its southern boundary adjacent to (**Hg**), or on its northern boundary adjacent to (**Mg**), or within the (**Mb**) unit. This may mean that the unit (**Mb**), rather than being a unit of distinctly Quetico belt origin, is a unit which makes up the boundary itself, and is, therefore, the unit which is most easily eroded to make topographic lineaments, such as the depression filled by Yum Yum Lake.

Faulting displaces the belt boundary at four places. The faulting also goes through all rock units, including those migmatized and metasomatized in the ductile event. The faulting creates brecciated areas within the plastically deformed units, therefore, the faulting must be post-ductile deformation.

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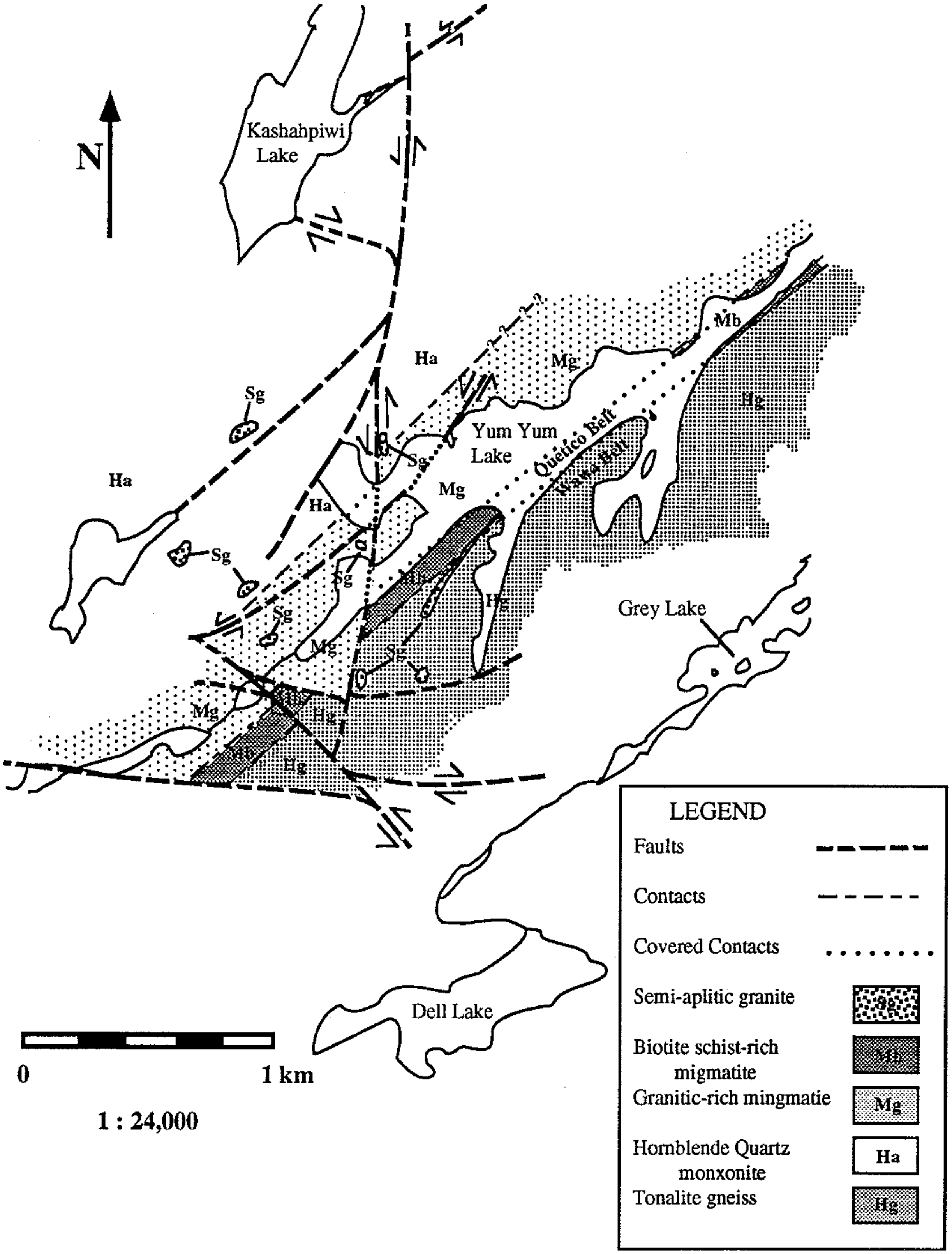

Figure 2: Geologic Map showing unit contacts and faults in southwestern Yum Yum Lake area.

YUM YUM

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My first impressions of the Yum Yum Portage were all negative. All the indications told me that it was going to be an ordeal that I would not soon forget. It sounded so terrible that I just avoided thinking about it. I was going to be an assistant cook and general handyman for the Keck Geology Consortium's Quetico Research Project. In preparation for the geologic mapping field season in Ontario's Quetico Provincial Park, I prepared fifteen copies of the Knife Lake Quadrangle for field use. On each copy of the map was a short dotted line from Yum Yum Lake to Kahshahpiwi Lake and in small print the words "Yum Yum Portage." I had to measure, cut, and then paste each section of map and every time that dotted line caught my eye. Forty-five times I looked at that line, and forty-five times I heard the leader of the trip, Chief, say, ". . . and then to get to Kahshahpiwi you have to climb down a cliff. They say you have to lower the canoes down with ropes." From reading that map I figured that I had to carry the eighty-seven pound canoe on my back three-quarters of a mile while going two hundred fifty feet up in elevation, and then turn around and do a half hour worth of back breaking labor to lower it down. I was really looking forward to the rest of the trip, but not the Yum Yum.

The first time I actually experienced the Yum Yum Portage was a cold and rainy day. Chief and I were paddling around exploring Yum Yum Lake and doing some reconnaissance geology. After lunch, Chief decided that he wanted to walk over the Portage without the canoe to see how difficult it was going to be. I chose to stay behind by the lake and take a nap. I was not about to attack that beast when I did not have to, even without a canoe. When he came back he said that it was not as horrible as we had heard and that we would not need ropes on the other side after all. I felt a little relieved, but I still did not want to portage over it.

The next time I saw it was two days later. Frank, the head cook, and Chief dropped me off there at nine o'clock in the morning. My task was to clear the trail of windthrown trees and meet them at lunch time. As they paddled off, I realized that I was really going to have to face the portage. I set out to assess my work and the portage itself. The trail surface was rocky, but I could keep my footing. The trail grade was generally steep, and extremely so in some areas. The worst area was a bare rock outcrop that went up for thirty feet at a twenty-five degree angle (a comfortable trail grade is about five degrees). At the top, the trail jumped a three and a half foot high ledge that I could not go around. It was definitely a stretch to get up, and would be a devil's task to do with a canoe on my back. The "cliff" on the Kahshahpiwi end of the portage was very steep, but would probably be negotiable if it was not for the fact that I would be exhausted by the time I got there. I gradually worked my way back clearing the trees, thinking about how difficult it was going to be to cross. Around lunch time and three big trees away from completion, Frank and Chief arrived. Frank and I worked for about a half hour to cut out the largest tree, and then headed down to the lake for lunch. Just as we finished eating, four park rangers with chainsaws paddled up to work on clearing the trail. All my work had been unnecessary! I hoped my luck would be better on my first carry with a canoe.

The next week, my first trial came. We needed to get a Vermilion Batholith specimen for radioactive age dating. The nearest place was Sarah Lake, and a round trip to Sarah would take a whole day. Getting to Sarah meant that we had to go over the Yum Yum to Kahshahpiwi. I was looking forward to the day, but not the Yum Yum. Frank carried our canoe first on the way there. He carried up over some steep spots and the horrible outcrop with the ledge. Each step he took was one I was not carrying the canoe, but one closer to when we would switch loads. After a while he got tired, and I carried the canoe. It was eighty-seven pounds plus two three pound paddles. That is forty-six pounds resting on each shoulder, going up hill. It felt like I had the bare metal yoke on my back, instead of the portage pads. I had to climb up and up and up even more. I had decided that I was in purgatory when the trail leveled off at last. I balanced my desire to appease my screaming shoulders and my need to be fair to Frank and traded it back about two-thirds of the way across. He carried it through the swamp and I was thankful that I did not have to. We got to the edge of the cliff and I could see the lake below. I was relieved and thought that Frank would make it. Frank called me just as I began to head down. I felt a sinking feeling and I knew what he wanted. He was tired and could not balance it well enough to make it down safely. I had to take it down to the lake. Downhill is very tricky- -worse than uphill- -because the canoe has to be tilted downward so that the stern does not bang against rocks. If you let it bang, it vibrates horribly and all the energy goes through your shoulders. When it is tilted downward, you have to hold it tight to counteract its tendency to slide forward. If you do not, the yoke will dig into your neck or club you in the head. The footing was loose and hard to see, and the yoke was often on my neck. Every third step the canoe slid forward and I had to stop to put it back into place. After I got it back on my