Contact Relationships and Petrography of the Williams Lake Granitoid Body, Quetico Provincial Park, Ontario

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INTRODUCTION:

The 1994 field season of the Keck Geology Consortium Quetico Project led by Dr. Henry H. Woodard carried out field research in an unmapped portion of the Archean Quetico-Wawa belt junction and surrounding areas. This study focused upon the eastern margin of a quartz monzonite body located in the vicinity of Williams Lake, referred to here as the Williams Lake pluton (Woodard, Root, and Askrin, 1994). We attempted to determine the lithologic characteristics, petrogenesis and relationships between the previously unmapped pluton and surrounding units. Within the study area the Williams Lake pluton is approximately 35 km^2. Reconnaissance outside the study area suggests that the pluton may extend further to the south, southwest, and possibly to the northeast.

GEOLOGIC SETTING:

Archean rocks of the Superior Province of southern Ontario are separated into several subprovinces based upon structural, lithologic, metamorphic, chronological, and geophysical characteristics. Metamorphosed plutonic, volcano-plutonic and sedimentary subprovinces exist within the Superior Province (Card and Ciesielske, 1986). According to Percival (1989), several subprovinces have accreted to create the southern portion of the Canadian Shield.

The Quetico Subprovince has been interpreted by Percival and Williams (1989) as metasedimentary deposits which formed along the margins of adjacent meta-volcanic subprovinces. Along the eastern margins of the Quetico Subprovice lies the Wawa Subprovince, which is considered volcano-plutonic in origin. According to Williams (1991) the Wawa structurally underlies the Quetico.

Our study area (figure 1) extends 14 km north from Williams Lake to the extreme northwest corner of Kawnipi Lake and east 4 km form the tentatively identified Side Lake shear zone (Woodard and Weaver, 1991) to the Cache River and central Kawnipi Lake areas.

The study area contains five mappable lithologic units: Williams Lake Quartz Monzonite (Agp), Biotite Schist Rich Migmatite (AP) which contains 50% or more biotite schist rafts, Granitic-Rich Migmatite (Agx) which contains less than 50% biotite schist rafts, a newly recognized unit described as a Biotite-Quartz-Feldspar Gneiss (Aqg), and a Muscovite Granite unit (Agm), found predominantly in association with the tentatively identified Side Lake shear zone. A sixth unit, a newly recognized Garnet Biotite Schist, also found within the sinistral Side Lake shear zone was too small to be a mappable unit.

PETROLOGY OF THE WILLIAMS LAKE PLUTON:

This unit is named for what was previously thought to be a large intrusion in the Williams Lake area, immediately to the southeast (Woodard, Root, and Askrin, 1994). It is typically a pale pink to white, medium grained quartz monzonite with microcline phenocrysts up to 2 cm. In the study area the Williams Lake quartz monzonite is comprised of approximately 40% plagioclase feldspar, 55% alkali feldspar, and 15% quartz. Abundance of mafic minerals is more variable and appears to be random throughout the pluton, with the exception of becoming slightly more felsic (3 to 6% fewer mafic minerals) in the northern portion of the study area. Phenocryst proportions range from 10-50% of the total rock. Previous reconnaissance of the Williams Lake pluton revealed a well-developed foliation with alignment of both microcline phenocrysts and smaller mafics (Woodard, pers. comm.). A specimen collected from a folded sill believed to contain Williams Lake plutonic rock exposed along the Basswood River approximately 40 kilometers to the southwest, gives a zircon age of 2678 +/- 1 Ma (Woodard and Root, 1993).

FOLIATION:

The foliation of the Williams Lake pluton, defined by mineral alignments, is generally well developed, yet somewhat variable. Up to two foliations were common within the pluton, with one station showing three. The foliation of the pluton is consistent across the study area, with a majority of the S_1 foliation measurements striking between N35E to N65E with a 50NW to vertical dip. The regional foliation of the area, trends between N30E to N65E with dips ranging from 40NW to vertical. At some locations within the pluton little or no foliation is visible. The development of foliation appears to be random and not related to the proximity of the contacts.

Differences in the number of measurable foliations could be explained by several mechanisms. A rock without foliation would have been exposed to the same deformational events as those displaying foliation, and because of a lack of elongate and platy minerals, the foliation is not visible. Multiple foliation directions result from the combination of several separate regional tectonic events. The variable development is related to local shear.

One of the most distinguishing and defining textural characteristics of the Williams Lake pluton is the existence of large perthitic microcline phenocrysts. Variation of the abundance and shape of these phenocrysts is common. Both equant and elongate shapes were observed, with the degree of elongation ranging up to grains with a 2:1 length to width ratio. In outcrops of the Williams Lake pluton that have no visible foliation, the phenocrysts tend to be equant in shape. Where foliation is present (as defined by the alignment of minerals), they are typically elongate, and where the foliation is strongest the phenocrysts display the largest length to width ratios. The distribution and abundance of phenocrysts in outcrops of the Williams Lake pluton appears to be random.

An explanation for the apparent correlation between foliation (visible in the mafic) and phenocryst shape is not readily available. One possibility, however, is if the phenocrysts grew from a viscous magma undergoing moderate shear stress it might be possible to create elongated phenocrysts in areas of well developed foliation. It should be noted that the elongate phenocrysts do not show signs of deformation or augen features.

CONTACT RELATIONSHIPS OF THE WILLIAMS LAKE PLUTON:

All contacts of the Williams Lake pluton are gradational. The gradational contacts in our study between the granitic migmatite and the quartz monzonite range from a few hundred meters to over half a kilometer. A typical traverse from the pluton to surrounding units (from east to west) reveals the gradational nature of the contacts (figure 1). Starting within the pluton itself, the outcrops consist of porphyritic quartz monzonite. As one moves outward form the pluton (heading east) the "inner zone" of the contact, which is typically 50 to 100 meters in width, is crossed. Within the inner zone a faint layered texture is apparent, due to the assimilation of biotite schist (stringers) into the granitoid groundmass. These stringers are predominantly oriented parallel to the regional S_1 foliation. These biotite-rich zones are not present within the pluton itself. The inner zone grades into a granitic-rich migmatite characterized by small rafts of nearly unaltered biotite schist. These biotite schist rafts tend to be aligned with the regional S_1 foliation. Microcline phenocrysts characteristic of the Williams Lake pluton are also found within the inner zone, but are not common within the granitic-rich migmatite. Continuing east, the amount of biotite schist in proportion to the leucosomal material increases until there is greater than 50% biotite schist rafts, at which time the lithologic unit is essentially a biotite schist-rich migmatite. The gradation from granitic-rich migmatite to biotite schist-rich migmatite is also gradational, occurring over a 1 to 2 km span. If this trend were continued, one would expect to encounter pure biotite schist beyond the effects of the Williams Lake pluton. Pure biotite schist was never reached however, and it is assumed that the Burntside Lake Fault creates a structural discontinuity offsetting biotite schist-rich migmatite and biotite schist units.

PETROGENESIS:

It is apparent from the foliation, metamorphic grade, and gradational contacts that the Williams Lake pluton is not an epizonal intrusion. We have developed two models to explain the petrogenesis of the Williams Lake quartz monzonite. The first model involves a magma body developing at depth and migrating upwards causing migmitization of the surrounding biotite schist country rock. The second model involves *in situ* petrogenesis of the pluton.

Model #1: In this model the magma formed at a greater depth and migrated upwards into its present position. Such a mechanism could account for the ringing of migmatites around the pluton. If the rising magma body was saturated with fluids, and the country rock into which it was rising was already near its melting point (common among deep intrusives) then the expelled fluid along with high temperatures could

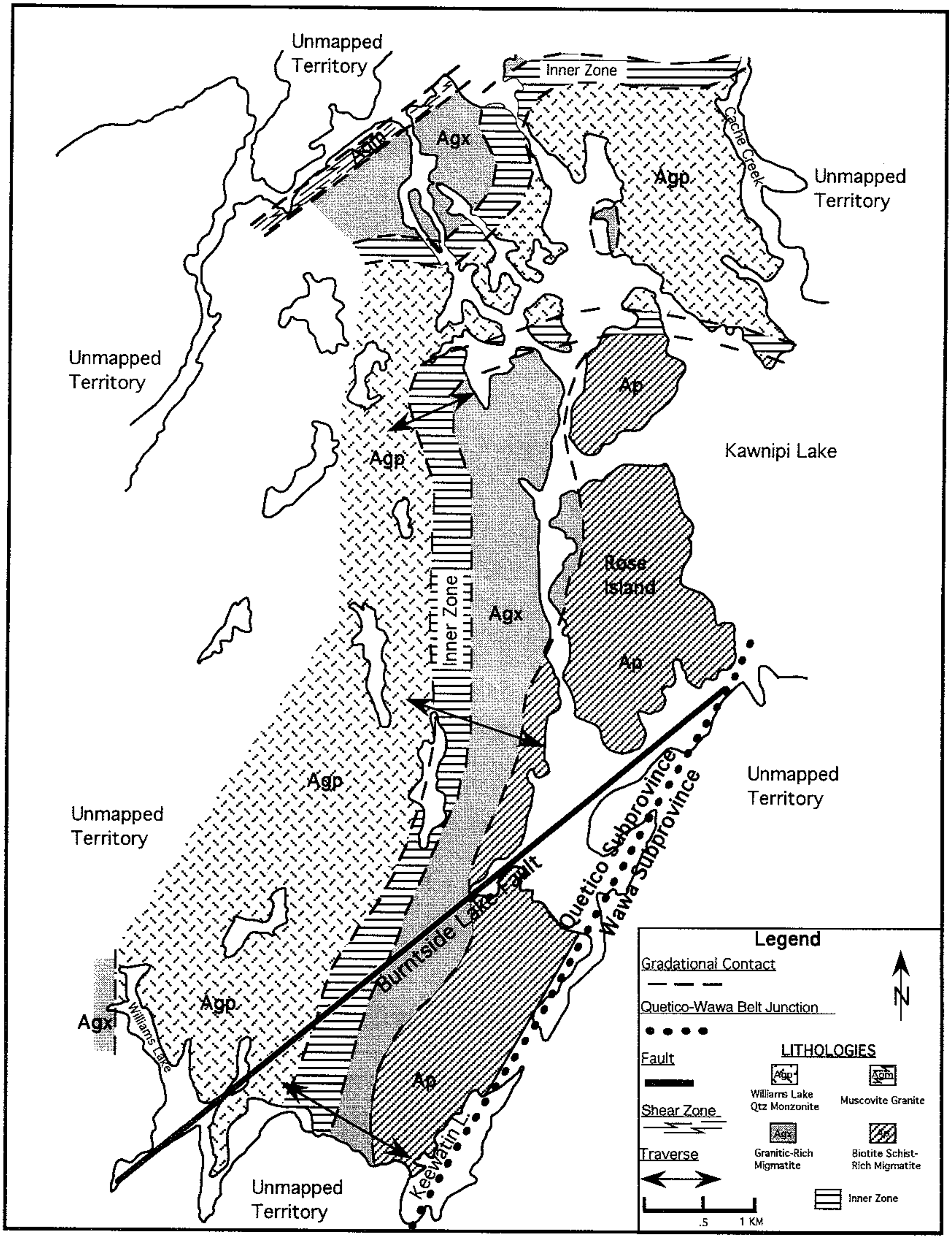

Figure One: A geologic map of the eastern margin of the Willimas Lake pluton, Ontario, Canada have caused migmatization close to the magma body, decreasing in intensity further from the pluton. This would account for the gradational nature of the contacts and lithologic relationships.

Modes #2: The second mechanism for the petrogenesis of the Williams Lake pluton involves *in situ* melt and emplacement. Being at great depths, the P-T conditions may have been such that an elevated geothermal gradient or water content could have caused complete melting of the sediments, whereas in adjacent areas only partial melting occurred. The Williams Lake quartz monzonite may represent such an area of complete melting while the granitic-rich and biotite schist-rich migmatites represent varying degrees of partial melting. The gradational contacts also support this hypothesis and the inner zone may represent the gradation to the complete melting region. In several locations within the inner zone, remnants of original sedimentary bedding could be identified. If the bedding is still preserved after nearly complete melting, then it can be assumed that the rock was stationary at the time of melting.

Although model #1 seems more plausible, being a common style for the petrogenesis of magma bodies, the evidence of relict sedimentary bedding in the inner zone and the yet unresolved solution to the "room problem" for intrusive bodies indicates that model #2 should not be thrown out. If the Williams Lake pluton is an *in situ* melt, then the modal percentages should plot on the eutectic minimum melting point. Preliminary mineral counts appear not to plot on this point. Further research is needed to clarify the question of petrogenesis of the Williams Lake pluton.

CONCLUSION:

In conclusion, the Williams Lake pluton represents an original igneous body of porphyritic quartz monzonite. The S_1 foliation within the pluton, being consistent with regional foliation, indicates that the pluton existed prior to at least one period of regional tectonism. Relationships between phenocrysts and foliation are not well understood. The gradational contact relationships between the pluton and surrounding lithologic units can be explained by either *in situ* or intrusive mechanisms. Gradation between the two models may exist as well. Based upon the field evidence collected model #1 is preferred for petrogenesis of the Williams Lake pluton.

REFERENCES:

Card, K. D. and Ciesielske, Andre, 1986, Subdivisions of the Superior Province of the Canadian Shield: *Geoscience Canada*, V. 13, p. 5-13.

Percival, J. A. and Williams, H. R., 1989, Late Archean Quetico accretionary complex, Superior province, Canada: *Geology*, V. 1 7, p. 23-25.

Woodard, H. H., 1992, 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: In Wilson, Mark, ed., Fifth Keck Research Symposium in Geology, Wooster, Ohio, p. 70-75.

Woodard, H. H. and Root, Samuel, 1993, The Side Lake shear zone, Quetico Provincial Park, Ontario, Canada: in Wilson, Mark, ed., Sixth Keck Research Symposium in Geology, Walla Walla, Washington, p. 58-62.

Woodard, H. H., Root, Samuel, and Askrin Daniel, 1994, Quetico-Wawa subprovince junction, Reid Lake area, Quetico Provincial Park, Ontario: In Wilson, Mark, ed., Seventh Keck Research Symposium in Geology, San Antonio Texas, p. 194-198.