BURNTSIDE LAKE FAULT ZONE, MINNESOTA-CANADA

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GEOLOGY OF ARCHEAN ROCKS, BASSWOOD LAKE - CROOKED LAKE REGION, NORTHERN MINNESOTA - SOUTHERN CANADA

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During the 1970 field season the Department of Geology at Beloit College put two students in the field to map a series of metamorphic rocks on United States Point in Basswood Lake, Boundary Waters Canoe Area Wilderness, northern Minnesota. Since that time over forty students have helped unravel a complex geologic history of the region. Immediately northwest of Basswood Lake in the Quetico Belt the bedrock is composed of a series of supracrustal metagreywackes overlain by coarse-grained breccias of mafic metavolcanic rocks. Thick sills of hornblende- and potassium feldspar-bearing felsic rocks were emplaced within this layered igneous pile. The preserved thickness of this sequence is approximately 2 km, although no base is currently known. The entire sequence was then folded into a large synclinorium of asymmetric folds overturned toward the south. These folds strike approximately eastnortheast and plunge 25°-30° NE, and have been named the Crooked Lake fold belt. This folding produced crustal shortening within the pile of approximately 22%. These relationships are shown in cross section in Figure 1.

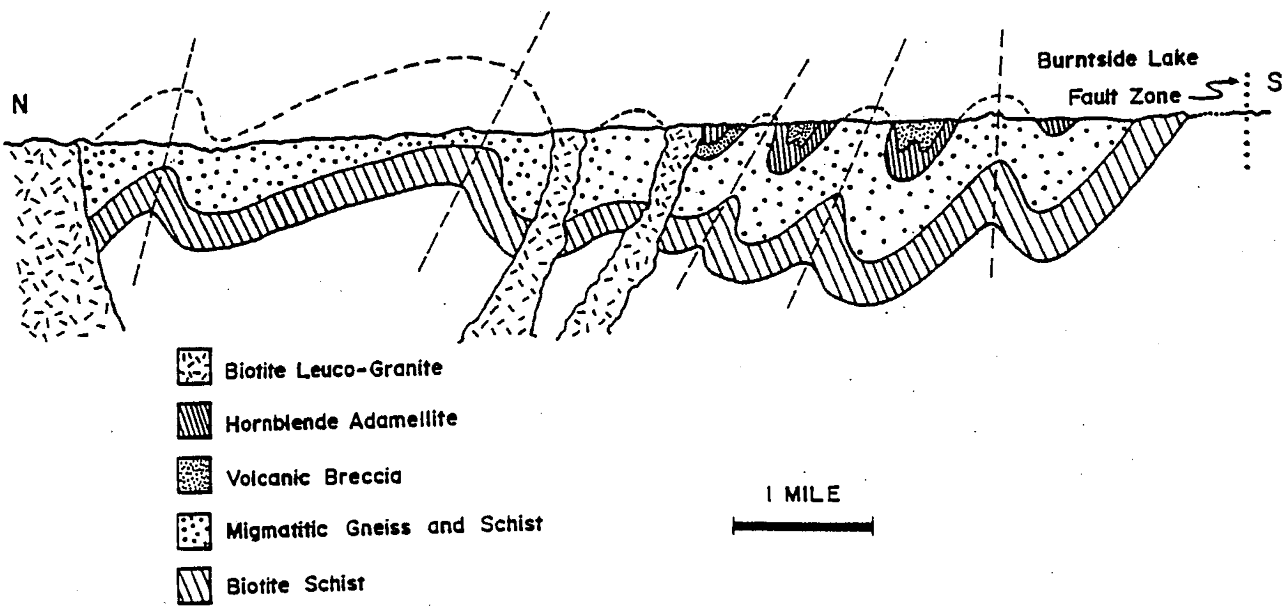

Figure 1. North-South Cross section lying between the Vermilion Batholith on the north and the Burntside Lake fault zone on the south.

During the folding event the rock sequence was migmatized and leucosomes of trondhjemite were abundantly developed throughout the stratigraphic section. Following the period of folding and migmatization, the 2,700-Ma leucogranite of the Vermilion Batholith was emplaced and the previously migmatized rocks forming the batholith walls were injected by dikes of biotite leucogranite and selectively metasomatised with potassium. This entire complex history probably developed over a period of approximately 300-400 Ma, although there are no systematic isotopic ages yet available for these rocks.

A complex fault zone called the Burntside Lake fault borders the Quetico Belt to the southeast (see Figures 1 and 2). The southeasternmost border of the zone is the most recently active fault trace and is exposed along the trend of Pipestone Bay, one of the many major bays forming Basswood Lake. North of the Pipestone Bay trace the zone is at least 3 km wide and an intricate set of splay faults eminate northward from the zone and break the supracrustal sequence into a megabreccia resembling a giant horsetail structure. This structure occupies an area approximately equivalent to four, 7-1/2 minute quadrangles. Although many of these splay faults cut the Vermilion Batholith contact to the north (see Figure 2), they quickly die out within the massive leucogranite of the batholith.

Along strike to the northeast, the fault zone narrows to a "single" continuous break and where it skirts the southeasternmost corner of the Vermilion Batholith the zone is probably not more than 100 meters wide. We believe that this change in character of the zone from one of considerable width (3-4 km) and complexity, to one of limited width, is the result of the buttressing effect the massive Vermilion Batholith has had on fault propagation. It is thought that the development of the horsetail fault structure displayed in Figure 2 is the result of the massive batholith's location within the northwest wall of the Burntside Lake fault. Strains within this northwest block (the Quetico Belt) would be dissipated by compressing the supracrustal rocks against the southeast end of the massive batholith with consequent brittle failure in the supracrustal sequence. If such a model for brittle strain is correct, one might expect to find right lateral displacements on the individual splay faults of the horsetail structure. In fact, as demonstrated in Figure 2 by displacement of northeast-trending fold axes when crossed by splay faults, both right and left lateral displacements are present.

Within the Burntside Lake fault zone, major fold axes are truncated and dragged in a right lateral sense (see Figure 2). This same displacement sense is demonstrated by dragged lithologic contacts (not shown on map). Further, fold axes, both within the fault zone and in the Wawa block to the southeast, plunge southwestward at 30^{o}-40^{o} while all major fold axes in the Crooked Lake fold belt (Quetico block) to the northwest of the fault zone plunge northeastward at 25^{o}-30^{o}. This reversal in plunge, with an angular difference of 55^{o}-70^{o}, possibly indicates that the Wawa block has rotated, with the northeastern portion of the block moving up and the southwestern portion of the block moving down. Complicating this picture is the probability that over time multiple displacements may have occurred on the Burntside Lake fault.

The entire fault complex recorded in Figure 2 shows significant control on hydrothermal activity. Where small scale brecciation is most intense, the rocks are often stained red by hematite and the feldspars are highly sericitized. Massive quartz veins, with or without epidote, are commonly emplaced along fault traces, and veins as thick as 1 meter have been observed. Along the main trace of the Burntside Lake fault and extending as much as a kilometer away from the fault, all rock units show a regressive metamorphic mineral assemblage. Chlorite + epidote + sericite + calcite + hematite is the characteristic mineral assemblage, and actinolite is often present in more mafic rocks.

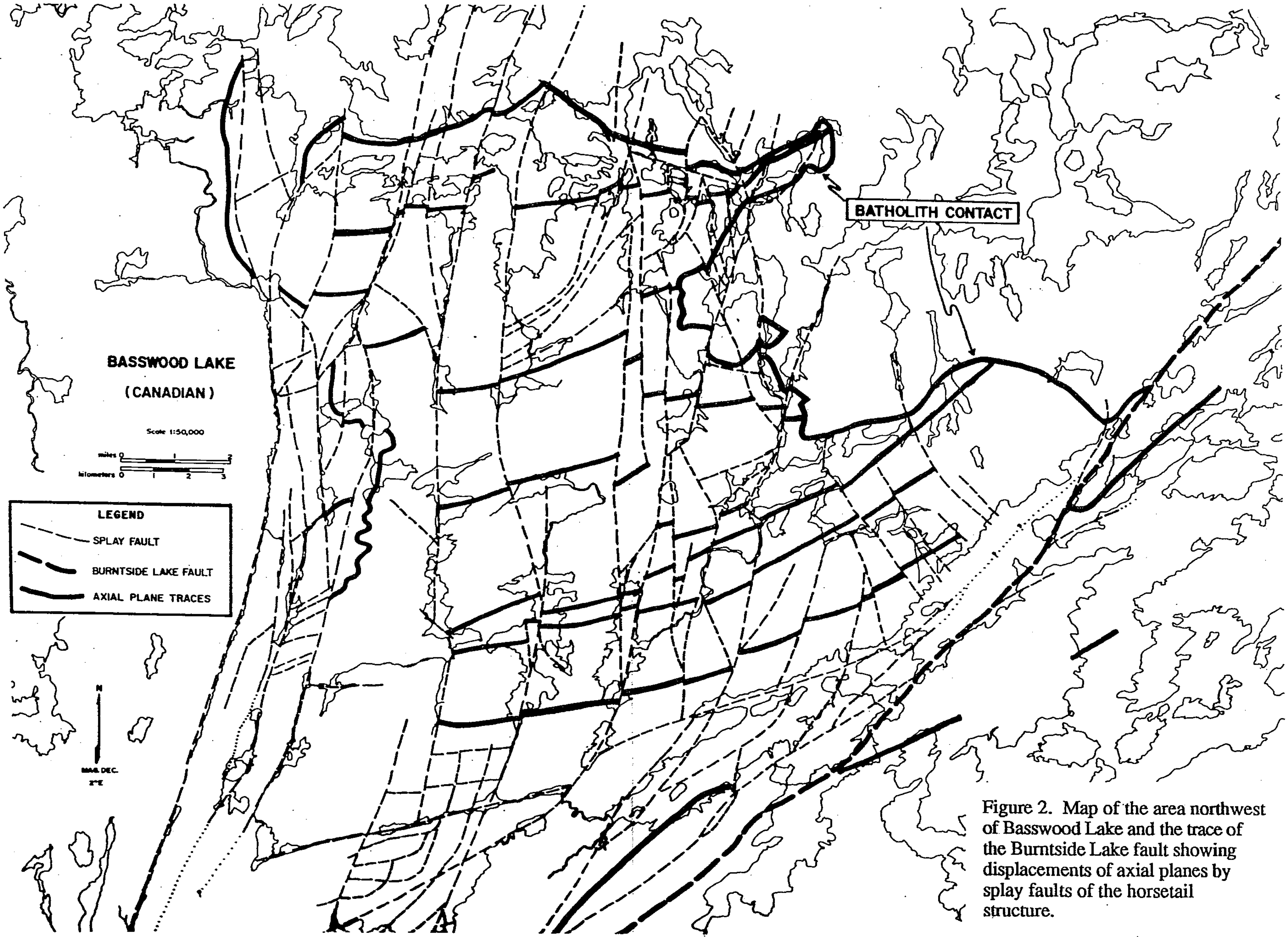

Figure 2. Map of the area northwest of Basswood Lake and the trace of the Burntside Lake fault showing displacements of axial planes by splay faults of the horsetail structure.