THE SIDE LAKE SHEAR ZONE, QUETICO PROVINCIAL PARK, ONTARIO, CANADA

FACULTY

Henry H. Woodard, Beloit College
Samuel Root, The College of Wooster

STUDENTS

Matt Bastress, Colorado College
Tara-Leisel P. Burgy, The College of Wooster
Kathleen E. Donnelly, Trinity University
Aimee O. Kambhu, Trinity University
Alan Kaufmann, Pomona College
William H. Peck, Beloit College
Jacob Russin, Williams College
Christopher Sanchez, Colorado College
Kathleen Schuh, The College of Wooster
Andrea Laur Troolin, Macalester College

VISITORS

John Craddock, Macalester College

STAFF

Peter Parham, Camp Manager
Brent Elliott, Beloit College
Laurel Nelson, Beloit College
Adam Robbins, Beloit College

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Henry H. Woodard
Beloit College
Beloit, Wisconsin 53511

Samuel Root
College of Wooster
Wooster, Ohio 44691

Introduction

The Side Lake shear zone is located in Quetico Provincial Park, Ontario, Canada. The zone is generally marked by a major topographic lineament which extends from south of Side Lake on the southwest, through the Kahshahpiwi Creek drainage, including Kahshahpiwi, Keefer, Sark and Cairn Lakes, to Kawnipi Lake on the northeast, a distance of approximately 40 km. Woodard and Weaver (1990) first reported the zone of shearing in the Side Lake area and the name Side Lake shear zone is now used to delineate the entire zone.

The geometry of the shearing is distinctive for this portion of the Canadian Shield and this distinctive character has led to a more thorough study with the hope that its origin could be satisfactorily explained.

Geometry of Shear Zone

The surface expression of the Side Lake shear zone is marked by a lineament that extends from the general area of Nest Lake on the southwest to Kawnipi Lake on the northeast, a distance of approximately 40 km. Side, Kahshahpiwi, Keefer, Sark, and Cairn Lakes all lie along this lineament and include much of the central, more highly sheared portion of the zone. In the vicinity of Nest Lake the zone intersects both the earlier Quetico-Wawa belt junction and the later Burntside Lake fault (Woodard and Weaver, 1990). Its northeast terminus has not yet been studied but aerial photos suggest that it lies at the junction with the Kawnipi Lake cross-lineament.

The map width of the zone is not easily defined. Little evidence for Side Lake shearing has been found in rocks east of the trace of the Burntside Lake fault. However, both Sanchez and Troolin, and Bastress and Schuh (this volume) report Side Lake shearing in rocks lying as far as three kilometers west of Kahshahpiwi Lake. Therefore, a map width of the shear zone of five kilometers appears reasonable. The zone dips westward at an average 25°, so the thickness of the shear zone is approximately 2.0-2.5 km. That the most highly sheared portion of the zone occurs along the pronounced topographic lineament is indicated by more closely spaced shear planes and the development of mylonite-ultramylonite. Distinctive topographic profiles are characteristic of the zone (Fig. 1). They result from differential erosion controlled in large part by the dip direction of shear planes in the adjacent rocks. Although the pre-glacial topography is unknown, it is clear from a variety of ice-directional features that the general latest ice-flow direction was from the north at approximately a 10° angle to the N25°E trend of the Side Lake shear zone. This ice movement produced typical steep ice-quarried cliffs along the west sides of Side and Kahshahpiwi Lakes and more gentle ice-smoothed surfaces on the east side of these lakes where the ice was moving up the dip of the shear planes.

Most mapped faults in this portion of the Canadian Shield are thought to be steeply dipping and dominated by a strike slip component of movement. The Burntside Lake fault described by Kambhu and Russin (this volume) is an example, although many other examples are present.

The Side Lake shear zone is distinctive because it dips gently (20°-25°NW) and has slickenlines which plunge gently down the shear planes. It therefore would technically classify as a gently dipping normal fault exhibiting diagonal slip. These relationships are illustrated diagramatically in Fig. 2. The work of Bastress and Schuh, and Sanchez and Troolin (this volume) illustrate well the high degree of structural consistency present throughout the Side Lake shear zone in the segment extending from Side Lake to the north end of Keefer Lake.

The character of the shearing in general lies chiefly in the field of cataclasis and essentially all shear planes show well developed slickensided surfaces, slickenlines, and typical step fractures at right angles to the slickenlines. In outcrops which immediately flank the main topographic lineament the shear planes are spaced 2-4 mm apart, but as Bastress and Schuh (this volume) point out, the spacing between shear planes rapidly increases as the zone is traversed west of the lineament. Large feldspar grains are commonly granulated but it is questionable if any show development of recognizable ductile "tails," even where the shear planes are closely spaced. Sanchez and Troolin (this volume) briefly describe a series of outcrops in Keefer Lake which resemble either well-formed mylonites or ultramylonites. No petrographic work has yet been done on these rocks but they typically show shear plane separations of a millimeter or less and ductile "tails" are developed on remnant grains. Sanchez and Troolin (this volume) were unable to find any slickenlines developed on the shear surfaces.

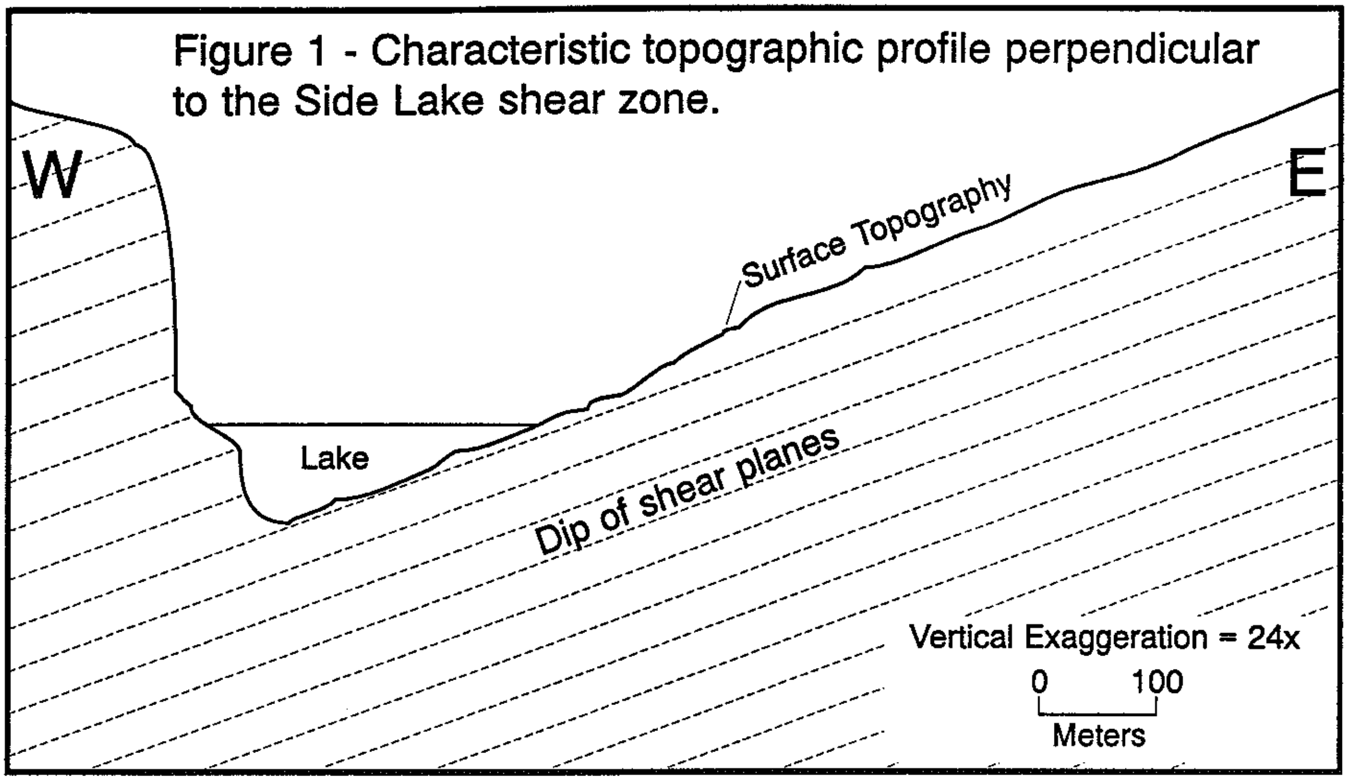
Figure 1 - Characteristic topographic profile perpendicular to the Side Lake shear zone.

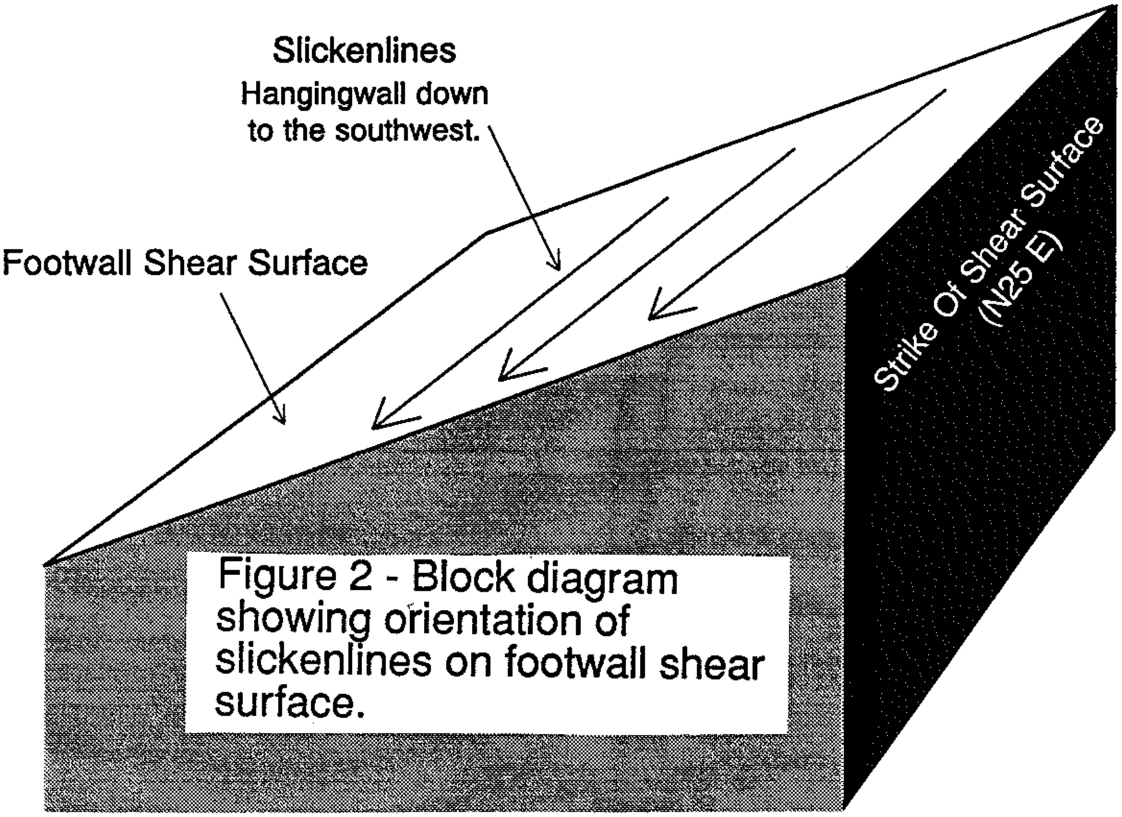

Figure 2 - Block diagram showing orientation of slickenlines on footwall shear surface.

The location of these "ultramylonites" in the center of the main topographic lineament suggests that they may be more common than the field mapping indicates. Most of the central zone mapped to date is covered by the waters of Side, Kahshahpiwi, and Keefer Lakes. Future field mapping may discover more of these rocks along strike, northeast of Keefer Lake.

Associated Rock Types and Folds

The Side Lake shear zone cuts a variety of lithologic units. These range from leucogranite of the Vermilion Batholith to older, muscovite granite, tonalite, granitic-rich migmatite, and biotite schist-rich migmatite. Except for the muscovite granite, the general age relationships of these units have been established by Woodard and Weaver (1990) and Woodard (1992) and will not be repeated here. Except for the leucogranite of the Vermilion Batholith, all rocks have been strongly folded and to some degree migmatized. The orientation of these major folds becomes important in evaluating possible origins for the Side Lake shearing. Burgy and Peck, and Bastress and Schuh (this volume) collected a variety of structural data west of the Side Lake shear lineament, and Donnelly and Kaufmann (this volume) collected structural data east of the lineament (and east of the Burntside Lake fault trace). Combining these data with an extensive study of the available aerial photos demonstrates that both regions (east and west of the Side Lake shear lineament) are deformed into a complex set of major folds which are overturned to the southeast and show moderate northeast plunges. Figure 3 shows the general map character of each group of folds.

These fold orientations are essentially identical to those described earlier by Kaszuba and others (1983) and Woodard and Weaver (1989) in the area of Crooked Lake approximately 20 km to the southwest, and named by them the Crooked Lake fold belt. The similar fold orientations in all three of these areas conforms to what is currently known about the regional orientation of folds and therefore eliminates regional rotational mechanisms as an explanation for the unusual orientation of the Side Lake shear zone.

Hypotheses and Conclusions

Four ideas have developed while attempting to explain the origin of the Side Lake shear zone. One deals with a regional rotation of a pre-existing thrust zone. A rotation of as little as 15° about an axis perpendicular to the slickenlines might be enough to transform this gently dipping "normal" shear zone into a thrust zone orientation. However inviting this explanation may seem, it would also require a similar rotation of the older fold structures which lie in both the hanging wall and footwall blocks of the shear zone (Fig. 3). Available data indicate that no such rotation has occurred and that these folds conform to the regional structures recognized in the Crooked Lake fold belt by Kaszuba and others (1983).

A second possible explanation of the shear zone is to relate it to low angle sliding off a rising metamorphic core complex. Although it is likely that a major metamorphic node does exist in the area west of Burt Lake, approximately 20 km west of the Side Lake shear lineament, any sliding from such a complex would be expected to occur at nearly right angles to the actual slickenlines, and therefore show thrust-type relationships. As indicated earlier the slickenlines actually show normal-type faulting with diagonal slip.

A third suggestion is that the Side Lake shear zone represents a low angle normal-type shear produced by the sliding of the northeast wall of the Vermilion Batholith into a low pressure area within the Vermilion Batholith magma chamber, presumably when liquid had been withdrawn. Physically, this model would explain the southwest orientation of slickenlines and the observed downward-to-the-southwest movement of the hanging wall block. Further, the supracrustal rocks which make up the Crooked Lake fold belt 20 km. to the southwest are best described as a major roof pendant, surrounded by intrusive rocks of the Vermilion Batholith. This roof pendant could have been emplaced into the Vermilion Batholith magma chamber when the northeast wall of the magma chamber slid southwestward and downward parallel the slickenlines of the Side Lake shear zone. However, the strike of the Side Lake shear zone (N25°E) seems not to be the most likely orientation if the zone were formed in this manner.

Lastly, it has been suggested that the Side Lake shear zone is related to the Burntside Lake fault which lies 1-3 km to the east and intersects the shear zone in the vicinity of Nest Lake about 15 km southwest. The Burntside Lake fault strikes N30-35°E and Kambhu and Russin (this volume) say that it is steeply dipping, strike-slip, and right-lateral. Along most of its length it shows coarse brecciation with a high percentage of open spaces within the breccias and it is characteristically stained red by hydrothermal hematite, accompanied by the development of epidote and quartz veins. None of these characteristics apply to the Side Lake shear zone.

In summary the age of the Side Lake shear zone can be placed in time after the major metamorphism, metasomatism, and folding of the region and after the post-folding intrusion of the Vermilion Batholith. It appears to be cut by the Burntside Lake fault and is thus earlier. None of the four proposed explanations for its origin seem to satisfy all the known data, although the sliding of an upper segment of wall rock into the partially voided Vermilion Batholith magma chamber appears to be the best explanation. It is hoped that future work northeastward along the trace of the Side Lake shear zone may help resolve these intriguing and unanswered questions.

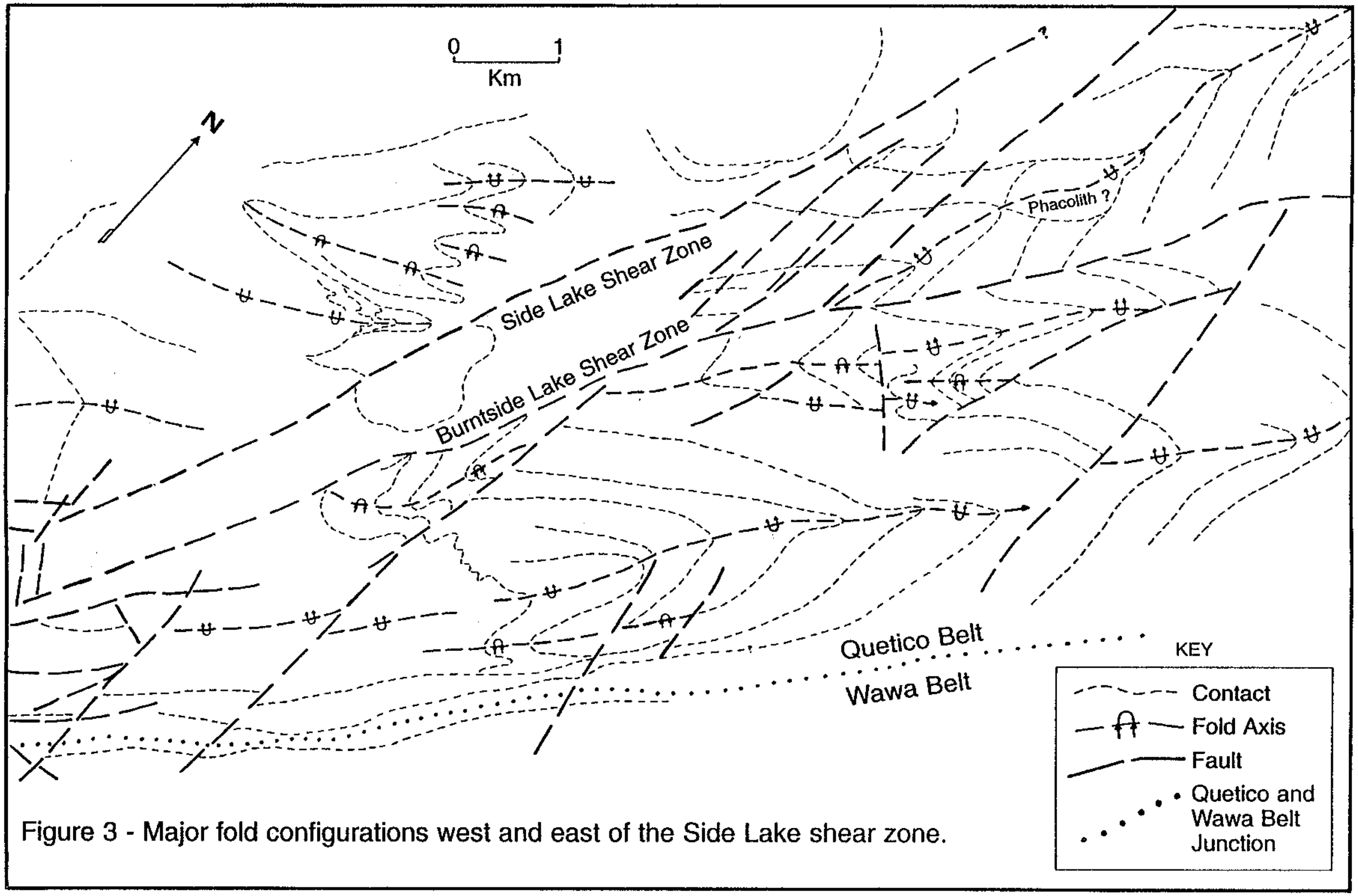

Figure 3 - Major fold configurations west and east of the Side Lake shear zone.

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