SUMMARY

The Edmund Lake and Little Stull Lake map areas in the Stull Lake greenstone belt are transected by the "Wolf Bay" shear zone, dividing the area into two domains. The domain south of the shear zone consists of pillowed basalt and related gabbro of MORB affinity considered to belong to the Hayes River Group. North of the shear zone, and at the bottom part of the supracrustal sequence, similar mafic rocks are exposed. Tectonically above the mafic complex diverse volcanic and volcanogenic sedimentary rocks of possible arc affinity are exposed. Preliminary structural analysis reveals four generations of deformation. D1 is only recognized in the mafic complex and is possibly low angle ductile shear zone deformation, and D2-4 affect all rock units. The map pattern in the Little Stull Lake area is controlled mainly by D2 structures modified by D3. The "Wolf Bay" shear zone formed during D3 dextral transpression, and small scale shear zones kinematically similar to the "Wolf Bay" shear zone are commonly observed in the area. D3 structures are interpreted to result from north side up thrusting.

INTRODUCTION

A multi-disciplinary study of the Edmund Lake - Little Stull Lake area has been carried out since 1996 (Corkery 1996a, Corkery et al., 1997b) following earlier work (Downie, 1937; Satterley, 1937; Corkery, 1981). It is one of Manitoba's Northern Superior projects and is a contribution to the Western Superior NATMAP Project, aimed at characterizing the volcanic, structural and tectonic evolution of greenstone belts of the Western Superior Province in particular and advancing our understanding of greenstone belts in general. Previous mapping in the Edmund Lake - Little Stull Lake area (Corkery, 1996b; Corkery et al., 1997a) identified a regional high-strain zone, the "Wolf Bay" shear zone, that contains several gold occurrences within and near the zone on Little Stull Lake. The structural geometry of the supracrustal belts in the area, the role this geometry plays in controlling the map pattern, and its possible genetic relationship with the "Wolf Bay" shear zone have been poorly understood. Such information is, however, of critical importance in understanding the geological history of the area including better constraints on the structural setting for gold mineralization. In the summer of 1998 a structural analysis of the area was conducted and some preliminary results of this work are presented below.

LITHOTECTONIC UNITS

The Edmund Lake - Little Stull Lake map area is situated in the Stull Lake greenstone belt, that extends from Ontario northwestward through the Rorke Lake and Little Stull Lake area to the Edmund Lake (Fig. GS-23-1). The belt is on strike with the Gods Lake greenstone belt to the west (Corkery, 1996a). A regional shear zone, the "Wolf Bay" shear zone, trending approximately 120°, divides the area into two domains. Supracrustal rocks in the southern domain consist of basalt of MORB affinity (Corkery and Skulski, GS-22 this volume) and associated gabbro, considered to belong to the Hayes River Group (Corkery et al., 1997b and references therein). These rocks are ca. 2830 Ma at Knee Lake (D. Davis, 1986 cited in Syme et al., 1997). Supracrustal rocks in the domain north of the shear zone are diverse and can be divided into four lithotectonic units.
Figure GS-23-1: Regional geologic setting and major subdivisions in the Edmund- Margaret- Stull lakes region.
Figure GS-23-2: General geology of the Little Stull, Rorke, Kistigan Lakes area.
STRUCTURE

Four generations of deformation are recognized.

D1: Possible low-angle ductile shear zones

The earliest deformation event, best observed along the west shoreline of Edmund Lake, produced a shallowly-dipping foliation (S1) and shallowly-plunging stretching lineation (L1) (Fig. GS-23-3 and 4). S1 is defined by a shape fabric in deformed gabbro and a compositional layering of mylonitized gabbro and basalt; L1 is defined by alignment of plagioclase on the S1 foliation surface (Fig. GS-23-3). The S1-parallel compositional layering of alternating gabbro layers and basalt layers along the west shoreline of Edmund Lake is tectonic in origin and represents the C-foliation in ductile shear zones, not the original gabbro sills. S1 is overprinted regionally by isoclinal D2 folding, dextral transpressional D3 shear and possibly north side up D4 overthrusting.

The dominant foliation in the mafic complex outside the “Wolf Bay” shear zone is interpreted to be S1. It is overprinted by F2 with a well-developed S2 foliation. In areas strongly affected by subsequent deformations, it is very difficult to identify the L1 lineations.

D1 deformation occurred in a ductile shear zone environment, but it is difficult to evaluate the initial orientation and sense of shear of D1 shear zones. This deformation is likely to have been dominated by low angle shear zones leading to regional tectonic transposition in the basalt-gabbro sequence near the contact between the granitoid and the supracrustal sequence. D1 deformation is only recognized in the mafic complex.

D2: Regional isoclinal folding

This generation of deformation is characterized by regional isoclinal folding. Map-scale F2 folds, well developed in the Little Stull Lake area (Fig. GS-23-2), have gentle plunges and include: an anticline in the Little Stull Lake fluvial - alluvial sequence, an anticline in the Minnow Bay sequence and a syncline and anticline in the Sickle Bay - Lodge Bay sequence (Fig. GS-23-2).

The anticline in the Sickle Bay - Lodge Bay sequence, recognized during this investigation, is cored by Rapson Bay mafic complex of the Hayes River Group. The isoclinal nature of the fold has caused the mafic complex in the core of the fold to be so strongly deformed that it was previously interpreted as a ductile shear zone (Corkery, et al., 1997a, 1997b). However, a clear S1/S2 overprinting relationship occurs along the shoreline of Rorke Lake northeast of the portage to Little Stull Lake, where S2 is a crenulation cleavage. Locally S1/S2 may resemble an S/C relationship, but unlike an S/C relationship in a ductile shear zone, the sense of shear that S1/S2 reflects varies spatially from one limb of the fold to the other.

Possibly the best example of overprinting of S2 on S1 and outcrop scale F2 folds occurs on a burnt island near the southwest shoreline of Margaret Lake (Fig. GS-23-5). There, S1 (defined by compositional layering) is folded by F2 with an axial plane cleavage S2 (a differentiated crenulation cleavage; Fig. GS-23-5).

Figure GS-23-3: Shallowly-dipping S1 foliation and stretching lineation (L1) commonly observed along the western shoreline of Edmund Lake. They suggest that D1 might have been low-angle shear zone deformation.

Figure GS-23-4: Lower hemisphere stenographic projections of S1 (great girdles) and L1 (dots) measured along the western shoreline of Edmund Lake.
Outcrop scale parasitic $F_2$ folds are not found in units other than the mafic complex. There are two possible explanations for this observation. One is that $S_1$ was not well developed in those units (i.e., $D_1$ shear zones were sporadically developed in these units or not developed at all), which would materially not favour development of small scale folds. The other is that the lack of markers in those units combined with limited outcrop make it difficult to identify $F_2$ folds in them.

The map pattern in the Little Stull Lake area is primarily controlled by $F_2$ folds. Fig. GS-23-6 is a schematic cross section showing the overall structure.

**D$_3$: Dextral transpression**

$D_3$ deformation is most likely a continuation of $D_2$, with an evolution in the kinematic framework from compression-dominated folding to more non-coaxial dextral transpression. The regional "Wolf Bay" shear zone formed during $D_3$. Smaller scale shear zones kinematically similar to the "Wolf Bay" shear zone are widely developed in the mafic complex south of the "Wolf Bay" shear zone in the Edmund Lake area (Fig. GS-23-7). The "Wolf Bay" shear zone and small scale shear zones typically strike 110°–130° with well developed $S/C$ fabrics and other kinematic indicators, that collectively suggest a dextral sense.
of shear (Fig. GS 23-8 and 9). Outside the shear zones, the rocks exhibit a variable degree of strain, and primary features such as pillow structures in basalt are preserved. The S/C relationship is observed on different scales from hand sample to a whole outcrop where flattened pillows define the shape foliation and cm-wide high-strain zones define the C-foliation. Lineations in the "Wolf Bay" shear zone are subhorizontal (Fig. GS-23-9), as are lineations in most outcrop scale shear zones parallel to the Wolf Bay shear zone. Lineations in less deformed wall rocks are steeper and more variable and thus suggest deformation path partitioning during transpression (Lin, et al., 1998; Jiang and Williams, 1998).

\( \text{D}_3 \): North side up thrusting

This deformation is recognized in the Minnow Bay area, where outcrop scale S-folds are well developed (Fig. GS-23-10), and along the south shoreline of Little Stull Lake within the "Wolf Bay" shear zone that lack an axial plane cleavage, plunge gently to the northwest, and have Z-asymmetry. Their geometry is inconsistent with \( \text{D}_4 \) dextral sub-transcurrent transpression. This eliminates the possibility that they are due to progressive \( \text{D}_3 \) deformation. Similarly, the S-folds at Minnow Bay do not have an axial plane cleavage. Their S-asymmetry shows that they cannot be attributed to either parasitic \( \text{F}_4 \) fold or \( \text{D}_4 \) drag folds. Kinematically, \( \text{F}_4 \) S-folds in the Minnow Bay area and \( \text{F}_4 \) Z-folds in the "Wolf Bay" shear zone form conjugate pairs, indicating north-south shortening.

In the Minnow Bay area, a shallowly north-dipping ductile shear zone is recognized, within which mylonitic foliation (\( \text{S}_3 \)) is shallowly north-dipping and a stretching lineation (\( \text{L}_3 \)) plunges to the north on the foliation plane. This shear zone separates granite from the mafic complex and thus suggests north side up thrusting (Fig. GS-23-2 and 6). Therefore we suggest that \( \text{D}_4 \) deformation is dominantly north-south compression.

CONCLUDING REMARKS

Preliminary structural analysis of the Edmund Lake - Little Stull Lake area suggests that the supracrustal rocks of the area underwent four generations of deformation. \( \text{D}_1 \) is probably represented by low-angle ductile shear zones in the Hayes River Group, near the contact of the greenstone belt with the granitoid terrane. Isoclinal folds, formed during \( \text{D}_2 \), control the map pattern. \( \text{D}_3 \) dextral transpression is most likely a continuation of \( \text{D}_3 \) with an evolution in kinematic framework from compression-dominated folding to more non-coaxial transpression. \( \text{D}_3 \) modifies \( \text{D}_2 \) structures and gives rise to an overall Z asymmetry of the map pattern of the Little Stull Lake area. \( \text{D}_4 \) structures, recognized only in Minnow Bay and along the south shoreline of Little Stull Lake area, arose from possible north side up thrusting of the granite onto the supracrustal rocks, leading to north-south compression of the area.

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