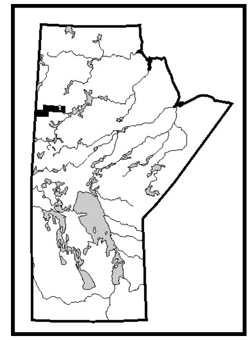
GS-6 Structural analysis of the Lynn Lake greenstone belt, Manitoba (NTS 64C10, 11, 12, 14, 15 and 16) by C.J. Beaumont-Smith and C.O. Böhm



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Summary

Structural analysis of the southwestern and northeastern portions of Lynn Lake greenstone belt has provided further constraints on the macroscopic (regional) structural geometry, and identified several major D_2 shear zones. The macroscopic structural geometry is dominated by horizontal F_2 folds, which produced a shallow-dipping regional enveloping surface. The upright, shallow to subhorizontally plunging F_2 folds may have resulted in fold repetition of supracrustal units across the strike of the greenstone belt. The D_2 dextral transpressional shear zones formed during the late stages of D_2, within rheologically favourable units or along the boundaries of contrasting rheology. Accordingly, the distribution of shear-hosted gold mineralization in the Lynn Lake belt may, in part, be influenced by macroscopic fold repetitions of the volcanic stratigraphy. This is demonstrated in the southern Barrington Lake area, where a major D_2 shear zone has been identified along a basalt-rhyolite contact zone within the regional gold metallotect.

Introduction

Structural analysis of the Lynn Lake greenstone belt attempts to provide a conceptual framework for understanding the tectonometamorphic history of the greenstone belt and gold mineralization hosted in the belt. In both cases, structural analysis has documented the important link between the tectonic assembly of the greenstone belt and the emplacement of shear-hosted gold mineralization. Structural analysis also provides a geological framework for the interpretation of geochemistry and radiogenic isotope data collected during this project (*see* Beaumont-Smith and Rogge, 1999; Beaumont-Smith, 2000; Ma et al., 2000; Ma and Beaumont-Smith, 2001; Beaumont-Smith et al., 2001; Beaumont-Smith and Böhm, 2002, 2003).

Structural analysis of the Lynn Lake greenstone belt, which began in 1999, was initially focused on analysis of the Johnson Shear Zone in the vicinity of the Burnt Timber mine (Beaumont-Smith and Rogge, 1999). The realization that gold mineralization in the central Lynn Lake belt was shear hosted led to expansion of the project to include the entire Lynn Lake belt. This year's report covers fieldwork undertaken in the previously unexamined southwestern and northeastern limits of the greenstone belt.

Regional setting

The Paleoproterozoic Lynn Lake greenstone belt is located within the internal Reindeer Zone (Stauffer, 1984; Lewry and Collerson, 1990) of the Trans-Hudson Orogen. The Lynn Lake belt consists of two east-trending, steeply north-dipping supracrustal belts located along the northern margin of the Kisseynew metasedimentary basin. The supracrustal rocks comprise a diverse tectonostratigraphy of contaminated and juvenile volcanic rocks and epiclastic sedimentary rocks that are collectively assigned to the Wasekwan Group (Bateman, 1945), and younger, synkinematic, fluvial-alluvial molasse-type sedimentary rocks of the Sickle Group (Norman, 1933). The southern Lynn Lake belt is separated from the northern Lynn Lake belt by plutons of the Pool Lake suite (Figure GS-6-1; Manitoba Energy and Mines, 1986).

The northern Lynn Lake belt consists of submarine, tholeiitic, mafic metavolcanic and metavolcaniclastic rocks interpreted to represent an overall north-facing, steeply dipping succession that occupies the upright limb of a major antiformal structure (Gilbert et al., 1980). Included in the north belt is the Agassiz Metallotect (Fedikow and Gale, 1982), a relatively narrow, stratigraphically and structurally distinct unit that occurs along a significant portion of the northern belt (*see* Ma et al., 2000; Ma and Beaumont-Smith, 2001; Park et al., 2002). The Agassiz Metallotect represents a structural-stratigraphic gold-bearing entity comprising an assemblage of ultramafic flows (picrite), banded oxide-facies iron formation and associated exhalative and epiclastic sedimentary rocks that locally is the locus of regional deformation. The Agassiz Metallotect probably formed during rifting of the northern belt, and was subsequently exploited by regional deformation to produce an important tectonostratigraphic gold metallotect.

The southern supracrustal belt consists largely of submarine tholeiitic to calcalkaline metavolcanic and metavolcaniclastic rocks, and minor amounts of mid-ocean ridge basalt (MORB). The southern belt comprises a collage of older

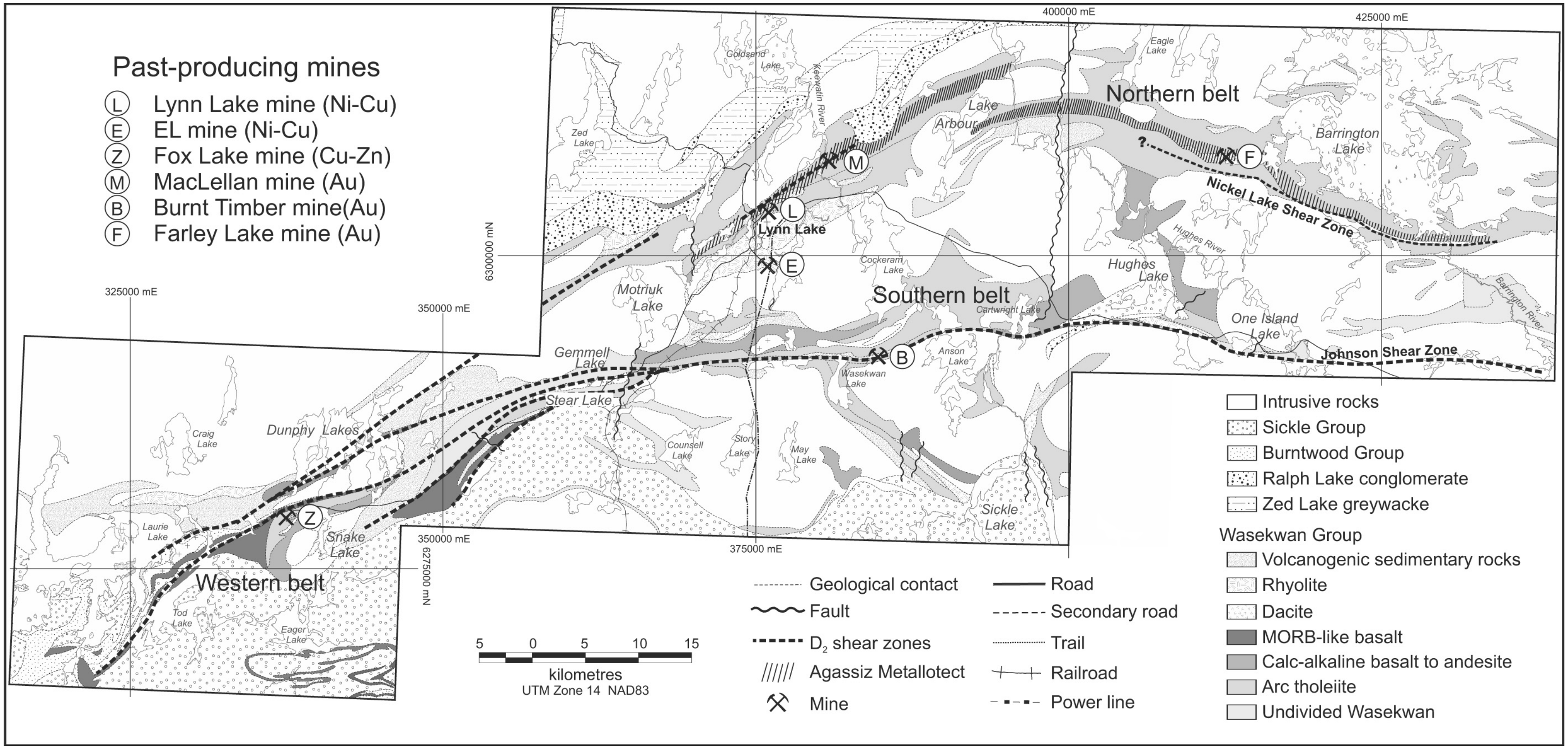


Figure GS-6-1: *General geology of the Lynn Lake greenstone belt.*

(ca. 1890 Ma) contaminated- and younger (ca. 1855 Ma) juvenile-arc volcanic rocks, as well as mid-ocean ridge basalt (MORB) of uncertain age (Zwanzig et al., 1999; Beaumont-Smith and Böhm, 2003). The MORB volcanic rocks are generally restricted to the western portion of the belt, west of Dunphy Lakes, where they are structurally juxtaposed with contaminated arc-tholeiite basalt. This juxtaposition reflects the intersection of the Granville Deformation Zone, and the MORB volcanic rocks that coincide with the deformation zone, with the contaminated-arc volcanic rocks of the Lynn Lake belt (White et al., 2000; Zwanzig, 2000). The southern belt has been interpreted as an overturned homoclinal volcanic succession, which represents the overturned limb of the major antiformal structure responsible for the distribution of the northern and southern supracrustal belts (Gilbert et al., 1980). Structural analysis of the Lynn Lake belt demonstrates that the belt is highly transposed (Beaumont-Smith and Rogge, 1999; Beaumont-Smith and Böhm, 2002), and the difference in the geochemistry of the northern and southern belts (Zwanzig et al., 1999) suggests a more complex deformational geometry.

Both southern and northern belts are unconformably overlain by clastic successions. To the south, the southern belt is structurally underlain by unconformably overlying (i.e., inverted) fluvial-alluvial conglomerate and arkosic sedimentary rocks of the Sickle Group (Norman, 1933). The Sickle Group also unconformably overlies the Pool Lake intrusive suite, and the basal conglomerate is characterized by a high proportion of proximally derived plutonic clasts. The tectonic juxtaposition of the volcanic rocks in the northern and southern belts occurred prior to emplacement of the Pool Lake suite and deposition of the Sickle Group. The age of the Sickle Group has not been determined directly, but it is intruded by the ca. 1830 Ma (post-Sickle) suite of plutons. The composition, stratigraphic position and contact relations of the Sickle Group correlate well with the 1850–1840 Ma MacLennan Group in the La Ronge greenstone belt in Saskatchewan (Ansdell et al., 1999).

The northern belt is unconformably overlain to the north by marine conglomerate and turbiditic metasedimentary rocks, known as the Ralph Lake conglomerate and Zed Lake greywacke, respectively (Gilbert et al., 1980). This clastic succession is largely derived from the supracrustal Wasekwan Group and older plutonic rocks, with the majority of the detrital zircons returning Wasekwan (ca. 1890 Ma) ages (Rayner, pers. comm., 2002).

The supracrustal rocks of the Lynn Lake belt are intruded by at least three suites of plutonic rocks. The oldest intrusive rocks are gabbroic to granodioritic plutons that range in age from ca. 1876 to 1871 Ma (Baldwin et al., 1987; Turek et al., 2000). This older suite, together with a second suite of plutons ranging from ca. 1857 Ma (Machado, unpublished data, 2000) to ca. 1847 Ma (Beaumont-Smith and Böhm, 2003), form the Pool Lake intrusive suite (Manitoba Energy and Mines, 1986). The youngest suite of plutons ranges from ca. 1832 Ma (Turek et al., 2000) to ca. 1820 Ma (Beaumont-Smith and Böhm, 2002). The Pool Lake suite was emplaced into the greenstone belt prior to the deposition of the synkinematic Sickle Group, whereas the ca. 1830 Ma plutons (the post-Sickle plutons of Milligan, 1960) intrude all supracrustal rocks in the Lynn lake belt, including the Sickle Group. The apparent three-fold age distribution of magmatism in the Lynn Lake belt appears to be similar to the early, middle and late successor-arc plutons identified in the Flin Flon Belt (Whalen et al., 1999), thereby suggesting a similar complex magmatic evolution in the Lynn Lake greenstone belt.

Structural geology

The deformational history of the Lynn Lake greenstone belt comprises six regionally penetrative, ductile deformation events (D_1–D_6; *see* Beaumont-Smith and Rogge, 1999; Beaumont-Smith and Böhm, 2002). The earliest deformation (D_1) assembled the complex volcanic tectonostratigraphy that characterizes the greenstone belt. Structures associated with this deformation have been significantly obscured by intense transposition associated with the D_2 deformation. The overprinting D_2 deformation produced horizontal, asymmetric, tight to isoclinal F_2 folds and a penetrative, differentiated S_2 foliation throughout the greenstone belt that postdate the intrusion of the youngest plutons and deposition of the Sickle Group. The overall asymmetry of F_2 folding is Z-asymmetric throughout the belt. The shallow F_2 plunge in areas of lower D_2 strain suggests the D_1 structural geometry was characterized by shallow dips, which were steepened to subvertical as a result of tight to isoclinal F_2 folding. Locally, the plunge of F_2 steepens, corresponding to the development of D_2 shear zones throughout the greenstone belt during the late stages of D_2, which reflects an evolution from fold-dominated deformation during the early stages of D_2 to dextral shear zone development during the later stages of the deformation.

The model for shear zone development involves the initial development of D_2 shear zones on the Z-asymmetric macroscopic F_2 fold limbs, which subsequently coalesced into broad, regional-scale shear zones with increased strain, generally exploiting rheological boundaries (Figure GS-6-2). As a result of D_2 evolution from F_2 folds to shear zones, the D_2 low-strain zones represent the short limbs of F_2 folds and are therefore characterized by S-asymmetric F_2 folds. The D_2 shear zones are characterized by dextral transcurrent shear fabrics and steeply plunging, generally down-dip stretching

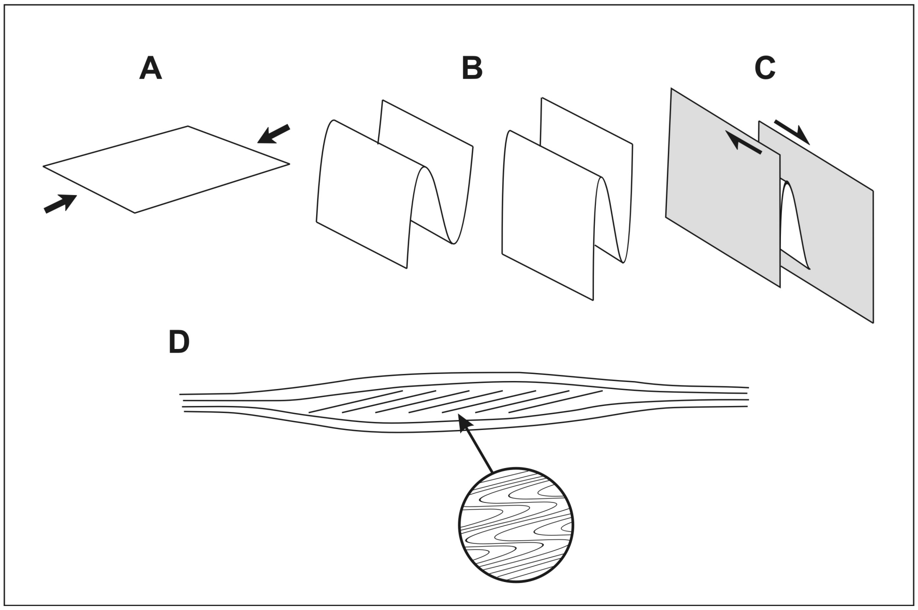


***Figure GS-6-2:** Structural model for the development of D_2 dextral transpressional shear zones: **A)** Initial flat-lying D_1 layering; **B)** tightening horizontal F_2 folding; **C)** late-stage D_2 shear zone development (shaded) along F_2 fold limbs; and **D)** preservation of S-asymmetric F_2 fold limb in low-strain 'fold packet' structural geometry.*

lineations. This is consistent with their development in response to dextral transpression (Lin et al., 1998).

The regional nature of D_2 shear zone development is a highly favourable indication of the exploration potential of the Lynn Lake belt. The majority of known gold deposits are hosted by, or demonstrate a close spatial association with, the D_2 shear zones (Beaumont-Smith and Rogge, 1999; Beaumont-Smith, 2000; Beaumont-Smith and Edwards, 2000; Jones et al., 2000; Ma et al., 2000; Ma and Beaumont-Smith, 2001; Park et al., 2002; Beaumont-Smith and Böhm, 2002, 2003). The gold mineralization is hosted by silica-carbonate-sulphide alteration zones within the shear zones. In the southern belt, gold mineralization is hosted by the Johnson Shear Zone (Bateman, 1945), which is located along the south margin of the southern greenstone belt. The Johnson Shear Zone (JSZ) has been delineated eastward to the Adams Lake area and westward to the Fox mine area (Beaumont-Smith et al., 2001; Beaumont-Smith and Böhm, 2002). Similarly, D_2 shear was an important process in the development of the Agassiz Metallotect in the northern belt. Recognition of D_2 shear zones in both northern and southern belts further demonstrates the regionally pervasive nature of D_2 shear zone development.

Subsequent deformations have had little macroscopic effect on D_1-D_2 structural geometry, or the distribution of gold mineralization. Fabric elements that make up the D_3 and D_4 deformations include tight S- and Z-asymmetric chevron folds and associated crenulation cleavage, respectively. The D_3 fabrics trend northwest, whereas D_4 fabrics trend northeast. Although mesoscopic fabric elements for both deformations are regionally penetrative (pervasive), the deformations have not significantly reoriented the regional D_2 structural trend. Open, kilometre-scale folds of the regional east-west D_2 structural trend are the result of D_5 deformation. Mesoscopic fabrics associated with this deformation include F_5 open conjugate folds, kink bands and open crenulations. A north-trending, spaced S_5 fracture cleavage is also common. These structures are penetrative at regional scale but not necessarily developed in every outcrop.

The final deformation (D_6) involves the brittle-ductile reactivation of D_2 shear zones, characterized by the development of pseudotachylite zones that overprint all other fabric elements. The reactivation is dominated by sinistral transcurrent movement within narrow zones in the D_2 shear zones. The T_1 fault in the footwall of the Burnt Timber gold deposit is a D_6 structure (*see* Peck and Eastwood, 1997; Peck et al., 1998).

Regional metamorphism

Metamorphism in the Lynn Lake greenstone belt increases from upper greenschist facies in the eastern portion of the belt to upper amphibolite facies in the far western portion. The tectonometamorphic history records two metamorphic events. The earliest metamorphism (M_1) is largely a contact-metamorphic event associated with the emplacement of several phases of mafic to felsic plutonic rocks prior to the main period of deformation (D_2) that transposed the greenstone belt into its generally east-west structural trend. The main regional metamorphic event (M_2) postdates D_2, resulting in the recrystallization of the regional transposition fabrics throughout the belt. The M_2 metamorphism was associated with medium to high temperatures and moderate to low pressures, typical of post-accretion sublithospheric delamination or slab roll-back, as opposed to the regional contact metamorphism associated with the widespread felsic magmatism.

Results from the 2004 field season

Fieldwork during the 2004 field season focused on structural analysis of the Laurie and Tod lakes area, west of the Fox Mine in the southern greenstone belt, and the northern greenstone belt from east of Lynn Lake to the southern Barrington Lake area. In both areas, major D_2 shear zones were delineated and constraints placed on the regional structural geometry. In the Laurie-Tod lakes area, the shear zones represent previously identified faults (*see* Gilbert et al., 1980), although timing and kinematics of these structures were previously unknown. In the southern Barrington Lake area, a major D_2 transpressional shear zone has been identified within the Agassiz Metallotect, a finding with important exploration implications due to its location relative to the most significant gold-exploration target in the Lynn Lake belt.

Laurie-Tod lakes structural analysis

Structural analysis in the Laurie-Tod lakes area concentrated on determining the kinematics and deformational history of the previously identified fault zones in this area (Gilbert et al., 1980) and their relationship to the various splays of the Johnson Shear Zone that have been delineated east of the Fox mine (Beaumont-Smith and Böhm, 2002). Two major fault zones were recognized in this area (Gilbert et al., 1980). One fault zone, identified as the Tod Lake Fault (Gilbert et al., 1980), trends southwest from the Fox mine area through Hatchet Lake and continues along the north shore of Tod Lake, producing a pronounced topographic linear. The second fault zone, the Laurie Lake Fault, trends west from the Fox mine area to Laurie Lake, where it follows the southeast shore of the lake west of the Laurie River (Figure GS-6-3).

Overprinting relationships and kinematics are consistent with both fault zones being westerly strike extensions of the Johnson and Pumphouse shear zones (Beaumont-Smith and Böhm, 2002). Both shear zones are overprinted by northeast-trending F_4 folds and have experienced metamorphic recrystallization, consistent with development during D_2. As in the case of D_2 shear zones identified elsewhere in the Lynn Lake belt, the shear zones in the Laurie-Tod lakes area consistently have dextral shear-sense indicators and are found within zones of complex stratigraphy, commonly involving pre–shear zone infolding of Wasekwan and Sickle group rocks. The orientation of the stretching lineation and the nature of the strain within the Tod Lake and Laurie Lake shear zones appear to suggest the two shear zones have slightly different kinematics.

The Laurie Lake Shear Zone is a relatively narrow (less than 50 m) tectonite zone exposed along the Laurie River and southeast shore of Laurie Lake. The shear zone occupies the south limb of a presumed doubly plunging synform. This macroscopic F_2 fold is overturned to the south, resulting in the placement of Wasekwan Group volcanic rocks structurally above younger Sickle Group conglomerate (Figure GS-6-3). The tectonite zone at the core of the shear zone is characterized by intense transposition and the development of S_2 tectonic layering, which was presumably a mylonitic fabric prior to metamorphic recrystallization (Figure GS-6-4). The tectonite zone also contains abundant quartz veining, which is invariably isoclinally folded and boudinaged, producing abundant shear-sense indicators. The style and orientation of F_2 folds associated with this shear zone vary systematically, with F_2 folds on the periphery of the shear zone plunging more steeply than those within the high-strain core of the shear zone. This shallowing of the F_2 fold axes also corresponds to a similar change in the orientation of the stretching lineation, which, unlike the D_2 shear zones in the eastern portion of the southern Lynn Lake belt, is strongly constrictional, producing prolate lineations, as opposed to the strong flattening component, which produced the strongly oblate stretching lineations common in transpressional shear zones observed to the east. The strongly constrictional nature of the stretching lineation appears to influence the orientation of overprinting F_4 fold axes, which plunge more shallowly within the shear zone than they do outside the shear zone. There is little evidence of D_4 reactivation of the shear zone to account for the change in plunge, as there is no significant deviation in the very penetrative S_4 crenulation cleavage that overprints S_2 within the shear zone.

The Laurie Lake Shear Zone is also characterized by a very complex internal stratigraphy involving Sickle Group conglomerate, Wasekwan Group sedimentary rocks, felsic and mafic volcanic rocks, and ultramafic actinolite and anthophyllite-chlorite schist of uncertain, but possibly volcanic, protolith. Mafic volcanic rocks dominate in the form of mafic tectonite, and the shear zone can generally be traced by a pronounced rusty-weathering zone caused by finely

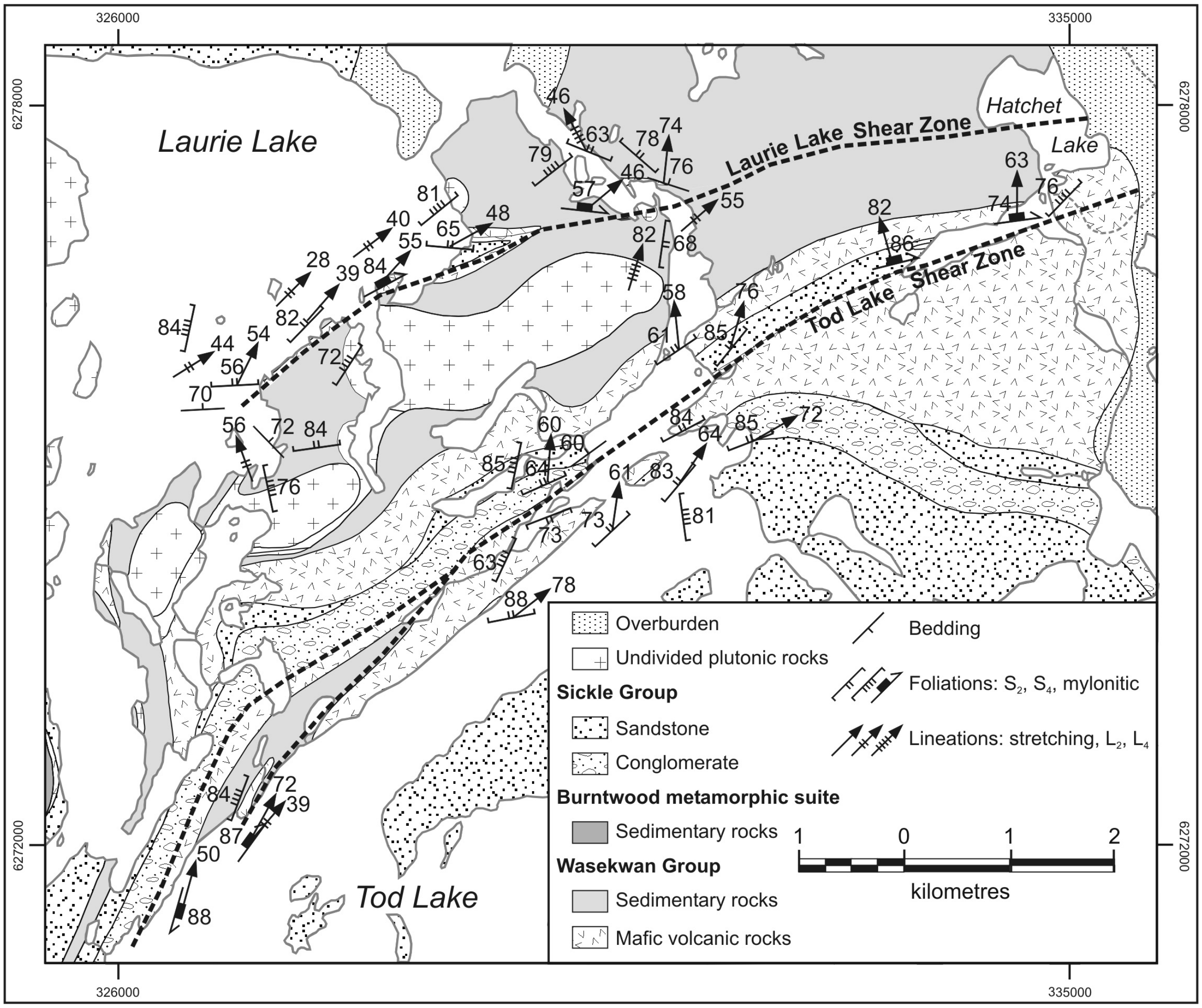


Figure GS-6-3: *Structural geology of the Laurie-Tod lakes area.*

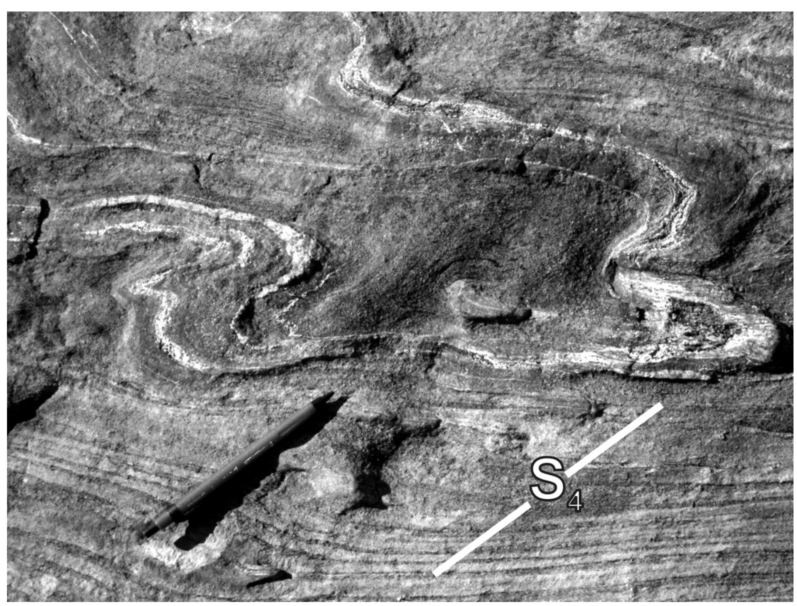
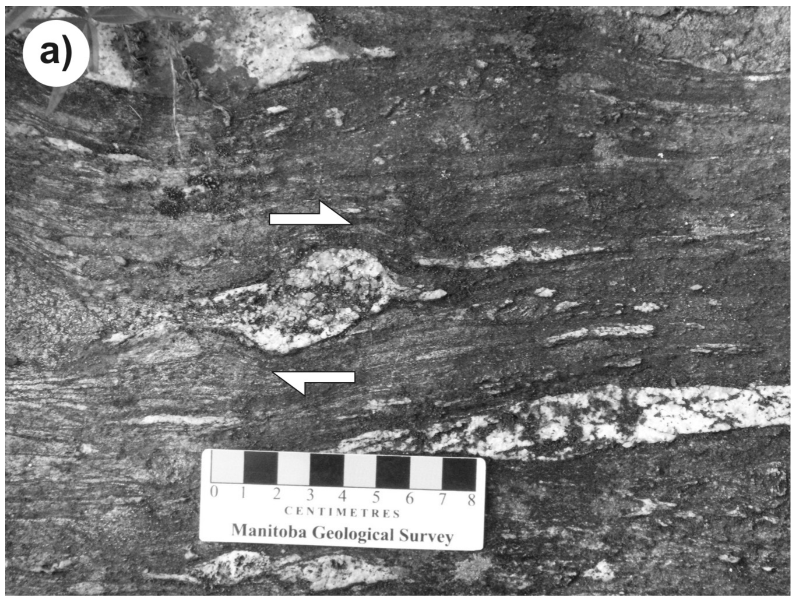


Figure GS-6-4: *Isoclinal F_2 folds overprinted by weakly differentiated S_4 crenulation cleavage, Laurie Lake Shear Zone.*

disseminated pyrrhotite. This alteration, which was previously the focus of base-metal exploration, is restricted to the shear zone and may represent a favourable horizon for gold mineralization.

The most significant shear zone in the western portion of the Lynn lake belt is the Tod Lake Shear Zone (TLSZ). The TLSZ represents an approximately 100 m wide zone of tectonite and mylonite that characteristically has a complex internal stratigraphy involving Wasekwan Group mafic and felsic volcanic rocks, plutonic rocks and Sickle Group conglomerate. The shear zone is characterized by dextral transcurrent shear-sense indicators and steeply plunging, generally down-dip stretching lineations (Figure GS-6-5). These kinematics are consistent with other shear zones in the Lynn Lake belt and are interpreted to result from dextral transpression during the late stages of D_2. The Tod Lake Shear Zone is located along the contact between infolded Sickle Group conglomerate and Wasekwan Group volcanic rocks. A pronounced D_2 strain gradient is present in the Sickle conglomerate, with a rapid decrease in D_2 strain to the north. This is evident along the northern contact of the Sickle conglomerate, where the degree of D_2 transposition lessens



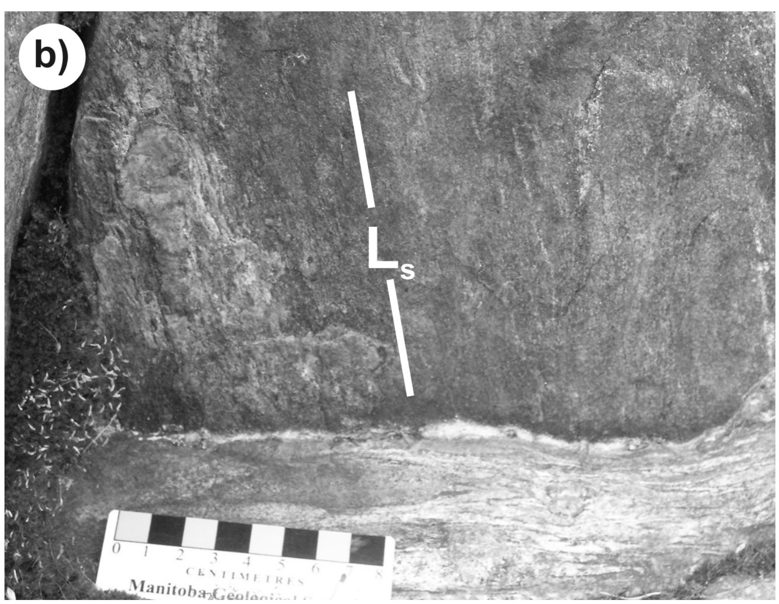


***Figure GS-6-5:** Kinematic indicators in the Tod Lake Shear Zone: **a)** dextral transcurrent shear fabrics; and **b)** steeply plunging oblate stretching lineation defined by deformed Sickle Group conglomerate clasts.*

and S_2 becomes oblique to the bedding in the conglomerate. There is also a commensurate decrease in the aspect ratios of the conglomerate cobbles. The localization of D_2 shear strain along one contact and the long strike length of the Sickle Group outliers further support the interpretation of macroscopic horizontal F_2 folding followed by shear zone development (see Beaumont-Smith and Böhm, 2002).

A third high-strain zone was identified south of the Tod Lake Shear Zone, along the contact of the Wasekwan and Sickle groups. This high-strain zone is the result of the concentration of regional D_2 deformation along a major rheological contact, a common feature in the Lynn Lake belt (Beaumont-Smith and Rogge, 1999; Beaumont-Smith, 2000; Beaumont-Smith and Böhm, 2002, 2003). The distribution of Sickle Group conglomerate and sandstone outlines a horizontally plunging synform. Parallelism between bedding and S_2, and the presence of abundant rootless F_2 folds within the sandstone unit demonstrate the high degree of transposition along the contact (Figure GS-6-6).

Northern belt structural analysis

The structural analysis of the northern belt represents a continuation of the fieldwork started in 2002 (*see* Park et al., 2002; Beaumont-Smith and Böhm, 2003), and was focused on determining the structural geometry of the Agassiz Metallotect east of the MacLellan mine area. Fieldwork in the northern belt undertaken in 2004 concentrated on extending the mapping to the east to Barrington Lake. The detail of mapping is seriously compromised in the area between the MacLellan mine and the Farley Lake mine due to very poor outcrop exposure. Nevertheless, available outcrop from immediately east of the MacLellan mine to the eastern end of Arbour Lake was sufficient to determine the macroscopic structural geometry in this area. Unfortunately, the level of outcrop exposure is insufficient for delineation of the extent of ultramafic (picrite) volcanic rocks.

The structural geometry west of the MacLellan mine area is characterized by shallowly plunging F_2 fold axes (Figure GS-6-7), which steepen to subvertical within D_2 shear zones (Park et al., 2002). This geometry persists west of the MacLellan mine, although F_4 refolding produces increased F_2 plunge variability. The intensity of F_4 development, and its resultant reorientation of older fabric elements, define a macroscopic F_4 antiformal hinge zone that trends south-southwest from the MacLellan mine area. This is evident at map scale by the discontinuous distribution of Wasekwan Group sedimentary rocks south of the MacLellan mine and the transposition of the macroscopic F_2 synform hinge that controls the distribution of Ralph Lake conglomerate northeast of the MacLellan mine (Figure GS-6-8). The absence of the sedimentary rocks reflects the intersection of a major F_2 synformal hinge, which these rocks occupy, and the erosion surface across the F_4 hinge.

Farther east in the Arbour Lake area and, in fact, throughout the northern greenstone belt, the basic structural geometry of horizontal F_2 folds is maintained. The area north of Arbour Lake is underlain by D_2 lower strain domains dominated by S-asymmetric F_2 folds characterized by oblique bedding-S_2 relationships and relatively widespread preservation of S_1. The relationship between lower D_2 strains and S-asymmetric F_2 folding seems to confirm the notion that, at a macroscopic scale, D_2 structural development represents large-scale fold packets, with the D_2 low-strain

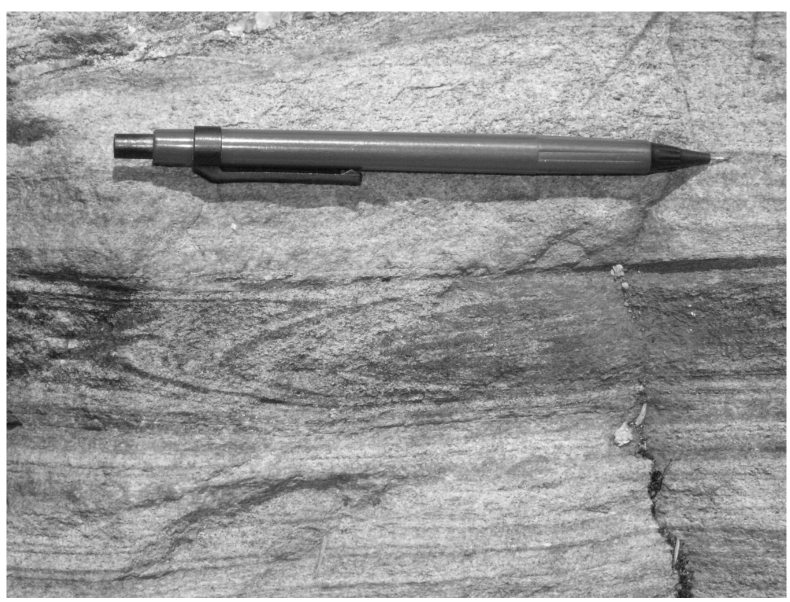


***Figure GS-6-6:** Rootless isoclinal folds indicating the transposition of Sickle Group sandstone, Tod Lake.*

***Figure GS-6-7:** Horizontal F_2 fold developed in highly deformed gabbro, south of Barrington Lake.*

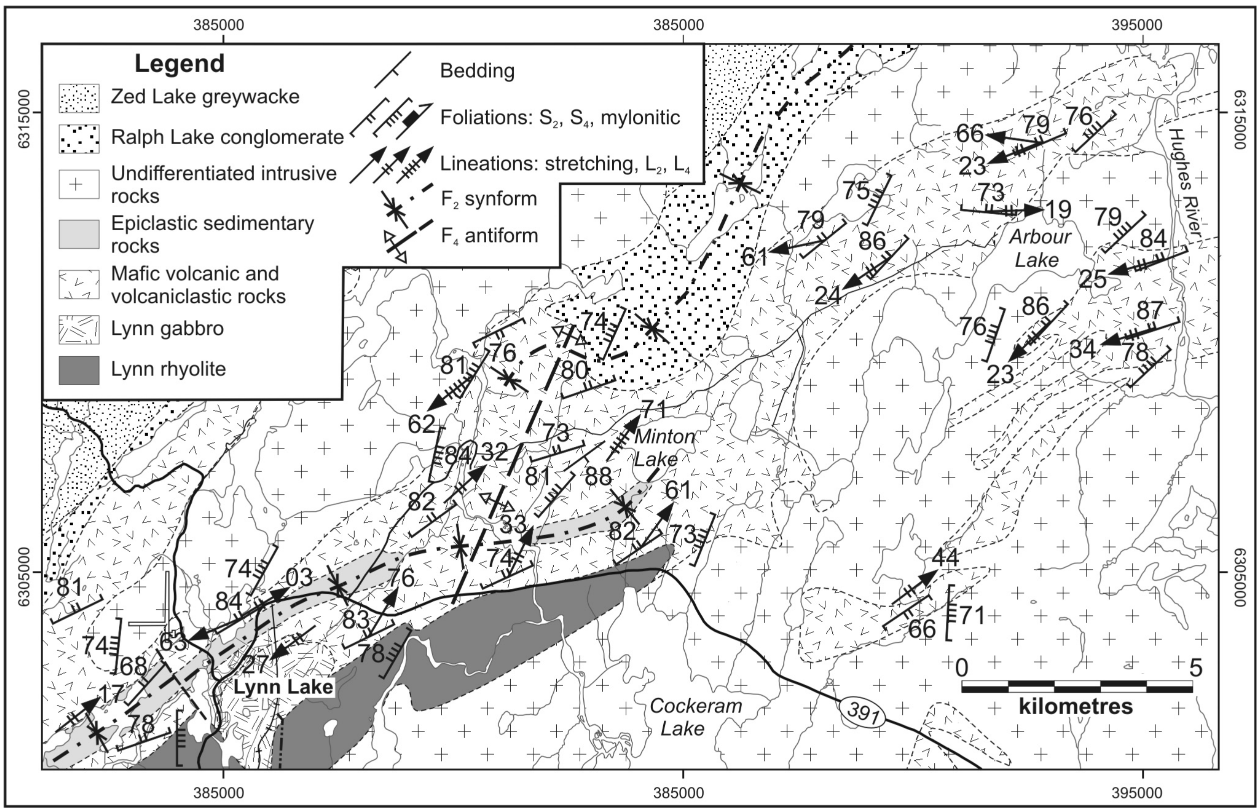


***Figure GS-6-8:** Structural geology of the Arbour Lake area.*

domains representing the short S-asymmetric limbs of transposed Z-asymmetric F_2 folds.

The area along the southern shore of Barrington Lake provided the most significant findings of this summer's fieldwork with the discovery and delineation of a major D_2 shear zone. Tentatively named the Nickel Lake Shear Zone (NLSZ), this shear consists of a 100–150 m wide zone of mylonite, ultramylonite and mafic tectonite (Figure GS-6-9). The shear zone is located along the southern contact between a thin porphyritic rhyolite unit and mafic volcanic rocks, and can be delineated along the entire length of the rhyolite unit. This represents a minimum strike length of 10 km, as the rhyolite is well exposed and forms a prominent topographic ridge. Further delineation of the NLSZ, particularly to

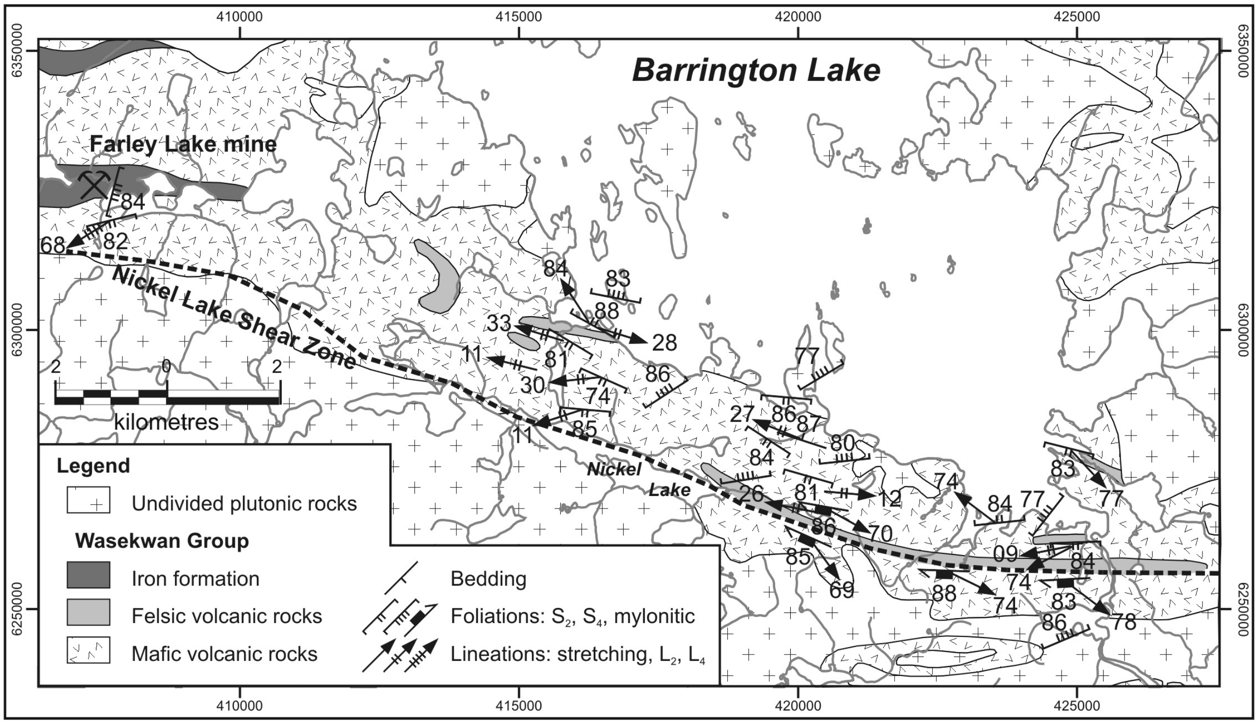


Figure GS-6-9: *Structural geology of the Nickel Lake Shear Zone, south of Barrington Lake.*

the west, is hampered by poor outcrop exposure, but it coincides with a strong topographic linear that extends west from the west end of Nickel Lake to the Farley Lake area, where the shear zone (as a topographic linear) is developed along the supracrustal-intrusive contact. The Farley Lake mine area is extremely poorly exposed, but a single outcrop of highly deformed mafic tectonite along the intrusive-supracrustal contact south of the mine supports the correlation between the topography and the location of the shear zone.

The kinematics and timing of the NLSZ are consistent with regional shear zone development identified throughout the Lynn Lake greenstone belt (Beaumont-Smith and Rogge, 1999; Beaumont-Smith and Böhm, 2003, 2003). The kinematics of the NLSZ consist of dextral transcurrent shear-sense indicators and steeply plunging stretching lineations (Figure GS-6-10). The structural geometry of the surrounding supracrustal rocks is also consistent with the geometry elsewhere in the northern and southern belts. The volcanic stratigraphy dips steeply north, the result of tight to isoclinal F_2 folds. The volcanic rocks are generally transposed parallel to the S_2 regional fabric, and local D_2 low-strain domains are characterized by S-asymmetric F_2 folds. The development of a major dextral transpressional shear zone in the eastern portion of the northern belt, within a macroscopic geometry dominated by horizontal F_2 folding, demonstrates the existence of a relatively consistent D_2 deformational history throughout the Lynn Lake belt.

Discussion

The fieldwork conducted in the Lynn Lake greenstone belt in 2004 represents the conclusion of the regional-scale structural analysis of the Lynn Lake belt. In the southeastern and northwestern extremities of the Lynn Lake belt, this structural analysis demonstrates that the deformation history is remarkably consistent through the belt. The macroscopic geometric model for the Lynn Lake belt (Beaumont-Smith and Böhm, 2003, 2003), a structural geometry dominated by horizontal F_2 folding of a shallow D_1 enveloping surface followed by dextral transpressional shear zone development, remains the best explanation of the observed deformation structures. One important feature of D_2 is that the short limbs of F_2 folds preserve low-strain domains characterized by S-asymmetric F_2 folds. An important implication of this geometry is that it produces the impression of a consistent stratigraphic younging direction. The transposition of the long Z-asymmetric F_2 fold limbs largely precludes the determination of younging, and therefore leads to an erroneous interpretation of a homoclinal regional geometry.

Structural analysis in the Laurie and Tod lakes area succeeded in confirming that major faults identified earlier in this area represent westerly strike extensions of the various splays of the Johnson Shear Zone. What remains

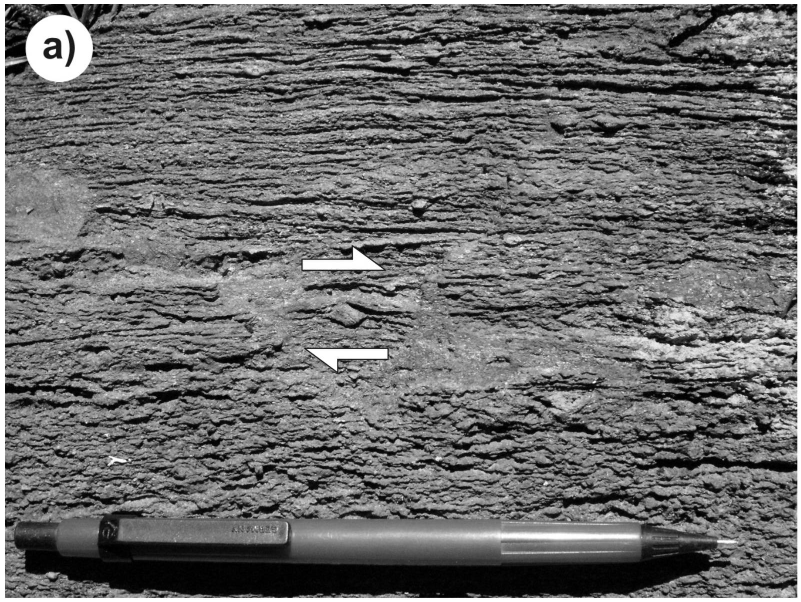


***Figure GS-6-10:** Kinematic indicators in the Nickel Lake Shear Zone: **a)** dextral transcurrent porphyroclast systems; and **b)** down-dip stretching lineation on C-plane.*

unclear is whether the Tod Lake and Laurie Lake shear zones represent two portions of an anastomosing macroscopic shear zone system, or whether these two shear zones overprint one another (*see* Rogge et al., 2003). Unfortunately the amount of outcrop exposure immediately west of the Fox mine is insufficient to delineate with certainty the relationships between the westernmost Johnson and Pumphouse shear zones and the Tod Lake and Laurie Lake shear zones. Based on kinematics, the Pumphouse Shear Zone, with its moderately plunging stretching lineations, is similar to the Laurie Lake Shear Zone (*see* Beaumont-Smith and Böhm, 2002). Similarly, the Johnson Shear Zone along the south shore of Dunphy Lakes has typical dextral transpressional kinematics that are similar to those of the Tod Lake Shear Zone. Although both shear zone systems (Pumphouse-Laurie Shear Zone and Johnson-Tod Shear Zone) share a late D_2 timing, this interpretation suggests that the two systems most likely do not intersect west of the Fox mine, as postulated by Rogge et al. (2003).

The delineation of a major dextral transpressional D_2 shear zone in the Barrington Lake area clearly demonstrates that D_2 shear zone development is a regional feature in the Lynn Lake belt. The location of the NLSZ along a major rheological boundary confirms the important role that stratigraphy played in the development of shear zones during the late stages of D_2.

Economic considerations

Two significant findings of the most recent structural analysis in the Lynn lake greenstone belt are that 1) the regional structural geometry may result in the replication of rheologically favourable supracrustal stratigraphy, such as the Agassiz Metallotect; and 2) newly recognized major shear zones have been delineated in the northern and southern belts. These include the westerly strike extensions of the Johnson Shear Zone in the Laurie and Tod lakes area and a major D_2 transpressional shear zone in the eastern portion of the northern greenstone belt.

The regional structural geometry in the Lynn Lake belt indicates that significant fold repetitions of the supracrustal stratigraphy should be relatively widespread. The demonstration that D_2 shear zones preferentially develop along rheological boundaries during the later stage of D_2, essentially overprinting the fold repetition of rheologically favourable units within the volcanic stratigraphy that represent horizons with a high potential for the development of D_2 shear zones, strongly suggests that there may be a significant amount of unexplored, fold-repeated stratigraphy in the Lynn Lake belt. This is certainly the case east of the MacLellan mine, where the eastward delineation of the Agassiz Metallotect is hampered by very poor outcrop exposure and the distribution of the Agassiz Metallotect is poorly delineated.

Identification of the NLSZ represents a significant advancement in the metallogenic understanding of the Agassiz Metallotect. The location of the NLSZ coincides with an area that has been the focus of a significant amount of gold exploration, largely due to the presence of a large number of electromagnetic conductors. The presence of a major shear zone reaffirms the critical deformational component of the Agassiz Metallotect. The location of the NLSZ within the portion of the Lynn Lake belt with the most favourable metamorphic grade for gold mineralization (i.e., greenschist facies), together with a large number of electromagnetic conductors, represents an inviting gold-exploration target.

From a gold-exploration standpoint, the assumed westerly strike extension of the Nickel Lake Shear Zone in the Farley Lake area places the gold deposits in the hangingwall of the shear zone. The Farley Lake gold deposits are unique compared to the other gold deposits in the Lynn Lake belt, in that their style and timing of mineralization emplacement differ significantly. The gold mineralization comprises flat-lying, open-vein–filling quartz-carbonate-sulphide veins and iron formation sulphidization envelopes that overprint F_5 folds (Beaumont-Smith et al., 2000). The mineralized veins are generally very high grade (up to 100 g/t Au), and the presence of abundant open space within the veins suggests that they may represent the products of remobilization from a primary depositional site. Although highly speculative, the application of the regional syn-D_2, shear zone–hosted gold-mineralization metallogenic model (see Beaumont-Smith and Böhm, 2002) suggests that the NLSZ is a potential site of primary gold mineralization, from which the Farley Lake mineralization was mobilized. The structural environment in the Farley Lake area is similar to the eastern portion of the Johnson Shear Zone, where the concentration of regional D_2 deformation along the southern supracrustal-intrusive boundary results in the development of a major D_2 dextral transpressional shear zone that hosts a number of gold deposits.

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