GS-13 STRATIGRAPHIC AND STRUCTURAL MAPPING OF THE AGASSIZ METALLOTECT NEAR LYNN LAKE, LYNN LAKE GREENSTONE BELT (PARTS OF NTS 64C/14, /15)

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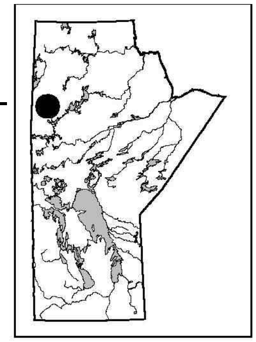

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SUMMARY

Detailed geological mapping of the western portion of the Agassiz Metallotect near Lynn Lake has documented a proximal to distal facies change, from east to west, that is reflected in the stratigraphic constituents of the metallotect and their immediate host rocks. The proximal facies of the metallotect is represented by a relatively thick (30–300 m) succession of high–Mg-Ni-Cr basalt (picrite), greywacke, siltstone and oxide-facies iron-formation that is associated with the MacLellan gold deposit. To the west, between Francis Lake and Sheila Lake, the distal facies of the metallotect is poorly developed, consisting of a thin (<20 m), possibly discontinuous unit of picrite and intercalated sulphidic siltstone within a thick sequence of volcanogenic siltstone, sandstone and fine-grained conglomerate. The hanging wall to the facies consists of a thick sequence of heterolithic basaltic breccia, whereas the structural footwall consists of mafic and felsic volcaniclastic rocks.

Detailed structural mapping of the MacLellan gold deposit and other subeconomic deposits shows that the host rock is strongly sheared and altered, high–Mg-Ni-Cr basalt (picrite). Fabric development within the picrite is interpreted to result from intense D_2 shearing within a regional-scale shear zone that formed as a result of partitioning of regional D_2 deformation into the picrite. The gold mineralization and associated alteration are hosted within the shear zone, and have been intensely deformed. The textural relationships between deformation structures and the ore and gangue mineral assemblages suggest an epigenetic, synshear origin for the gold mineralization in the MacLellan deposit.

INTRODUCTION

The Agassiz Metallotect (Fedikow and Gale, 1982) is characterized by a unique stratigraphy highlighted by high–Mg-Ni-Cr basalt (picrite). These rocks are an important host to gold mineralization in the northern Lynn Lake greenstone belt, including the past-producing MacLellan and Farley Lake mines, the undeveloped Dot Lake and K-Zone deposits, and a number of smaller occurrences (Fedikow, 1986). The metallotect has been the target of gold exploration since the 1950s, and the focus of research regarding its geology, geochemistry and relationship to gold mineralization (Fedikow and Gale, 1982; Fedikow, 1983, 1986, 1992; Ferreira, 1986; Fedikow et al., 1991, 1996; Gagnon, 1991; Samson and Gagnon, 1995; Ferreira and Baldwin, 1997; Peck et al., 1998; Beaumont-Smith et al., 2000; Ma et al., 2000). However, the westward extension of the metallotect and the strike-parallel variations in stratigraphy are poorly understood. In addition, there has been a simmering dispute over the genesis of gold mineralization in the MacLellan deposit, with both syngenetic exhalitive (Fedikow, 1986) and epigenetic (Samson and Gagnon, 1995; Samson et al., 1999) models being proposed.

In order to address these problems, detailed stratigraphic and structural analysis of the Agassiz Metallotect has been undertaken west of, and including, the MacLellan deposit. This report presents the structural and stratigraphic findings from this year's fieldwork.

GEOLOGICAL SETTING

The Lynn Lake greenstone belt consists of two west-trending, mafic volcanic–dominated supracrustal belts, termed the northern and southern belts (Gilbert et al., 1980). The Agassiz Metallotect, as defined by Fedikow and Gale (1982) and Fedikow (1986), is a unique metalliferous entity in the northern Lynn Lake greenstone belt, comprising a distinctive stratigraphic sequence as well as a zone of anomalously high strain. The Agassiz Metallotect is hosted by the Wasekwan Group (Bateman, 1945), which includes the ca. 1910 Ma (Baldwin et al., 1987) metavolcanic and subordinate metasedimentary rocks in the Lynn Lake greenstone belt. In detail, the Wasekwan Group stratigraphy comprises a diverse assemblage of lithological units with highly variable tectonostratigraphic affinities (Zwanzig et al., 1999) that were tectonically assembled prior to, or synchronous with, intrusion of the ca. 1876 Ma Pool Lake plutonic suite (Gilbert et al., 1980; Baldwin et al., 1987). These rocks were subsequently unconformably overlain by coarse alluvial-fluvial clastic sedimentary rocks of the Sickle Group (Norman, 1933). Intense deformation transposed the belt into the present, steeply north-dipping, west-striking attitude.

Overprinting relationships between structural fabric elements define six discrete deformational events (D_1–D_6). The macroscopic distribution of major units in the Lynn Lake belt is controlled mainly by the D_1/D_2 structural geometry. The D_2 deformation is also responsible for the development of ductile shear zones, which are important hosts to gold mineralization in the Lynn Lake belt (Bateman, 1945; Milligan, 1960; Fedikow et al., 1991; Beaumont-Smith and Rogge, 1999; Beaumont-Smith, 2000; Jones et al., 2000; Ma et al., 2000). Overprinting of the D_1/D_2 structural geometry by subsequent deformations

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produced a variety of mesoscopic fabric elements, but these deformations were of insufficient intensity to significantly re-orient the pre-existing geometry.

Peak metamorphism in the Lynn Lake belt ranges, from east to west, from upper greenschist facies to middle amphibolite facies. In the area of the MacLellan deposit, metamorphic mineral assemblages indicate peak metamorphism in the lower amphibolite facies. The timing of metamorphism is relatively late in the deformational history of the area, and postdates penetrative foliations and shear zones formed during D_2 deformation. Accordingly, there is widespread recrystallization of these high-strain fabrics. The metamorphic peak is broadly coeval with northeast-trending chevron folds and crenulation cleavage that are attributed to the D_4 deformation phase.

STRATIGRAPHY OF THE AGASSIZ METALLOTECT

Examination of the Agassiz Metallotect over 65 km of strike length has resulted in the identification of stratigraphic facies changes within the metallotect and changes in the nature of the associated gold mineralization (Fedikow and Gale, 1982; Fedikow, 1983, 1986, 1992; Ferreira, 1986; Fedikow et al., 1991, 1996; Gangon, 1991; Parberry, 1991; Samson and Gagnon, 1995; Peck et al., 1998; Beaumont-Smith et al., 2000; Ma et al., 2000). Detailed geological mapping between the MacLellan deposit and Frances Lake demonstrates that there is a significant facies change from east to west, toward the western extent of the metallotect (Fig. GS-13-1). This change may represent an important control on the development of gold mineralization in the western portion of the metallotect.

Agassiz Metallotect Stratigraphy

The Agassiz Metallotect in the MacLellan mine area comprises a typical stratigraphy of picrite (high–Mg-Ni-Cr basalt), biotitic greywacke, sulphidic siltstone and oxide-facies iron-formation (Fedikow and Gale, 1982). The stratigraphic thickness of the metallotect is up to 500 m in the Farley Lake area (Peck et al., 1998; Beaumont-Smith et al., 2000) and is approximately 100 m in the MacLellan mine area. Gold mineralization that makes up the MacLellan deposit is associated with a thick unit (>30 m) of highly deformed and altered picrite. Unaltered, weakly deformed picrite is bright olive green and contains obvious pillow structures. These rocks are composed of coarse-grained actinolite (up to 5 mm) in a fine- to coarse-grained chlorite groundmass. The alteration is generally characterized by intense biotitization and silicification of the picrite, with the gold mineralization associated with the introduction of finely disseminated pyrite and lesser amounts of other sulphide minerals (Fedikow, 1986; Gagnon, 1991).

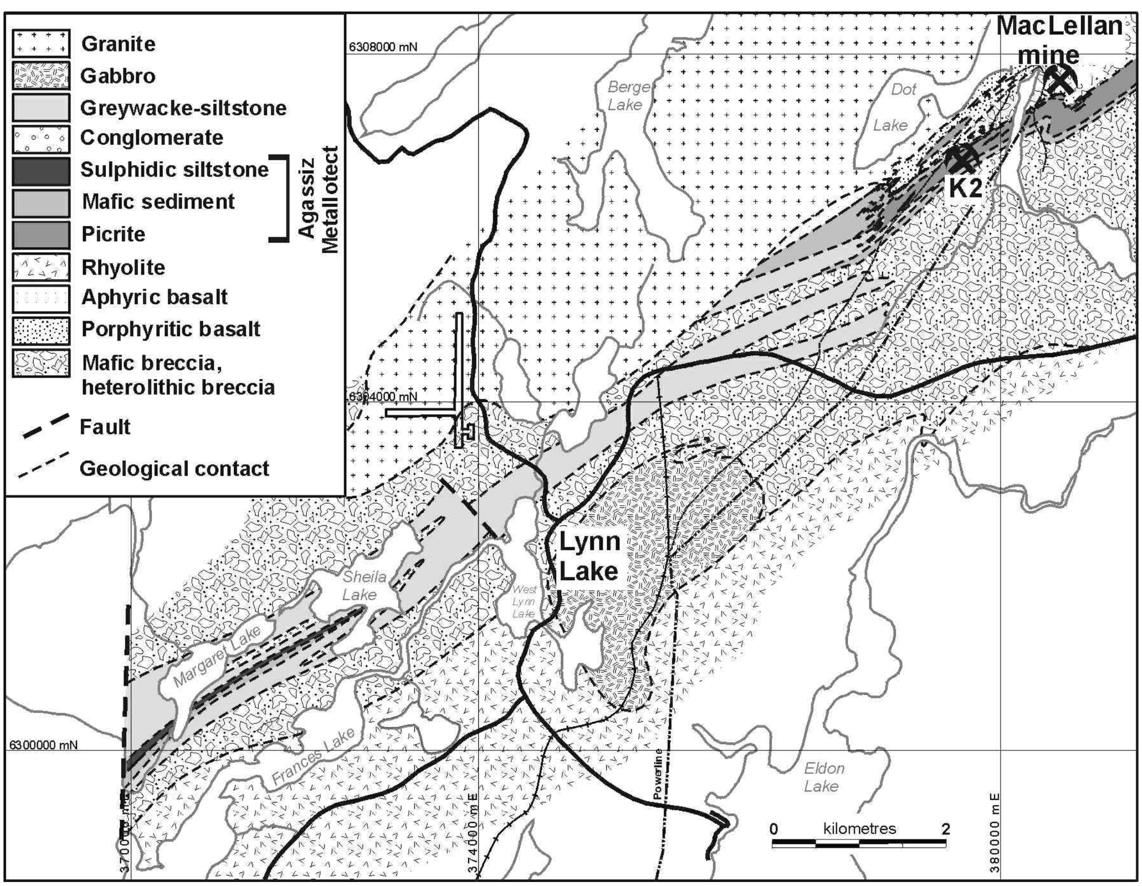

Figure GS-13-1: Geology of the MacLellan mine-Frances Lake area.

In the MacLellan mine area, the hanging wall to the metallotect consists of high-Al, amygdaloidal, plagioclase- and/or hornblende-porphyritic to aphyric basalt. Texturally, this unit is dominated by thick volcaniclastic breccia, composed of coarse (up to 20 cm), subangular to rounded basalt clasts supported by a silty to locally plagioclase-porphyritic matrix. The breccia is weakly heterolithic, with subordinate felsic volcanic and possibly sedimentary clasts. Interlayered with the breccia are thin mafic siltstone units. This unit is interpreted as a series of proximal debris flows in the immediate mine hanging wall, with finer grained breccia units west of the mine representing more distal facies. The footwall to the metallotect in the MacLellan mine area is poorly exposed, but appears highly variable. In the immediate mine area, the footwall consists of fragmental, porphyritic to aphyric basalt. West of the Keewatin River, the exposed footwall consists of felsic volcaniclastic rocks in the form of fine-grained breccia and laminated, coarse pebbly sandstone.

The stratigraphy of the metallotect west of Dot Lake changes, both in terms of the stratigraphic units constituting the metallotect and those making up the immediate hanging wall and footwall rocks. The metallotect in the area between Frances Lake and Sheila Lake is recognized by the presence of three widely spaced outcrops of olive green picrite, and is likely 5 to 20 m in thickness. The picrite is composed of fine-grained chlorite, hornblende, plagioclase and calcite, and is strongly foliated and crenulated. Chemical analyses of the picrite in this area (Ferreira, 1986) demonstrate that it is similar in composition to picrite in the MacLellan mine area, but has slightly lower total iron and slightly higher silica and total alkali content. There is no significant alteration or sulphide mineralization, and the typical metallotect stratigraphy is absent. In the Sheila Lake–Frances Lake area, the picrite is associated with a thick sulphidic siltstone unit but lacks the oxide-facies iron-formation that forms an important component of the metallotect stratigraphy in the MacLellan mine area. The immediate host to the metallotect is a thick sequence of Wasekwan Group conglomerate and siltstone. The metallotect appears to be located along a transition zone between a sequence of psammite, coarse pebbly psammite and fine-grained conglomerate to the south, and fine-grained siltstone, garnetiferous siltstone and psammite to the north.

The thick Wasekwan Group sedimentary unit that hosts the metallotect in the Sheila Lake–Frances Lake area is overlain by a thick sequence of mafic debris flows similar in appearance to those overlying the metallotect in the MacLellan mine area. Rocks exposed south of the sedimentary rocks comprise a diverse stratigraphy of amygdaloidal, plagioclase-porphyritic to aphyric basalt and felsic volcaniclastic rocks. The internal stratigraphy of this sequence is not well determined but, based on the intensity of foliation development in these rocks (as elsewhere), the stratigraphic complexity may result from considerable fold intercalation and the attenuation of units along strike. These rocks are best described as S-tectonites, owing to the development of a penetrative differentiated layering. The basalt is characterized by fine, millimetre-scale, alternating hornblende- and plagioclase-rich layers, whereas the felsic volcaniclastic rocks have similar-scale alternating quartzose and biotite-hornblende–rich layers that anastomose around strongly flattened felsic clasts. The differentiated layering developed in these rocks represents the regional foliation (S_2) and is the product of amphibolite-facies metamorphic recrystallization of an original crenulation cleavage or differentiated composite foliation (Beaumont-Smith and Rogge, 1999).

Comparison of the metallotect stratigraphy and host stratigraphy between the MacLellan mine area and the Sheila Lake–Frances Lake area poses several important questions. Of primary concern is whether the sequence of picrite and sulphidic siltstone in the western portion of the area constitutes the Agassiz Metallotect. If so, and the westward change in metallotect stratigraphy represents a more distal facies, does the metallotect include the entire sedimentary succession in the Sheila Lake–Frances Lake area? It could be argued that the heterolithic mafic breccia (debris flows) overlying the sedimentary succession represents the metallotect hanging wall, as is the case in the MacLellan mine. Similarly, the sequence of mafic and felsic metavolcaniclastic rocks exposed south of the sedimentary succession may represent the metallotect structural footwall. These rocks are similar to those underlying the metallotect in the MacLellan mine–Dot Lake area. Furthermore, the stratigraphy of the metallotect, as well as large portions of the Lynn Lake belt, has been affected by intense deformation and many aspects of the stratigraphy may be deformational in origin. These questions will be addressed in future research.

STRUCTURAL ANALYSIS

Detailed structural analysis in the MacLellan mine area has defined at least six phases of deformation (D_1–D_6), based on overprinting relationships between fabric elements. The distribution of major units is largely controlled by D_2, which represents the most penetrative and pervasive deformation. The overprinting of D_1 fabrics by D_2 produces a steeply north-dipping regional S_2 composite foliation, resulting from D_2 transposition similar in magnitude to that documented in the southern Lynn Lake greenstone belt (Beaumont-Smith and Rogge, 1999; Beaumont-Smith, 2000; Beaumont-Smith et al., GS-11, this volume). The morphology of S_2 is variable, ranging from rare differentiated crenulation cleavage to differentiated layering, the latter representing recrystallized crenulation cleavage commonly developed in mafic volcanic rocks. Relict S_1 slaty cleavage is locally preserved in S_2 crenulation microlithons or as a slightly S_2-oblique, clast-preferred orientation in fine-grained conglomerate beds. Transposition folds (F_2) are tight to isoclinal with shallow plunges (Fig. GS-13-2). Local style variations of F_2 folds include chevron folds and centimetre-scale crenulation folds.

Large strain gradients record the development of ductile shear zones during the late stages of the D_2 deformation. The D_2 shear zones are linear zones of intense S_2 crenulation cleavage, overprinted by an anastomosing network of ductile fabrics and isoclinal to rootless F_2 folds. The D_2 shear zones have a strong spatial relationship to picritic units in the metallotect stratigraphy. West of the MacLellan mine, along the east shore of the Keewatin River, a pronounced D_2 strain gradient exists in the

Figure GS-13-2: Tight to isoclinal, shallowly plunging F_2 folds developed in Wasekwan Group sedimentary rocks.

structural hanging wall of the contact between the high-Al basalt and picrite. The intensity of S_2 and the tightness of F_2 folds increase toward the contact. The picrite has undergone intense deformation, characterized by shear-fabric development, which provides support for the interpretation that the picrite represents the locus of regional D_2 strain (Ma et al., 2000). The intensity of D_2 fabric development within picritic units is not uniform, as picritic rocks do not ubiquitously display shear-fabric development, but the partitioning of regional D_2 strain into picritc units does appear to be critical to the formation of the MacLellan deposit (*see* Ma et al., 2000).

The structural geometry of the D_2 shear zones is characterized by dextral shear-sense indicators developed on horizontal surfaces, and a steeply plunging, generally down-dip to slightly oblique (easterly pitch), stretching lineation (Fig. GS-13-3). The relationship between transcurrent shear-sense indicators and steep stretching lineations is generally interpreted as the product of transpressional deformation (Lin et al., 1998). These kinematics are similar to shear zones in the southern Lynn Lake belt (Beaumont-Smith and Rogge, 1999; Beaumont-Smith 2000), supporting the interpretation of regional D_2 shear-zone development (Beaumont-Smith, 2000).

An understanding of the relationship between shear-zone development and gold mineralization in the MacLellan gold deposit is critical to gold exploration in the northern Lynn Lake belt. Gold mineralization in the southern Lynn Lake belt is controlled by the Johnson Shear Zone (Beaumont-Smith and Rogge, 1999; Beaumont-Smith 2000; Beaumont-Smith and Edwards, 2000; Jones et al., 2000). The similarity of shear-zone timing and kinematics in the two belts presents the possibility that the metallotect-hosted gold mineralization may also reflect a genesis that depends on shear zones.

Although the gold mineralization is clearly shear hosted, various syngenetic and epigenetic origins for the mineralization have been proposed (Fedikow, 1986; Gagnon, 1991; Samson and Gagnon, 1995; Fedikow et al., 1996). A possible synshear origin is demonstrated by the relationship between shear-zone fabric development and the alteration assemblages at the MacLellan mine and the K-2 zone east of the mine. Gold mineralization at these deposits is associated with intense silicification of the picrite, largely in the form of quartz veins (Gagnon, 1991) within a broader zone of biotitization

Figure GS-13-3: Dextral D_2 S-C fabric and shear-band foliation developed in picrite at the K-2 deposit, west of the MacLellan mine.

(K-metasomatism). At the K-2 zone, the intense silicification of the picrite occurs in a variety of manifestations, representing a spectrum from narrow, variously folded and transposed quartz veinlets to massive, penetrative silicification that obliterates the deformational fabrics. The relationships between shear-zone fabrics and the degree of quartz-vein transposition indicates that the introduction of the veins clearly spans the deformation. The youngest veins are relatively weakly folded, whereas the older veins are isoclinally folded and locally form laminated lenses, reflecting their transposition during deformation (Fig. GS-13-4).

These relationships clearly demonstrate that at least a portion of the silicification is synshear in origin. The remaining question is whether the boudinaged, massively silicified zones represent a variant on the synshear, transposed, laminated veins. The evidence to date is not conclusive, but there is sufficient textural similarity between the transposed, laminated quartz veins at the K-2 zone and a large number of massively silicified zones exposed in the MacLellan crown pillar to support a synshear, epigenetic origin for the gold mineralization, as opposed to a syngenetic origin. These observations are also consistent with those of Gagnon (1991), who described a continuum in the nature of silicification from weakly folded quartz veins through transposed, laminated veins to massive silicification on the 370 m level of the MacLellan mine. The textural relationships do not address the possibility that the gold mineralization represents remobilization of syngenetic mineralization. Detailed microstructural and isotopic studies are therefore planned to help resolve this issue.

The D_2 fabric elements are overprinted by close to tight, S-asymmetrical F_3 folds and northwest-trending, axial-planar S_3 crenulation cleavage. The F_3 folds are very penetratively developed west of the MacLellan mine area, where they plunge moderately to steeply southeast. Elsewhere, D_3 fabric elements are generally rare and D_4 fabrics comprise dextral kink to chevron folds and steeply dipping, northeast-striking, axial-planar S_4 crenulation cleavage (Fig. GS-13-5). The F_4 folds plunge steeply to the northeast and are penetratively developed throughout the area. Locally, D_4 fabrics include narrow, discrete, S_4-parallel cataclasite zones. These zones represent D_4 strain partitioning into narrow zones of dextral noncoaxial

a)

b)

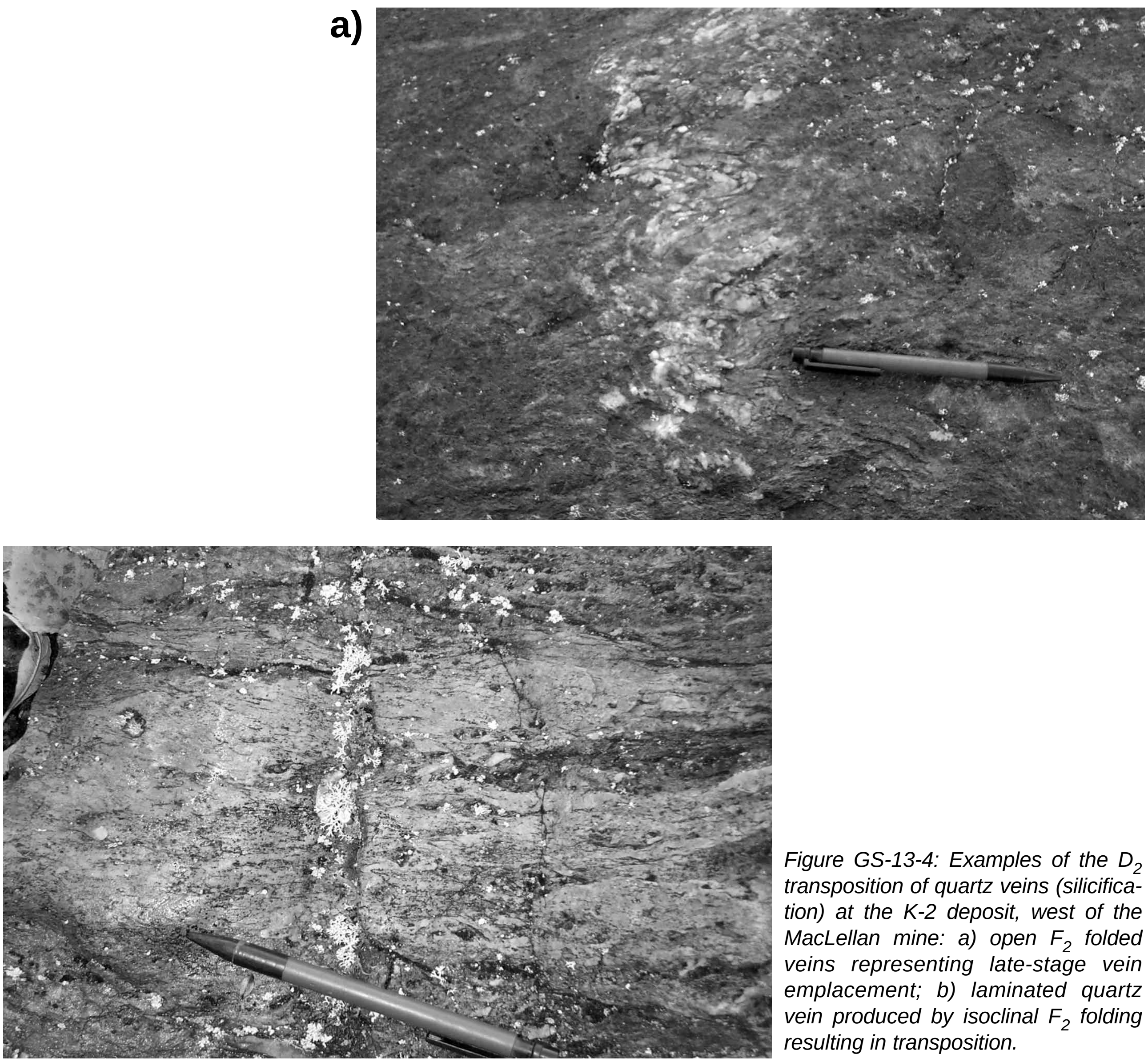

Figure GS-13-4: Examples of the D_2 transposition of quartz veins (silicification) at the K-2 deposit, west of the MacLellan mine: a) open F_2 folded veins representing late-stage vein emplacement; b) laminated quartz vein produced by isoclinal F_2 folding resulting in transposition.

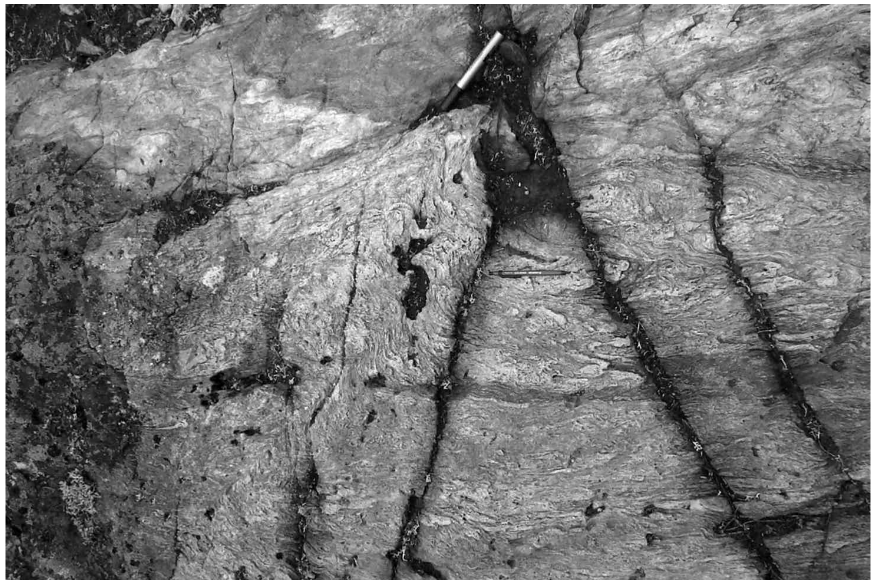

Figure GS-13-5: F_2 chevron folds overprinted by Z-asymmetrical F_4 fold, Dot Lake area.

deformation, which locally produces pseudotachylite. Displacement on these zones is not significant, with displacements being limited to metre scale, and results in fabrics similar to those developed in the Pool Lake area (*see* Anderson et al., GS-12, this volume).

The youngest ductile deformation (D_5) produced north-trending open folds and penetrative spaced cleavages. The S_5 spaced cleavages commonly form conjugate sets and, in areas of increased intensity, form tight undifferentiated crenulations. The D_5 structures are regionally penetrative and this deformation is interpreted to be responsible for the macroscopic warping of the Lynn Lake belt, possibly resulting from east-west compression. The final deformation (D_6) is brittle-ductile, and includes development of east-trending pseudotachylite zones that overprint the older deformational fabrics (Fig. GS-13-6). This deformation is thought to represent sinistral reactivation of D_2 shear zones. Accordingly, the distribution of D_6 pseudotachylite demonstrates a strong spatial association with D_2 shear zones (Beaumont-Smith and Rogge, 1999).

The most significant change in the deformational history of the area involves the distribution of D_2 shear zones. Shear-zone development has been demonstrated to play a major role in the genesis of gold mineralization in the MacLellan mine area (Ma et al., 2000). Although the research to date has not reconciled whether the gold mineralization represents epigenetic synshear mineralization or sheared syngenetic mineralization associated with exhalitive units in the metallotect, the mineralization and associated alteration are unquestionably shear hosted. The D_2 deformation west of Dot Lake is characterized by intense transposition of units, but shear-zone development has not been documented. This may reflect the decrease in the amount and strike continuity of picrite in the western portion of the area.

There is also a perceptible change from east to west in the development of fabric elements that overprint D_2 structures. Most notable is the decrease in the development of S-asymmetrical F_3 folds and S_3 crenulation in the Frances and Sheila lakes area. These fabrics represent a major control on the distribution of units immediately west of the MacLellan mine, whereas they are very poorly developed in the Sheila Lake–Frances Lake area. This results in a more linear map pattern in the western portion of the map area. The intensity of D_4 fabric development is generally consistent throughout the study area,

Figure GS-13-6: D_6 pseudotachylite zones developed in picrite and sedimentary rocks from the MacLellan mine area.

although the development of mesoscopic F_4 folds is qualitatively more penetrative to the west. Other changes include 1) a lack of calcite veinlets formed along S_5 spaced cleavage, which characterizes S_5 in the MacLellan mine area; and 2) the apparent absence of D_5 pseudotachylite zones west of Dot Lake.

CONCLUSIONS

Detailed mapping demonstrates that the Agassiz Metallotect extends west from the MacLellan mine to the Frances Lake area. The typical stratigraphy of the metallotect is largely absent west of Dot Lake, with the metallotect defined by the presence of thin picrite units within a thick unit of epiclastic sediments. The change in the nature of the metallotect may reflect a lateral facies change, with the western extension representing a more distal facies. Alternatively, the apparent discontinuous westward strike extension of the metallotect could reflect the attenuation of F_2 fold limbs during transposition, fold intercalation of units and/or (possibly) stratigraphic complexities resulting from the intersection of the shallow D_2 enveloping surface with the erosion surface. These factors could contribute to the development of a complex geometry that may result in poor strike-parallel continuity of stratigraphic units and strike-perpendicular repetitions of stratigraphy.

Detailed mapping in the main zone of the MacLellan deposit indicates that the various units making up the deposit largely represent variations in the intensity of alteration, producing different assemblages within the host picrite. The alteration is strongly deformed, commonly resulting in the boudinage of zones of silicification, which produces a lens-like distribution of alteration and mineralization. The relationship between D_2 shearing and silicification strongly suggests a synshear origin for the mineralization.

Further microstructural and geochemical analyses are planned for this year. Lead and sulphur isotope compositions are to be measured to constrain the possible source of the ore-forming fluids. Further mapping to the east of the MacLellan mine is also planned for next year, in order to determine the distribution and facies of the Agassiz Metallotect.

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REFERENCES

Baldwin, D.A., Syme, E.C., Zwanzig, H.V., Gordon, T.M., Hunt, P.A. and Stevens, R.P. 1987: U-Pb zircon ages from the Lynn Lake and Rusty Lake metavolcanic belts, Manitoba: two ages of Proterozoic magmatism; Canadian Journal of Earth Sciences, v. 24, p. 1053–1063.

Bateman, J.D. 1945: McVeigh Lake area, Manitoba; Geological Survey of Canada, Paper 45-14, 34 p.

Beaumont-Smith, C.J. 2000: Structural analysis of the Johnson Shear Zone in the Gemmell Lake–Dunphy Lakes area, Lynn Lake greenstone belt (parts of NTS 64C/11, 12); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 57–63.

Beaumont-Smith, C.J. and Edwards, C.D. 2000: Detailed structural analysis of the Johnson Shear Zone in the west Gemmell Lake area (NTS 64C/11); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 64–67.

Beaumont-Smith, C.J. and Rogge, D.M. 1999: Preliminary structural analysis and gold metallogeny of the Johnson Shear Zone, Lynn Lake greenstone belt (parts of NTS 64C/10, 11, 15), *in* Report of Activities 1999, Manitoba Energy and Mines, Geological Services, p. 61–66.

Beaumont-Smith, C.J., Lentz, D.R. and Tweed, E.A. 2000: Structural analysis and gold metallogeny of the Farley Lake gold deposit, Lynn Lake greenstone belt (NTS 64C/16); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 73–81.

Fedikow, M.A.F. 1983: Geological and geochemical investigations at the Agassiz Au-Ag deposit, Lynn Lake, Manitoba; *in* Report of Field Activities 1983, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 94–97.

Fedikow, M.A.F. 1986: Geology of the Agassiz stratabound Au-Ag deposit, Lynn Lake, Manitoba; Manitoba Energy and Mines, Minerals Division, Open File Report OF85-5, 80 p.

Fedikow, M.A.F. 1992: Rock geochemical alteration studies at the MacLellan Au-Ag deposit, Lynn Lake, Manitoba; Manitoba Energy and Mines, Geological Services, Economic Geology Report ER92-1, 237 p.

Fedikow, M.A.F. and Gale, G.H. 1982: Mineral deposit studies in the Lynn Lake area; *in* Report of Field Activities 1982, Manitoba Department of Energy and Mines, Mineral Resources Division, p. 44–54.

Fedikow, M.A.F., Baldwin, D.A. and Taylor, C. 1996: Gold mineralization associated with the Agassiz Metallotect and the Johnson Shear Zone, Lynn Lake greenstone belt, Manitoba; *in* Gold in the Western Shield, (ed.) L.A. Clark; Canadian Institute of Mining, Metallurgy and Petroleum, Special Volume 38, p. 361–378

Fedikow, M.A.F., Parbery, D. and Ferreira, K.J. 1991: Geochemical target selection along the Agassiz Metallotect utilizing stepwise discreminant analysis; Economic Geology, v. 86, p. 588–599

Ferreira, K.J. 1986: Geological investigations in the Sheila Lake–Margaret Lake area; *in* Report of Field Activities 1986, Manitoba Energy and Mines, Minerals Division, p. 8–12.

Ferreira, K.J. and Baldwin, D.A. 1997: Mineral deposits and occurrences in the Cockeram Lake area, NTS 64C/15, Manitoba Energy and Mines, Geological Services, Mineral Deposit Series Report No. 8, 134 p.

Gagnon, J.E. 1991: Geology, geochemistry and genesis of the Proterozoic MacLellan Au-Ag deposit, Lynn Lake greenstone belt, Manitoba; M.Sc. thesis, University of Windsor, Windsor, Ontario, 275 p.

Gilbert, H.P., Syme, E.C. and Zwanzig, H.V. 1980: Geology of the metavolcanic and volcaniclastic metasedimentary rocks in the Lynn Lake area; Manitoba Energy and Mines, Geological Paper GP80-1, 118 p.

Jones, L.R., Beaumont-Smith, C.J and Lafrance B. 2000: Preliminary structural and gold metallogenic studies at the Burnt Timber mine and surrounding area, Lynn Lake greenstone belt (NTS 64C/10); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 68–73.

Lin, S., Jaing, D. and Williams, P.F. 1998: Transpression (or transtension) zones of triclinic symmetry: natural example and theoretical modelling; *in* Continential Transpressional or Transtensional Tectonics, (ed.) R.E. Holdsworth, R.A. Strachan and J.F. Dewey; Geological Society, London, Special Publication 135, p. 41–57.

Ma, G., Beaumont-Smith, C. J. and Lentz, D.R. 2000: Preliminary structural analysis of the Agassiz Metallotect near the MacLellan and Dot Lake gold deposits, Lynn Lake greenstone belt, Manitoba (parts of NTS 64C/14, /15); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 51–56.

Milligan, G.C. 1960: Geology of the Lynn Lake district; Manitoba Department of Mines and Natural Resources, Mines Branch Publication 57-1, 317 p.

Norman, G.W.H. 1933: Granville Lake district, northern Manitoba; Geological Survey of Canada, Summary Report, Part C, p. 23–41.

Parbery, D. 1992: Agassiz Metallotect Project; Manitoba Energy and Mines, Geological Services, Economic Geology Report ER91-2, geological maps at 1:5000 scale.

Peck, D.C., Lin, S., Atkin, K. and Eastwood, A.M. 1998: Reconnaissance structural studies of the Au Metallotects in the Lynn Lake greenstone belt (parts of NTS 64C/10, 11, 15); *in* Report of Activities 1998, Manitoba Energy and Mines, Geological Services, p. 69–74.

Samson, I.M. and Gagnon, J.E. 1995: Episodic fluid infiltration and genesis of the Proterozoic MacLellan Au-Ag deposit, Lynn Lake greenstone belt, Manitoba; Exploration and Mining Geology, v. 4, no. 1, p. 33–50.

Samson, I.M., Blackburn, W.H. and Gagnon, J.E. 1999: Paragenesis and composition of amphibole and biotite in the MacLellan gold deposit, Lynn Lake greenstone belt, Manitoba, Canada; Canadian Mineralogist, v. 37, p. 1405–1421.

Zwanzig, H.V., Syme, E.C. and Gilbert, H.P. 1999: Updated trace element geochemistry of the ca. 1.9 Ga metavolcanic rocks in the Paleoproterozoic Lynn Lake belt; Manitoba Industry, Trade and Mines, Geological Services, Open File Report OF99-13, 46 p. plus map and diskette.