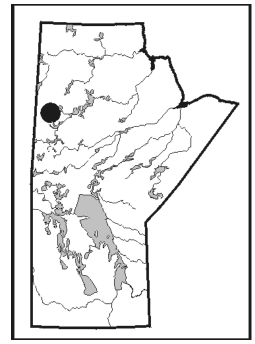
GS-16 RECONNAISSANCE STRUCTURAL STUDIES OF AU METALLOTECTS IN THE LYNN LAKE GREENSTONE BELT (PARTS OF NTS 64C/10, C/11, C/15)



by D.C. Peck, S. Lin, K. Atkin[1] and A.M. Eastwood[2]

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

SUMMARY

Preliminary structural investigations reveal the importance of structures on the distribution of Au within the Farley Lake and Burnt Timber deposits. In the Farley Lake deposit, Au was introduced along southwest-dipping fractures and related quartz-sulphide veins and was concentrated within semi-conformable alteration zones in an oxide facies banded iron formation. The mine sequence is interpreted to represent an east-striking anticlinorium. In the Burnt Timber deposit, Au occurs with pyrite in quartz-carbonate-sulphide vein networks developed in metabasalt and metasedimentary rocks that occur in the hanging wall of the T1 fault. The T1 fault truncates the mineralization and new structural evidence sugests that additional Au mineralization may be present at depth on the footwall side of the fault.

The Johnson Shear Zone is a major auriferous structure that developed along the contact between the southern part of the Lynn Lake greenstone belt and an intermediate to felsic plutonic terrain to the south. New field observations in a recently burned area suggest that the Johnson Shear Zone extends further to the west than was previously recognized. Detailed structural investigations are proposed for several, well exposed parts of the shear zone, and will be of critical importance in future exploration.

INTRODUCTION

Since 1987, three gold deposits (Farley Lake, Burnt Timber and MacLellan) have operated in the Lynn Lake area. In addition, several smaller gold deposits and numerous gold occurrences have been discovered in the Lynn Lake region dating back to the 1940s (Bateman, 1945; Milligan, 1960; Gilbert et al., 1980; Fedikow et al., 1989, 1991; Richardson and Ostry, 1996). Most of these gold occurrences are structurally-controlled, comprising late quartz + sulphide veins developed within competent and/or chemically active units (granite, iron formation, felsic volcanics) of the Wasekwan Group or the Pre-Sickle calc-alkaline plutons. Thesis studies focused on specific gold occurrences in the Lynn Lake area include those of Gagnon (1991), Sherman (1992), Kenaley (1982) and Peck (1986). Most of the gold occurrences in the Lynn Lake area occur along the Johnson Shear Zone (JSZ; Bateman, 1945; Gilbert et al., 1980; Fedikow et al., 1991) and the Agassiz Metallotect (Fedikow et al., 1989) (Fig. GS-16-1). The JSZ (Fig. GS-16-1) is a >40 km long, predominantly ductile deformation zone that generally follows the contact between metaplutonic rocks (Pre-Sickle granitoid suite) to the south and supracrustal rocks (southern part of the Wasekwan Group) to the north (Fedikow et al., 1991). Recent studies of gold mineralization along the JSZ include an investigation of the geology and geochemistry of the Burnt Timber Deposit (Peck and Eastwood, 1997) and detailed mapping of the JSZ in the vicinity of gold occurrences at Franklin Lake and Cartwright Lake (Peck et al., 1995) (Fig. GS-16-1).

The current study was undertaken in order to redress the lack of detailed structural mapping along the JSZ, and the need for a synthesis of the mineralogical and geochemical characteristics of the many gold occurrences along both the JSZ and the Agassiz Metallotect. It is hoped that careful documentation of these gold metallotects, principally involving structural geology and mineralogical and geochemical characterization of known deposits, will provide new exploration criteria.

LITHOSTRUCTURAL FEATURES OF GOLD MINES IN THE LYNN LAKE AREA

Three gold deposits (Farley Lake, Burnt Timber and MacLellan) have been mined in the Lynn Lake area over the past decade. Each displays distinctive structural and lithologic characteristics. In each case, Au typically occurs in native form, as micron-sized grains within or in association with pyrite and/or pyrrhotite +/- other base metal sulphides. Visible gold is rarely observed in these deposits. Although Au grades are, like most lode gold deposits, erratic on a local scale, at the mine scale they are suitably uniform to allow visual grade control (based on total sulphide abundance) in two of the deposits (Burnt Timber and Farley Lake).

Farley Lake Deposit

The mine sequence exposed at the Farley Lake deposit comprises oxide facies banded iron formation, argillite, siltstone and rhyolite/dacite belonging to the Wasekwan Group in the northern part of the Lynn Lake greenstone belt (Gilbert et al., 1980). The mine sequence is east-striking and ca. 400 m wide (north-south dimension). The sequence is in contact with, both to the north and the south, Mg-rich basalt and associated mafic pyroclastic rocks (Gilbert et al. 1980). The mine sequence is intruded by Pre-Sickle granodiorite plutons and mafic dykes. The dykes appear to be concentrated near two northwest-striking faults (Wendy and East faults), which dip steeply to the northeast.

The Farley Lake deposit is hosted within a generally east-striking alteration zone largely contained within the oxide facies banded iron formation. Gold mineralization is focused along shallow to moderate, northeast-trending and southwest-dipping fractures and, on a local scale, along a pre-existing, steeply dipping and east-striking penetrative foliation (S_1). Gold abundance typically is strongly correlated with total sulphide abundance. The mine comprises 4 closely spaced ore zones, including the Wendy, East, South and Southeast zones (Fig. GS-16-2).

Most of the mineralization occurs within conformable sulphidation zones in the banded-iron formation. Higher grade Au mineralization (up to ~30 g/tonne) occurs in two quartz + sulphide + dolomite ± chlorite vein sets that cut bedding and pre-existing S_1 penetrative metamorphic foliation. The southwest-dipping fractures appear to represent permeable horizons along which auriferous fluids penetrated the banded iron formation and, locally, a black argillite unit.

It is unclear when the Au was introduced with respect to the development of the faults and introduction of sulphur. Currently, the key controls on the distribution of the Au mineralization are interpreted to be: (1) the cm- to dm-thick quartz-sulphide veins within or adjacent to the southwest-dipping fractures (Fig. GS-16-3); and, (2) the development of fine scale Fe sulphide banding, replacing original magnetite bands, within the iron formation. The chert-magnetite bedding is typically steeply dipping and east trending and is intersected by the southwest-dipping fractures at high angles. Auriferous fluids were clearly focused along these fractures and infiltrated the oxide facies banded iron formation along the quartz-sulphide veins and pre-existing S_0 bedding planes and nearly coplanar S_1 foliation. The iron formation is believed to have acted as a chemical trap in which auriferous fluids were oxidized in the presence of magnetite, resulting in the reduction of magnetite, oxidation of Au sulphide complexes, and deposition of Au and sulphides. An unexplained feature of the Farley Lake deposit is that pyrrhotite is the predominant sulphide mineral in the Wendy, South and Southeast zones, whereas pyrite is the principal sulphide mineral in the East zone.

Based on previous drillhole interpretations by Manitoba Mineral Resources Ltd. and Black Hawk Mining Inc., and a cursory examination of the lithostructural characteristics of the mine sequence, a simple structural cross section has been developed (Fig. GS-16-2). The main structure shown by this cross section is an anticlinorium that is based on both the observed repetition of lithological units and local reversals in younging directions. In this interpretation, the rhyolite at the north limb and the dacite, at the south limb are treated as lateral equivalents, which is supported by the observation that rhyolite also occurs at the

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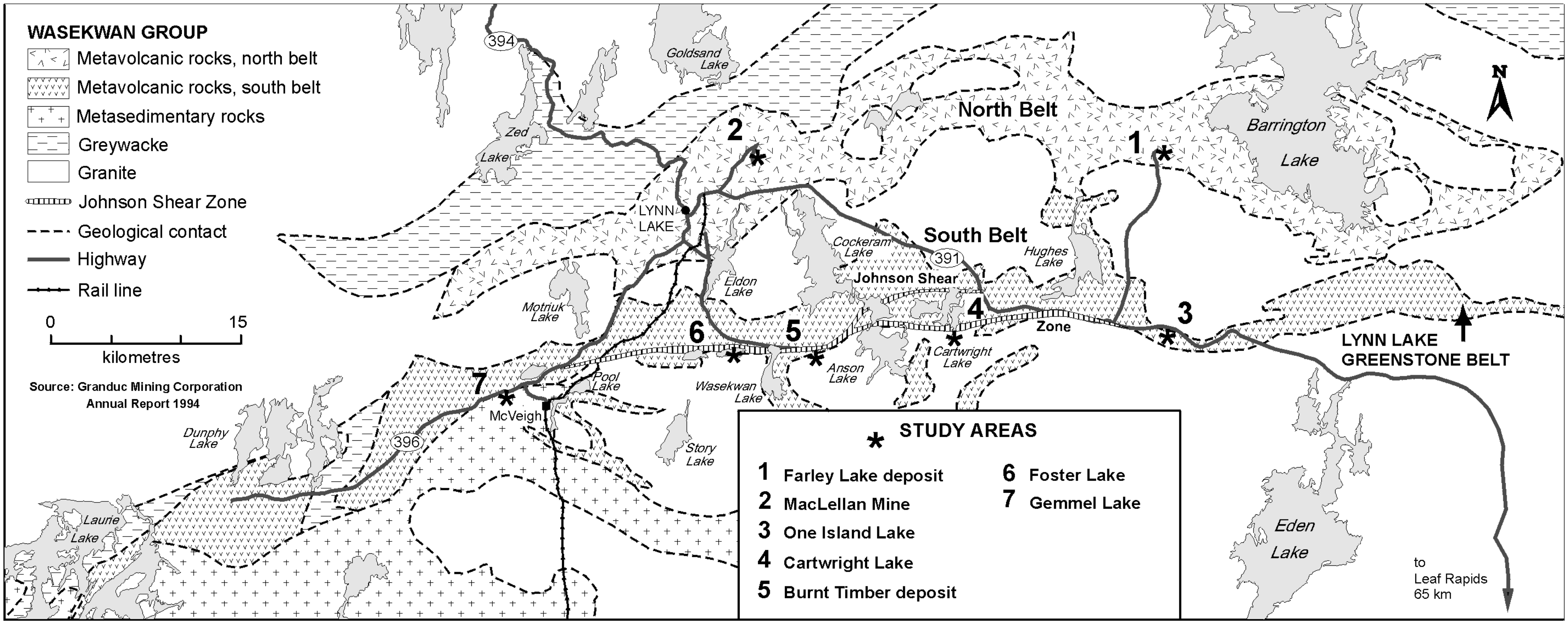


Figure GS-16-1: Location of Au deposits, Au metallotects and study sites, Lynn Lake greenstone belt.

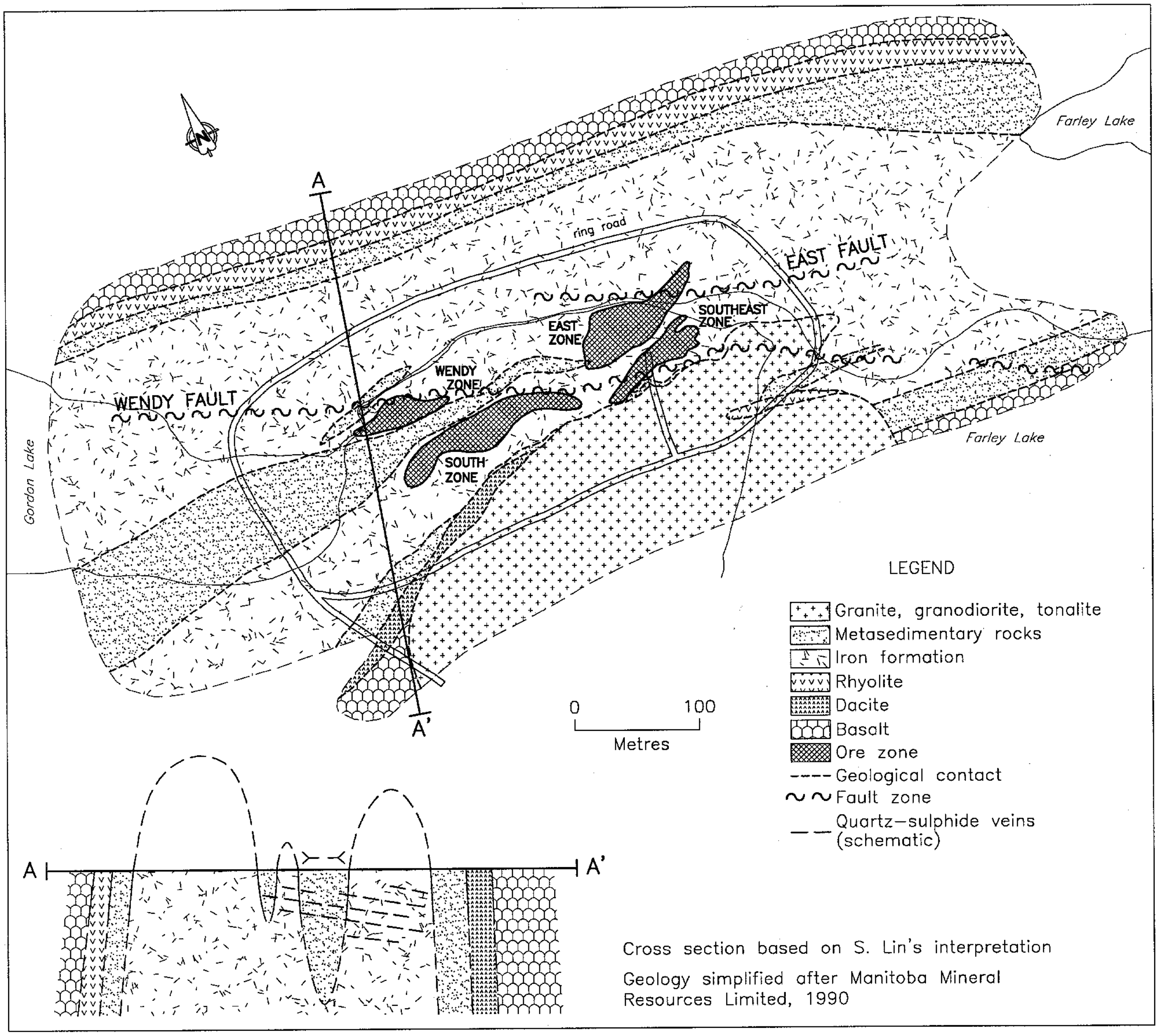


Figure GS-16-2: Simplified geological map of the Farley Lake Au deposit and adjacent areas (adapted from geological mapping provided by Black Hawk Mining Inc.). Also shown is an interpreted geological cross-section (this study) for the Farley Lake deposit (looking east). The schematic cross section shows the interpreted anticlinorium and the setting of quartz-sulphide veins. The rhyolite at the north limb and the dacite at the south limb are interpreted to be stratigraphic equivalents.

Figure GS-16-3: Quartz-sulphide vein (QSV) along southwest-dipping fault, East Pit, Farley Lake Deposit. Looking north. Field of view ~10 m.

south limb, to the east of the dacite but occupying the same stratigraphic position (Fig. GS-16-2). The anticlinorium is along strike from a major anticline, mapped to the west by previous workers (Gilbert et al., 1980). The dominant foliation in the mine area is probably axial planar to the folds. This interpretation shows that the ore zones at the Farley Lake deposit occur in the core of the anticlinorium. However, note that the southwest-dipping fractures and the associated quartz-sulphide veins (and gold mineralization) are late features relative to the folding, because: (1) they cut the folds at a high angle; and (2) they are brittle structures whereas the folds are clearly ductile features.

MacLellan Mine

The MacLellan Mine (1986-89; J. Chornoby, Sherritt Gordon Mines Ltd., internal report) is the only underground gold mine to have operated in the Lynn Lake greenstone belt. It comprises auriferous quartz-carbonate-sulphide veins that are concentrated along an S_2 shear fabric that transects a penetrative F1 schistosity in the host rocks (Gagnon, 1990). Gold mineralization is commonly associated with quartz, biotite, pyrite and/or pyrrhotite, and seems to involve pervasive K metasomatism. Detailed mineralogical and geochemical studies of the vein systems and the wall rock alteration at the MacLellan Mine were completed by Gagnon (1991). However, further study of the deposit is warranted, in order to develop a regional structural model for the Agassiz Metallotect.

Burnt Timber Deposit

The Burnt Timber deposit (1994-97) occurs within the JSZ, east of Wasekwan Lake (Fig. GS-16-1). Preliminary structural characteristics and lithogeochemical observations for the Burnt Timber deposit are described by Peck and Eastwood (1997).

Gold mineralization occurs in pyrite-bearing quartz veins within the JSZ. The mineralization generally follows three nearly coplanar fabrics, *viz.* (1) S_0 bedding features in metasedimentary units; (2) penetrative and, on a regional scale, east-striking and steeply-dipping S_1 foliations associated with upright to overturned isoclinal folds; and, (3) S_2 mylonitic banding associated with the JSZ. All of these fabrics and the Au mineralization are deformed by northeast-plunging, tight to open folds that locally produced crenulation cleavage (S_3). The mineralization is truncated by a north-dipping fault zone (the T1 fault) that produced a narrow (<2 m thick) fault gouge.

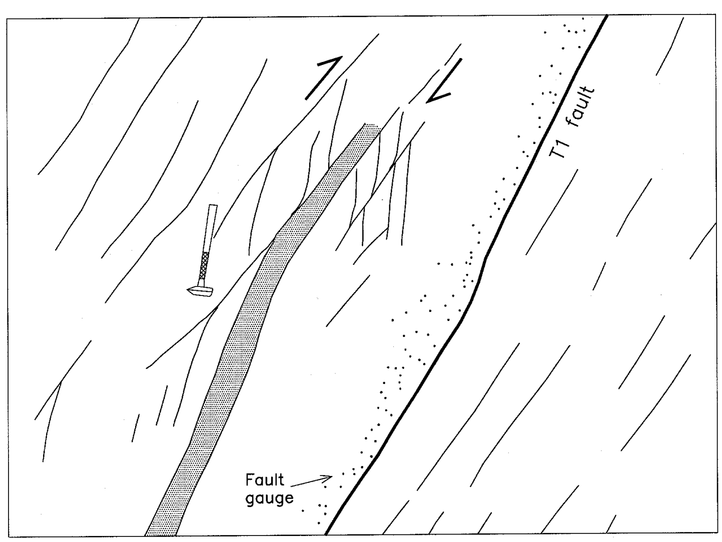
The Au mineralization is hosted by a sequence of intensely deformed and variably silicified basalt, basaltic andesite, andesite and intermediate siltstone. The volcanic rocks may be stratigraphically equivalent to basalt and andesite in the Hughes Lake calc-alkaline suite (Syme, 1985; Peck and Eastwood, 1997). Gold mineralization occurs in quartz + pyrite veins and, less commonly, in younger aplite and quartz veins that cut both the S_1 and S_2 fabrics. The exact timing of the introduction of gold into the Burnt Timber deposit is unresolved, but it was clearly pre-S_3 and post-S_1.

A critical, new observation concerning the sense of shear of the T1 fault was made at the east end of the Burnt Timber deposit. In the hanging wall near the fault surface, S-C structures are recognized (Fig. GS-16-4). The C-surfaces are subparallel to the T1 fault. The S-C relationship indicates a component of north-over-south dip-slip movement component (Fig. GS-16-4). This observation is important because the ore body at the mine is cut by the T1 fault and the sense of shear indicates that the rest of the ore body is present, at depth, on the footwall (south side) of the T1 fault. Additional structural observations will be required to confirm the timing of the Au mineralization and the sense of movement along the T1 fault.

a)

Figure GS-16-4: (a) Photo of T1 fault and related structures (looking east). (b) Sketch of part of the photo showing the S-C structures and their relationship to the T1 fault. The sense of shear indicated by the S-C structures is shown. Interpretation by S. Lin.

b)



REGIONAL STRUCTURAL CHARACTERISTICS OF THE JOHNSON SHEAR ZONE

Several of the best exposures along the JSZ were re-examined in an effort to identify suitable areas for detailed structural investigations in support of Au exploration. The areas investigated include (from east to west, see Fig. GS-16-1): (1) the east end of the JSZ near One Island Lake; (2) the Cartwright Lake area; (3) the type location for the JSZ, at the Johnson Vein (Bateman, 1945) on the south shoreline of Reservoir Lake; (4) a recently burned area immediately to the south and west of the Burnt Timber Deposit; and, (5) a recently burned area immediately to the south of Gemmel Lake near the McVeigh siding (see Fig. GS-16-1 for locations).

Preliminary results from our reconnaissance structural investigations in these areas suggest that the JSZ is, as believed by previous workers (see Gilbert et al., 1980; Fedikow et al., 1991), a major, crustal-scale shear zone. Mylonite and quartz-sulphide vein networks are typically developed along the JSZ where it intersects granitic rocks (e.g., granodiorite and quartz-feldspar porphyry intrusions at Cartwright Lake; Peck, 1986). Well developed granitic mylonite was observed in most of the areas investigated (Fig. GS-16-1). The JSZ is commonly expressed as multiple, discrete mylonite zones, a few metres wide, separated by broader zones of less intense shearing. This structural style is well documented in the JSZ along the eastern shoreline of Franklin Lake (Peck et al., 1995). The JSZ is locally overprinted by a northeast-trending crenulation cleavage (Fig. GS-16-5), possibly relating to northeast-trending axial planes of F_2(?) folds similar to those seen at the Burnt Timber deposit. However, the JSZ, like other faults developed along granite-greenstone belt boundaries, is likely to have a long and complex history of deformation. Detailed structural analyses must be undertaken before a regional, tectonic model for the JSZ can be developed.

The western extent of the JSZ was previously considered to be the Finlay-McKinlay Au occurrences near Gemmel Lake (Fedikow et al., 1991; Sherman, 1992). A recent forest fire exposed outcrops of mylonitized and strongly foliated intermediate to felsic metavolcanic rocks (Wasekwan Group) and clastic metasedimentary rocks (Sickle Group arkose and conglomerate; Fig. GS-16-6) to the east of the McVeigh siding road and immediately south of Highway 396 (Fox Mine road; Fig. GS-16-1). The foliation dips steeply and contains a well developed, steeply-plunging stretching lineation. Based on the regional easterly strike of the JSZ, we suggest that this area represents the westward continuation of the JSZ and, if so, means that the JSZ is younger than the Sickle Group sediments. Accordingly, we strongly recommend that detailed, structurally-oriented mapping be carried out through newly exposed areas within the extensively burned region between Gemmel Lake and Dunphy Lakes on Highway 396.

Figure GS-16-5: Earlier mylonitic fabric overprinted by crenulation cleavage in metagreywacke from the Burnt Timber deposit area. Where the later deformation is stronger, the earlier fabric is obliterated and a new mylonitic fabric is developed.

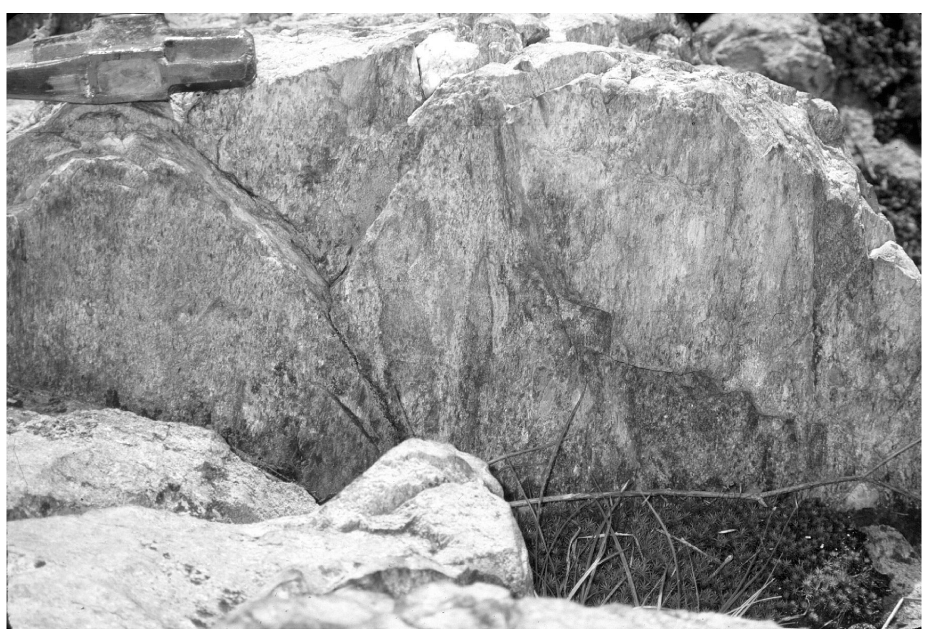


Figure GS-16-6: Strongly foliated and lineated sandstone within Sickle Group, immediately to the east of the McVeigh siding road, ca. 750 m south of Gemmel Lake.

Based on the abundant Au showings (Fedikow et al., 1991) and its structural attributes, the JSZ is one of the most prospective metallogenic features in the Lynn Lake greenstone belt. A series of inter-related lithostructural studies of the JSZ and its gold deposits, in combination with mineralogical and geochemical studies (surficial media geochemistry, whole-rock geochemistry, microbeam analysis of gold distribution and associated minerals) are needed to advance our understanding of Au mineralization in the Lynn Lake greenstone belt.

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