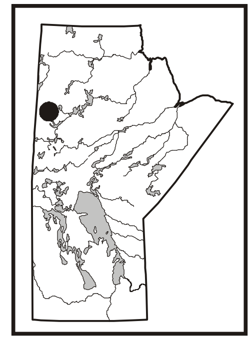
GS-13 DETAILED STRUCTURAL ANALYSIS OF THE JOHNSON SHEAR ZONE IN THE WEST GEMMELL LAKE AREA (NTS 64C/11)

by C.J. Beaumont-Smith and C.D. Edwards[1]



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. 64-68.

SUMMARY

Gold mineralization hosted by the Johnson Shear Zone in the west Gemmell Lake area is associated with finely disseminated arsenopyrite in sericitized and silicified volcaniclastic dacite intercalated with porphyritic gabbro. The distribution of the dacite is controlled by tight to isoclinal F_2 folds, with an overall Z-asymmetry and moderate easterly plunge, that have produced considerable fold thickening of the mineralized horizon. The style of mineralization and alteration differs from previously documented styles associated with the Johnson Shear Zone and demonstrates the unrealized gold-exploration potential of the Lynn Lake greenstone belt.

INTRODUCTION

The Johnson Shear Zone (JSZ) is a major east-trending structure in the southern Lynn Lake greenstone belt (Fig. GS-13-1). The JSZ has been the focus of gold exploration since the 1940s (Bateman, 1945) and hosts the depleted Burnt Timber deposit (Richardson and Ostry, 1996). Earlier exploration for shear-hosted gold was concentrated on the then-known extent of the JSZ east of Gemmell Lake, where the shear zone forms the boundary between the greenstone belt and the Pool Lake suite plutonic rocks to the south (Gilbert et al., 1980). The recent delineation of the JSZ west of Gemmell Lake (Beaumont-Smith and Rogge, 1999; Beaumont-Smith, GS-12, this volume) has resulted in the discovery of shear-hosted gold mineralization in several new, widely separated locations.

Gold mineralization hosted within the JSZ in the west Gemmell Lake area represents a different style than that previously recognized in the Lynn Lake greenstone belt. Gold mineralization east of Gemmell Lake can be characterized by two end members: 1) gold associated with finely disseminated pyrite, accompanied by silicification, biotitization and carbonatization of the hosting, sheared, mafic volcanic rocks (BT style; Peck and Eastwood, 1997; Peck et al., 1998); and 2) gold associated with finely disseminated pyrite and lesser arsenopyrite, accompanied by silicification and variable carbonatization of the hosting, sheared, felsic dykes and intrusive rocks (Bonanza style; Peck, 1984, 1985, 1986).

The mineralization in the west Gemmell Lake area is associated with fine-grained acicular arsenopyrite and lesser pyrite accompanying the emplacement of syn-shear quartz veins and bulk silicification of weakly to moderately sericitized, dacitic volcaniclastic rocks. The objectives of this study are to 1) characterize this style of mineralization and alteration; 2) document the deformation history and structural geometry in the area of mineralization; and 3) determine the relationship, if any, between the deformation, alteration and mineralization.

GEOLOGICAL SETTING

The Paleoproterozoic Lynn Lake greenstone belt is an area of metamorphosed volcanic and sedimentary rocks that extends for 130 km from Laurie Lake in the west to Magrath Lake in the east. The belt has been subdivided into northern and southern, dominantly volcanic sequences of the Wasekwan Group (Bateman, 1945), separated by intrusive rocks of the Pool Lake suite (Gilbert et al., 1980). The Wasekwan Group was isoclinally folded into an east-trending anticlinorium prior to the intrusion of the Pool Lake suite (Gilbert et al., 1980). The Wasekwan Group and Pool Lake suite are unconformably overlain by an upper sedimentary succession of fluvial-alluvial conglomerate and sandstone that

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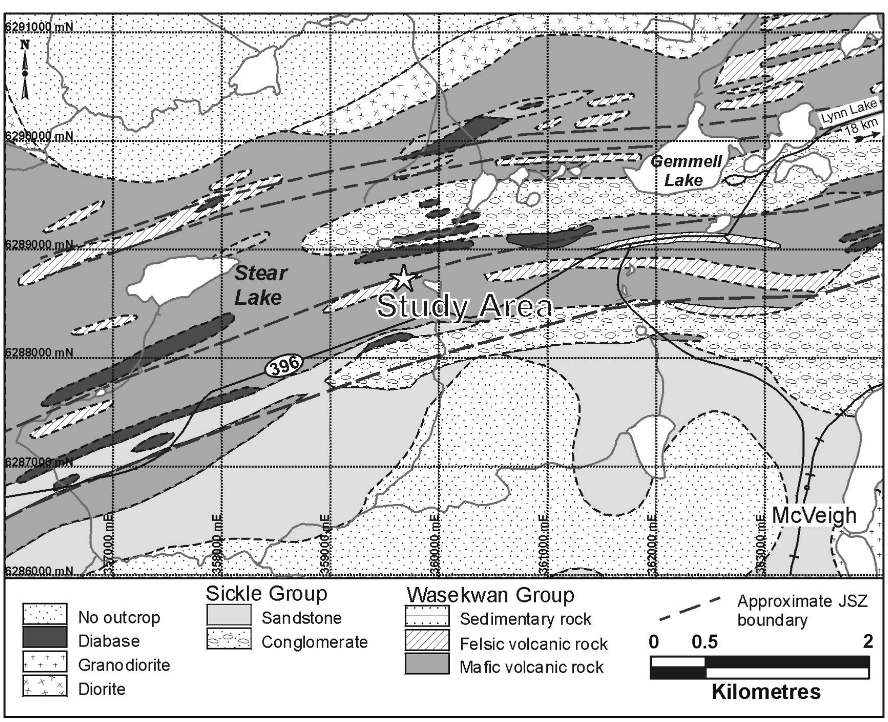

*Figure GS-13-1: General geology of the Lynn Lake greenstone belt west of Gemmell Lake and location of the Johnson Shear Zone. The area of this study is highlighted (*after *Gilbert et al., 1980).*

constitute the Sickle Group (Norman, 1933).

Metamorphic grade in the Lynn Lake belt ranges from upper greenschist to upper amphibolite facies. There is a general increase in metamorphic grade from east to west. The Gemmell Lake area underwent middle amphibolite facies peak metamorphism, following the development of the JSZ, that resulted in the recrystallization of primary and shear-zone fabrics. The timing of the metamorphic peak is broadly coincident with D_3 (Beaumont-Smith and Rogge, 1999).

Gold mineralization associated with the JSZ west of Gemmell Lake is hosted by sheared, dacitic, volcaniclastic rocks intercalated with variably deformed porphyritic gabbro within the southern Lynn Lake greenstone belt. The dacite is a fine-grained pyroclastic unit composed of fine to coarse ash with rare, thin, fine lapilli horizons. It has a white to beige weathered surface and is commonly strongly micaceous, the result of metamorphic recrystallization of sericitic alteration. The thickness of this unit varies from decimetres to approximately 25 m and is repeated several times across strike. Intercalated with the dacite is medium to coarsely porphyritic gabbro (now amphibolite). This unit has been interpreted as gabbro, based on the coarse grain size and local preservation of primary layering. These features are not unique to intrusive rocks, however, and this unit could possibly represent a mafic volcaniclastic rock. The gabbro is variably deformed, most likely the result of heterogeneous D_2 strain distribution and metamorphic recrystallization of the gabbro. Discrete high-strain zones are developed in the gabbro, producing fine-grained, finely laminated mafic tectonite units and narrow protomylonitic (porphyroclastic) zones.

STRUCTURAL ANALYSIS

Detailed structural analysis was conducted on an area of semicontinuous outcrop that includes several outcrops of newly discovered gold mineralization within the JSZ. The deformational history of the JSZ is characterized by the development of transcurrent, dextral shear-sense indicators and steep stretching lineations as a result of the concentration of regional D_2 deformation into an east-trending zone of very high strain (Beaumont-Smith and Rogge, 1999). Fabric development in the west Gemmell Lake area is consistent with that documented along the southern margin of the greenstone belt east of Gemmell Lake. The rocks underlying the study area are strongly foliated and lineated, and distribution of the units is controlled by tight Z-asymmetrical folds (Fig. GS-13-2).

The dacitic rocks are intensely foliated and mylonitic fabrics are commonly preserved. The main foliation, interpreted as S_2, is a finely spaced, muscovite-rich discrete shear foliation (C-plane) and quartz-ribbon orientation. Locally, dextral S-C fabrics are preserved in coarse ash layers, with the long dimension of the clasts defining the shape fabric. The high shear strain has resulted in the emplacement of a large number of fine quartz veinlets and ribbons at various times during D_2. Early syn-D_2 quartz veins are isoclinally folded and asymmetrically boudinaged, with D_2 dextral shear bands forming the boudin terminations (Fig. GS-13-3). Late-D_2 quartz veins have an anticlockwise orientation with respect to the S_2 mylonitic foliation and show the initial stages of asymmetrical boudinage. The intense D_2 deformation is characterized by steeply plunging to down-dip lineations. Lineations defined by stretched lapilli and quartz rodding plunge parallel to the striations on the C-planes (ridge-in-groove lineation).

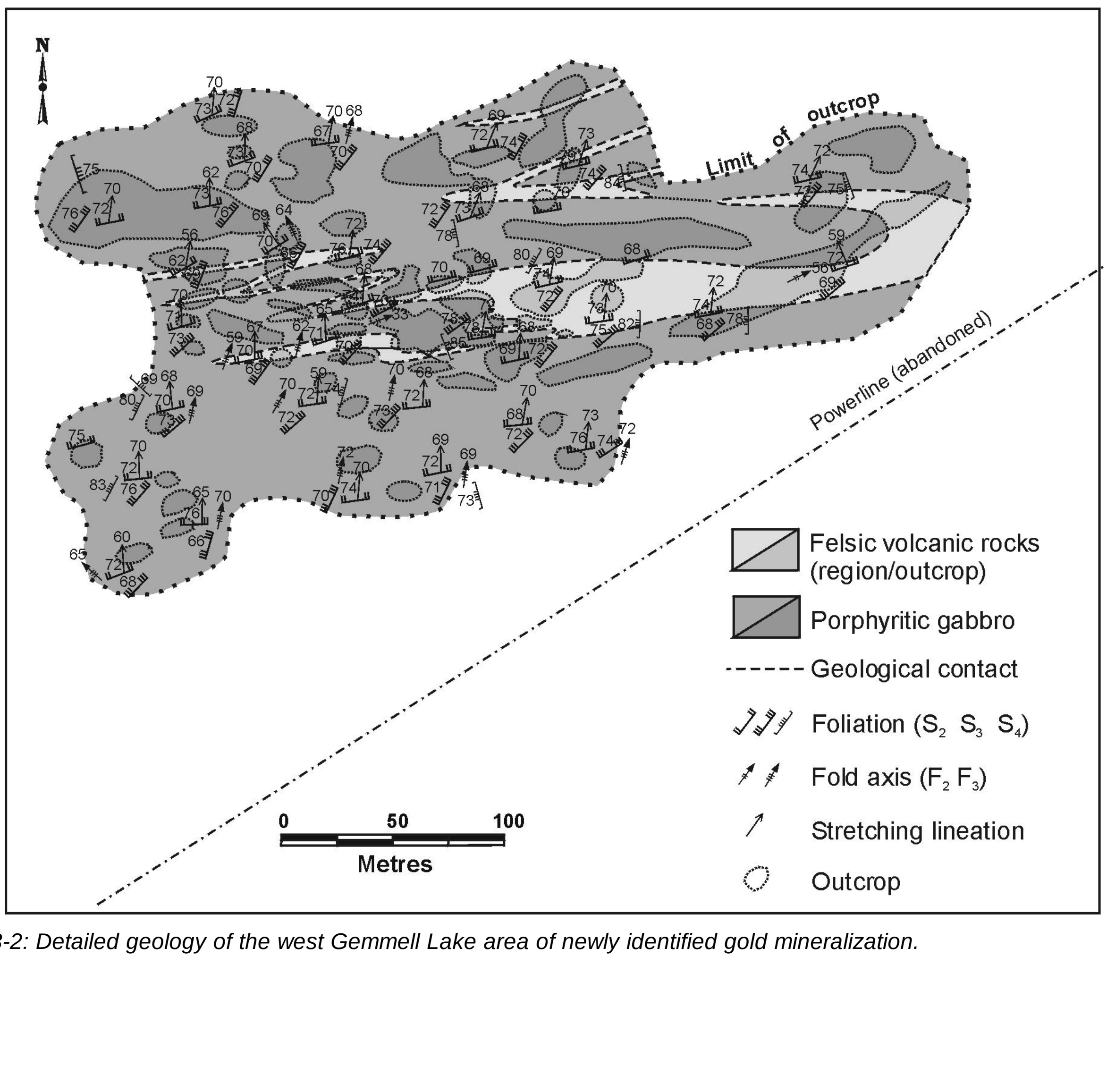

Figure GS-13-2: Detailed geology of the west Gemmell Lake area of newly identified gold mineralization.

Figure GS-13-3: Dextral shear bands and asymmetrical boudinage of quartz veins in host sericitized dacite.

The D_2 shear fabrics are overprinted by several generations of fabrics. Most penetrative is D_3, which produced northeast–plunging, open to close F_3 folds and axial-planar S_3 crenulation cleavage. The S_3 orientation is subparallel to the D_2 instantaneous stretching direction, the expected orientation of S-fabric development, making mesoscopic interpretation of D_2 fabrics difficult due to the possible confusion between S_3 and the D_2 mylonitic S-fabric. Development of S_3 is broadly synchronous with peak metamorphism and is manifested by the growth of amphiboles parallel to S_3. This represents a possible microstructural avenue to differentiate between S_3 and the mylonitic S-fabric. Weak, conjugate, S_4 spaced foliations and open folds overprint the older fabric elements about a north-south axis.

The final deformation (D_5) produced a variety of narrow pseudotachylite veins and breccia zones. The pseudotachylite veins are narrow (1–2 mm), extremely fine grained, and have distinct chilled margins locally forming the matrix to angular breccia zones. Pseudotachylite development is subparallel to S_2 and appears restricted to the JSZ (Beaumont-Smith and Rogge, 1999; Beaumont-Smith, GS-12, this volume).

Fabric development within the gabbro is significantly different and appears less intense. The gabbro generally contains a penetrative S_2 foliation, and S_3 is locally observed. The development of discrete zones (1–3 m) of D_2 protomylonitic to mylonitic fabrics, opposed to the pervasive mylonitization of the dacite, suggests that the D_2 deformation may have been partitioned into the dacite as a result of its high silica content and the resultant diffusion-dependent strain-softening mechanisms provided by quartz-rich rocks. Discrete protomylonitic and mylonitic zones are characterized by anastomosing, fine plagioclase ribbons in the gabbroic matrix and plagioclase pressure fringes on pyroxene (now hornblende) phenocrysts, producing an augen texture (Fig. GS-13-4). Mylonitic zones are defined by dextral (σ-type) asymmetrical pressure-fringe development. The finely laminated mafic tectonite units are interpreted as recrystallized zones of intense crenulation-cleavage development (cf. Beaumont-Smith and Rogge, 1999).

The distribution of dacite and gabbro delineate tight to isoclinal F_2 folds. This accounts for the multiple dacite horizons and the great variation in the thickness of the dacite. The dacite is considerably thinned on the F_2 fold limbs, whereas the thick areas of dacite (up to 25 m) occupy F_2 hinge regions. The F_2 folds are Z-asymmetrical and plunge moderately east. This geometry has the potential to cause considerable fold thickening of the dacite, improving the economic potential. The distribution of the dacite can be explained without invoking F_1/F_2 fold interference or noncylindrical F_2 folding, and does not reflect significant F_3 refolding.

Figure GS-13-4: Discrete shear zone (fine grained, lower portion of photo) developed in coarse-grained porphyritic gabbro (upper portion of photo).

MINERALIZATION AND ALTERATION

Gold mineralization was identified in 1999 through the geochemical analysis of several widely spaced samples of sheared and weakly sericitized dacite that contained trace, finely disseminated arsenopyrite. The exact nature and distribution of the gold mineralization is poorly understood at present, but detailed sampling was carried out this season to address this situation.

Based on field observations and the limited geochemical analyses, gold mineralization appears to be associated with syn-shear silicification and sericitization of the host dacite, and the presence of finely disseminated arsenopyrite. The silicification resulted from the emplacement of quartz ribbons and veins during D_2 mylonitization, and the degree of silicification ranges from simple quartz-vein emplacement (Fig. GS-13-5) to intense silicification producing massive, cherty regions in the dacite. The sericitization appears to have accompanied the silicification, with S_2 defined by muscovite-rich foliation septa. The muscovite is beige to pale green in colour and locally imparts a greenish hue to the dacite. The green tint may represent a fuchsitic component to the muscovite, with the required chromium having been liberated from the adjacent gabbro.

Extremely finely disseminated arsenopyrite and lesser pyrite, associated with the gold mineralization, form zones of dark reddish brown bloom on the weathered surface of the dacite. The distribution of the bloom corresponds to zones of silicification in sericitized dacite, either as quartz veins or bulk silicification, that are locally several metres in width and continuous along strike for tens of metres. The association between gold mineralization and presence of the sulphide minerals is reinforced by the absence of arsenopyrite in unaltered dacite and the adjacent gabbro.

Further investigations into the nature of this gold mineralization include detailed geochemical analysis of the host dacite and intercalated gabbro to determine the distribution of gold in these rocks, and the characterization of the associated alteration. Microstructural analysis will determine the relationship between the mineralizing event and the deformation, and micro-analytical analysis of mineralized samples will investigate the distribution of gold and the suspected link to sulphide concentration and species.

CONCLUSIONS

Gold mineralization in the west Gemmell Lake area is associated with the presence of finely disseminated arsenopyrite in sericitized and silicified, dacitic volcaniclastic rocks within the Johnson Shear Zone. The mineralization and accompanying alteration are the result of syn-D_2 shear-zone development, which is characterized by intense foliation and Z-asymmetrical, tight to isoclinal folding. This gold mineralization, hosted by felsic volcaniclastics, associated with ansenopyrite and coeval with shear zone development, represents a previously unrecognized style of mineralization associated with the Johnson Shear Zone.

ACKNOWLEDGMENTS

Adele Tweed, Cristina Edwards, Koren Bailes and Robert Jones are thanked for their assistance in the field. Dan Ziehlke of Strider Resources Ltd.-Union Gold, Inc. is thanked for property access. Herman Zwanzig's thorough review greatly improved the manuscript.

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Figure GS-13-5: Moderately sericitized and silicified volcaniclastic dacite with late-stage D_2 quartz veins (arrow) and D_2 dextral shear bands (SB).

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