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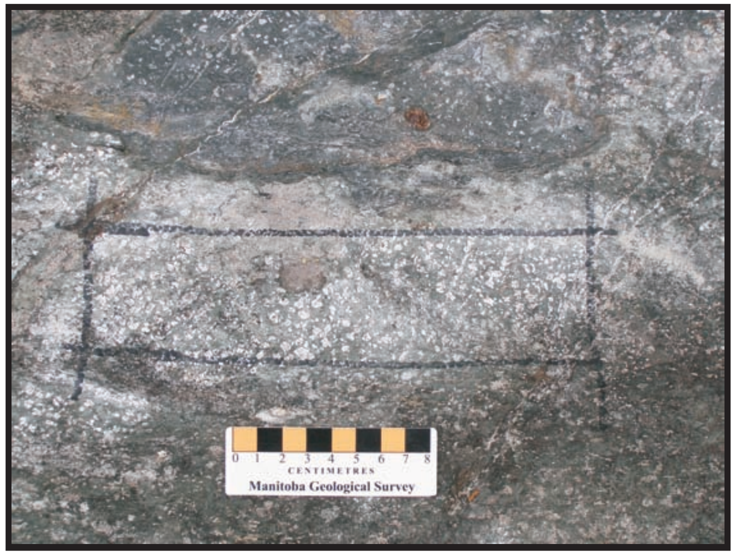

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Manitoba

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Geochemistry data for the Lynn Lake greenstone belt, Manitoba (NTS 64C11–16)

by C.J. Beaumont-Smith
Winnipeg, 2008

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Cover photo: Porphyritic debris-flow clast marked off for geochemical sampling with a rock saw, MacLellan mine area.

Abstract

The MGS, in collaboration with several university researchers, has completed a series of regional- and deposit-scale geological mapping projects in the Lynn Lake greenstone belt. These projects have included the completion of a large number of geochemical analyses. The results of these analyses have been compiled into a database comprising 507 results from fusion inductively coupled plasma (ICP) analysis for major oxides and trace elements and inductively coupled plasma-mass spectrometry (ICP-MS) analysis and induced neutron activation analysis (INAA) for selected trace elements. The database includes both unaltered and altered samples collected during the course of gold metallogeny and regional tectonics studies.

TABLE OF CONTENTS

Page

FIGURES

APPENDIX

Introduction

The diverse geochemistry exhibited by supracrustal rocks comprising the Lynn Lake greenstone belt reflects the assembly of volcanic rocks with a variety of tectonic affinities (see Zwanzig et al., 1999). The tectonic assembly is the result of a series of deformational events that transposed the greenstone belt into its present east-trending orientation and produced a subhorizontal regional enveloping surface (Beaumont-Smith and Böhm, 2003, 2004). The greenstone belt comprises volcanic arc and back-arc rocks and epiclastic sedimentary rocks that were intruded by three suites of successor arc plutons (Syme, 1985; Zwanzig et al., 1999; Beaumont-Smith and Böhm, 2002, 2003).

The Lynn Lake belt has been the subject of a number of regional- and deposit-scale mineral deposit studies since 1999. The focus of these studies is gold metallogeny and the geological and tectonic context for gold mineralization in the Lynn Lake belt. In the course of these studies, a large number of samples were collected and analyzed, which generated a large volume of geochemical data. While many of the gold metallogeny and tectonic studies are ongoing, this large dataset represents a potentially significant resource for exploration companies undertaking gold and base metal exploration in the belt and has thus been compiled for public dissemination.

The geochemical database (Appendix 1) that forms the basis of this report was compiled from geochemical sampling associated with four geological mapping projects. Two of the projects are regional gold metallogeny and tectonics studies and the other two projects are deposit studies of the Burnt Timber (BT) and MacLellan mines. The BT deposit study was completed in 2005 in the form of a M.Sc. thesis (Jones, 2005) and a series of publications (Jones et al., 2000, 2006). The MacLellan mine project is an incomplete Ph.D. project in which the preliminary results have been published in a number of publications (Ma et al., 2000; Ma and Beaumont-Smith, 2001; Park et al., 2002).

Regional Geology

The Lynn Lake greenstone belt represents a Paleoproterozoic granite–greenstone terrain 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 (Figure 1; Milligan, 1960; Gilbert et al., 1980). The various metavolcanic and metasedimentary units making up the greenstone belt represent a variety of tectonic affinities (see Zwanzig et al., 1999) that were structurally assembled and transposed during the early stages of the orogen. The supracrustal rocks in the Lynn Lake belt were initially assigned to the Wasekwan Group (Bateman, 1945) but recent structural, geochemical, isotopic and geochronological studies (Zwanzig et al., 1999; Beaumont-Smith, 2000; Beaumont-Smith et al., 2001; Beaumont-Smith and Böhm, 2002, 2003, 2004) have identified the need to revise the volcanic stratigraphy to reflect differences in their age and geochemical and isotopic composition. The greenstone belt is overlain by younger, synkinematic, fluvial-alluvial molasse-type sedimentary rocks of the Sickle Group (Norman, 1933).

The greenstone belt is intruded by three suites of successor arc plutons: the ca. 1875 Ma Poole Lake intrusive suite (Baldwin et al., 1987; Turek et al., 2000), the ca. 1855 Ma Chipewyan (Wathaman) batholith (Manitoba Energy and Mines, 1986; Turek et al., 2000; Beaumont-Smith et al., 2006), and the ca. 1830 Ma post-Sickle plutons (Milligan, 1960; Turek et al., 2000; Beaumont-Smith and Böhm, 2002, 2003). The youngest intrusive body in the Lynn Lake area is the Eden Lake Alkaline Complex, located at the eastern end of the greenstone belt. The Eden Lake Alkaline Complex comprises older tonalite to granodiorite that has been intruded by a series of metaluminous, alkaline affinity granodiorite to monzogranite plutons and aegirine-augite syenite (Cameron, 1988; Arden, 1995) and rare carbonatite (Mumin, 2002). Accompanying the intrusion of the younger phases is widespread potassium metasomatism (Cameron, 1988). The carbonatite generally forms dikes containing very high concentrations of rare earth elements (Arden, 1995; Mumin, 2002).

The deformational history of the Lynn Lake belt comprises seven discrete deformations (D_1–D_7; Beaumont-Smith and Rogge, 1999; Beaumont-Smith and Böhm, 2002). The regional structural geometry is dominated by isoclinal, upright, horizontally plunging F_2 folds and D_2 shear zones that developed during the later stages of D_2. The regional structural geometry is characterized by steeply north-dipping strata, down-dip stretching lineation and a subhorizontal macroscopic enveloping surface.

Mineralization

A brief summary of the known styles of mineralization characterizing the Lynn Lake greenstone belt is included to provide context for the attached geochemical data. The Lynn Lake belt has been the site of mining operations for a variety of commodities representing a number of different deposit types. Mining started with the development of the magmatic nickel-copper deposits associated with the Lynn Lake gabbro, which was followed by development of copper-zinc volcanogenic massive sulphide (VMS) mineralization at the Fox Lake mine. The last operating mines exploited a number of gold deposits in the central and eastern portion of the greenstone belt.

The magmatic nickel-copper deposits are associated with the 1871 Ma (Turek et al., 2000) Lynn Lake gabbro, which comprises the A and EL plugs (Pinsent, 1980). The A plug hosts a series of steeply plunging, structurally controlled orebodies within a composite ultramafic to intermediate body along the northern margin of the Lynn rhyolite (see Pinsent, 1980). The EL plug is a small, carrot-shaped ultramafic to mafic body that intruded the south margin of the Lynn rhyolite. The EL plug comprises marginal contact diorite and an inner peridotite core (Pinsent, 1980). Both bodies are tholeiitic and show varying degrees of silica contamination (Pinsent, 1980).

Pinsent (1980) presents a variety of genetic models for the origin of the nickel-copper mineralization in the A and EL plugs. The location of the parent ultramafic to mafic plutons in relation to the Lynn rhyolite, the evidence of assimilation of rhyolite by the host intrusions (Pinsent, 1980), and the presence of high concentrations of zinc in many of the mine stopes (P. Pawliw, pers comm, 1999; Assessment File 72772, Manitoba Science, Technology, Energy and Mines, Winnipeg)

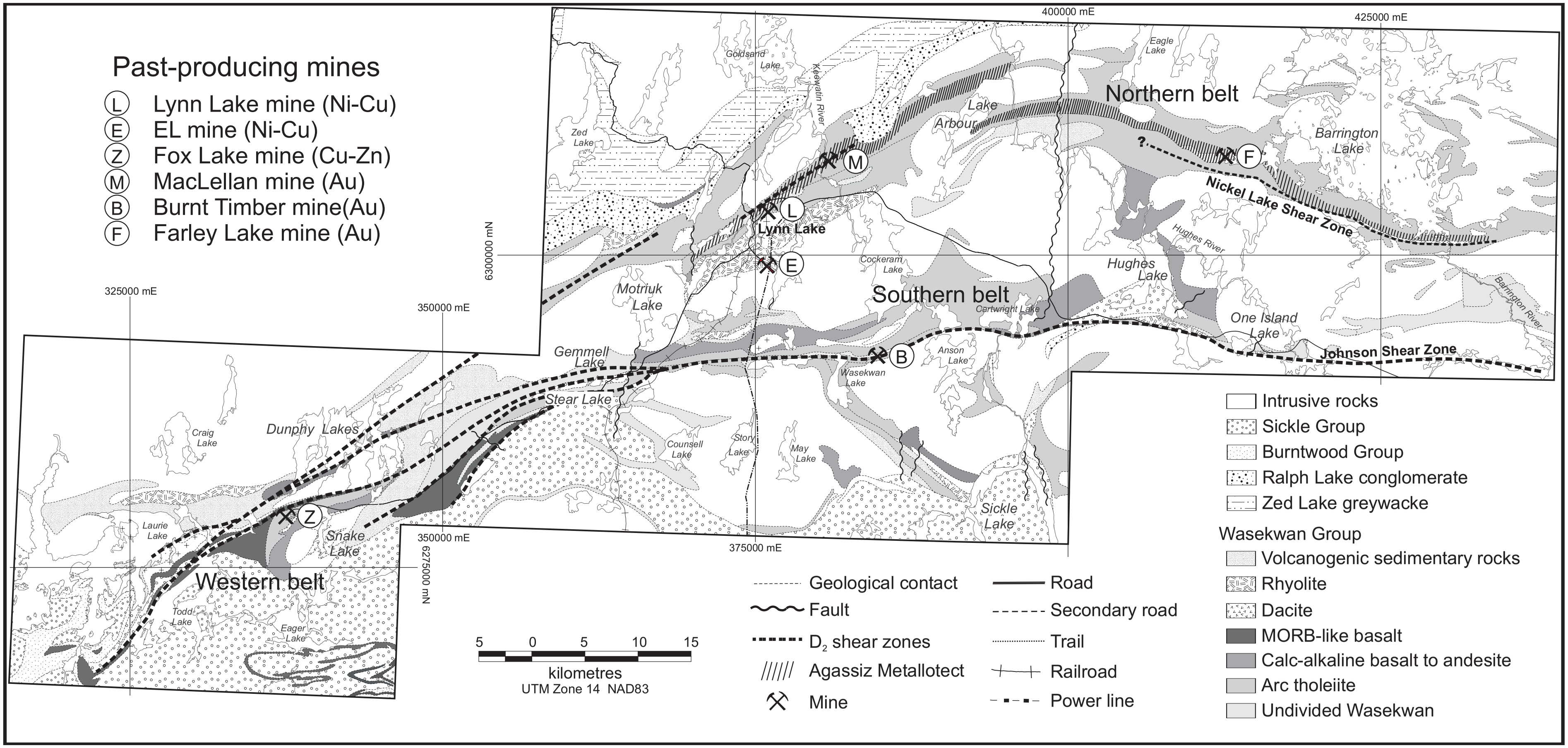

***Figure 1:** General geology of the Lynn Lake greenstone belt.*

suggests the mineralization resulted from the intrusion of fertile parent magmas into a VMS system associated with the Lynn rhyolite.

VMS mineralization at the Fox Lake mine in the western Lynn Lake belt is found in a series of calcalkaline transitional to tholeiitic mafic and felsic volcanic rocks (Zwanzig et al., 1999). The host volcanic rocks in this portion of the Lynn Lake belt have weakly contaminated ε_{Nd} values (Beaumont-Smith and Böhm, 2003). The Fox Lake deposit comprises two massive sulphide lenses that exhibit strong vertical copper-zinc metal zonation (Olson, 1987).

The majority of gold mineralization in the Lynn Lake belt is genetically associated with shear zones developed during the later stages of the transpositional D_2 deformation. The D_2 deformation produced upright, horizontal-plunging tight to isoclinal folds that culminated with the development of a regional network of anastomosing dextral-transpressional shear zones (Beaumont-Smith and Rogge, 1999; Beaumont-Smith and Böhm, 2002). The most significant D_2 shear zone is the Johnson Shear Zone, which forms the southern boundary of the Lynn Lake belt, reflecting the concentration of regional strain along the southern supracrustal-intrusive boundary of the greenstone belt. The Johnson Shear Zone is a major crustal-scale structural feature that can be traced from the LaRonge, Saskatchewan area east through the Lynn Lake belt to the Waskiaowaka Lake area in the Superior Boundary Zone.

The localization of D_2 strain along rheological boundaries is a major factor in the development of D_2 shear zones as well as in the emplacement of gold mineralization within the shear zones. In all cases of shear-hosted gold mineralization in the Lynn Lake belt, gold mineralization and its associated alteration are hosted by shear zones or highly sheared rocks developed in areas of large rheology contrasts. The alteration generally consists of synshear potassium metasomatism, either as sericite or biotite, followed by carbonatization and silicification. The relationship between gold mineralization, rheological boundaries and shear zone development gives rise to the concept of gold metallotects. In the northern belt, the Agassiz Metallotect (Fedikow and Gale, 1982; Fedikow, 1983) represents a thin, laterally persistent sequence of ultramafic volcanic rocks (picrite), finely laminated sedimentary rocks and banded iron formation that is the locus of D_2 shear zone development and hosts most gold occurrences in the northern belt. The MacLellan deposit is located within a sequence of alternating (fold repeated) highly deformed picrite and siliceous siltstone (Fedikow, 1986, 1992; Gagnon, 1991). In the southern Lynn Lake belt, the Johnson Shear Zone represents a gold metallotect. The BT deposit is situated within a thin sequence of mafic epiclastic sedimentary rocks in a thick mafic volcanic package deformed by the Johnson Shear Zone. The gold mineralization is associated with synshear granodiorite dikes within the epiclastic rocks.

Gold mineralization in the Lynn Lake belt is not restricted to syndeformational emplacement. A second period of gold deposition occurred following the intense D_2 shear zone development of the greenstone belt that hosts the bulk of the gold mineralization identified in the belt. This event is characterized by the Farley Lake deposit, which comprises several zones of gold mineralization hosted by a significantly F_2 fold-thickened sequence of interbedded oxide, silicate and sulphide facies iron formation in the eastern Agassiz Metallotect (Peck et al., 1998). The gold mineralization is characterized by the emplacement of high-grade (up to 100 g/t Au), flat-lying, vuggy quartz-carbonate-sulphide veins, which resulted in the development of broad, gold-bearing sulphidization haloes around the veins. Structural relationships are consistent with the post-D_5 emplacement of the flat veins.

Analytical Methods

Samples presented in this report were collected in the course of deposit- and regional-scale geological mapping and structural analysis as part of a project focussed on the study of gold metallogeny of the Lynn Lake greenstone belt. Accordingly, sample selection reflects a variety of purposes. Many of the samples represent the least-altered material, collected to provide representative examples of supracrustal and intrusive rocks comprising the greenstone belt and plutonic environs. Unlike standard regional lithogeochemistry, many samples included in the attached database (Appendix 1) represent altered and mineralized material collected during gold deposit studies, which contributes to a highly variable sample density in addition to the variability of material analyzed.

Samples submitted for analysis were cleaned of their weathered surfaces wherever possible. In the case of highly altered samples, this was not always possible. Sample preparation was done at the Manitoba Geological Survey laboratory. The preparation process involved cleaned rock chips being jaw crushed to fragments less than 5 mm in size followed by powdering in a tungsten carbide swing mill. The powders were homogenized by rolling and then split and placed into vials each weighing approximately 55 g. Vials were then submitted for instrumental neutron activation analysis (INAA) and inductively coupled-plasma mass spectroscopy (ICP-MS) analysis at Activation Laboratories Ltd. Major oxides and selected trace elements were analyzed with fusion ICP (code 4B) and trace elements were analyzed by ICP-MS (code 4B2). Selected trace elements (Au, As, Br, Cr, Ir, Sb, Sc, Se) were analyzed by INAA (code 4B-INAA), which provides lower detection limits. Values below the detection limits for the respective elements are reported as negative values in the database. Over the time period of the study, improvements in analytical methodology occurred resulting in improved detection limits. Therefore, several elements have multiple detection limits in the database.

Synthesis

The highly variable nature of the samples analyzed in Appendix 1 reflects the multiple applications for which the analytical data were collected. This contrasts to the more uniform sample composition and distribution of other geochemical databases complied for the Lynn Lake greenstone belt that afforded regional-scale comparisons of rock compositions to determine volcanic chemostratigraphy, tectonic affinity or base metal prospectivity (cf. Syme, 1985; Zwanzig et al., 1999). Many of the trace elements analyzed demonstrate strong bulk rock compositional controls and can therefore be used to map the distribution of chemically distinctive units. This is demonstrated by the distribution of ultramafic volcanic rocks (picrite) as delineated by concentrations of nickel and chrome throughout the northern and southern Lynn Lake belts. The trace element data suggests that the distribution of picrite is potentially more widespread than previously thought. The presence of picrite in the southern belt stratigraphy is significant on several fronts. First, its presence suggests that the two belts constituting the Lynn Lake belt are more similar in composition and represent portions of the same arc system. This has major implications regarding the regional structural geometry and tectonic history of the greenstone belt. Secondly, picrite characteristically represents a locus for the concentration of the regional D_2 deformation, and accordingly, represents a favourable horizon for the development of gold-bearing structures.

Several regional anomaly trends can be extracted from the dataset. Although many gold-mineralization pathfinder elements (Ag, As, Sb, Sn, W) have high numbers of analyses below analytical detection limits, there is a correlation between the anomalous pathfinder analyses and known gold mineralization and mineralized structures in the Lynn Lake belt. Gold mineralization in the BT deposit and Gemmell Lake gold-showing areas is characterized by high gold pathfinder and base metal (Cu, Pb, Zn) analyses, whereas the MacLellan area and western strike extension lack Sn, Sb and W correlations. This difference may be significant and useful in categorizing the style of mineralization associated with geochemical anomalies found elsewhere in the belt.

Similarly, the silicification associated with gold mineralization in the Agassiz Metallotect is characterized by highly anomalous values of high-field-strength elements. This includes rare earth elements (REE), especially the heavy rare earth elements (HREE). This either reflects preferential enrichment during the alteration event, or more probably, element immobility. The application of REE analysis to regional prospecting for alteration (silicification) associated with picrite-hosted gold mineralization may prove useful in the eastern portions of the northern Lynn Lake belt, where the sample density in this dataset is very low, and the southern Lynn Lake belt, where picrite has not previously been identified.

These trends are confounded by the sampling bias and differences in bulk rock compositions of the host rocks, but clearly the associations between the pathfinder- and base-metal elements indicates their application to the targeting of hydrothermal fluid-focussing structures throughout the Lynn Lake belt. While there is a bias towards known areas of gold mineralization, there is a wealth of data distributed throughout the Lynn Lake belt. This is exemplified by the highest nickel analysis, which was returned from the eastern Dunphy Lake area. This highly anomalous analysis was returned from an environment similar to known nickel mineralization elsewhere in the Lynn Lake belt. Additional data is available (Zwanzig et al., 1999), which complements this dataset, expanding the sample distribution and the rock types sampled. The two combined datasets represent more than 700 geochemical analyses from the Lynn Lake belt.

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References

Arden, K.M. 1995: Mineral paragenesis and pegmatite formation associated with the Eden Lake syenite complex, northern Manitoba; M.Sc. thesis, University of Manitoba, Winnipeg, 240 p.

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 Lake 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 Böhm, C.O. 2002: Structural analysis and geochronological studies in the Lynn Lake greenstone belt and its gold-bearing shear zones (NTS 64C10, 11, 12, 14, 15 and 16), Manitoba; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 159–170.

Beaumont-Smith, C.J. and Böhm, C.O. 2003: Tectonic evolution and gold metallogeny of the Lynn Lake greenstone belt, Manitoba (NTS 64C10, 11, 12, 14, 15 and 16); *in* Report of Activities 2003, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 39–49.

Beaumont-Smith, C.J. and Böhm, C.O. 2004: Structural analysis of the Lynn Lake greenstone belt; *in* Report of Activities 2004, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 55–68.

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 Industry, Trade and Mines, Geological Services, p. 61–66.

Beaumont-Smith, C.J., Anderson, S.D. and Böhm, C.O. 2001: Structural analysis and investigations of shear-hosted gold mineralization in the southern Lynn Lake greenstone belt (parts of NTS 64C/11, /12, /15, /16); *in* Report of Activities 2001, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 67–75.

Beaumont-Smith, C.J., Machado, N. and Peck, D.C. 2006: New uranium-lead geochronology results from the Lynn Lake greenstone belt, Manitoba (NTS 64C11–16); Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, Geoscientific Paper GP2006-1, 11 p.

Cameron, H.D.M. 1988: Geology of the Eden Lake area; Manitoba Energy and Mines, Minerals Division, Geological Report GR84-2, 18 p.

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.

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, 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 Department of Energy and Mines, Mineral Resources Division, Geological Paper GP80-1, 118 p.

Jones, L.R. 2005: Geology of the shear-hosted Burnt Timber deposit, Lynn Lake, northern Manitoba; M.Sc. thesis, Laurentian University, Sudbury, 74 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.

Jones, L.R., Lafrance, B. and Beaumont-Smith, C.J. 2006: Structural controls on gold mineralization at the Burnt Timber mine in the Lynn Lake greenstone belt, Trans-Hudson Orogen, Manitoba; Exploration and Mining Geology, v. 15, p. 89–100.

Lewry, J.F. and Collerson, K.D. 1990: The Trans Hudson Orogen: extent, subdivisions, and problems; *in* Lewry, J.F. and Stauffer, M.R. (ed.), The Early Proterozoic Trans-Hudson Orogen of North America, Geological Association of Canada, Special Paper 37, p. 1–14.

Ma, G. and Beaumont-Smith, C.J. 2001: Stratigraphic and structural mapping of the Agassiz Metallotect near Lynn Lake, Lynn Lake greenstone belt (parts of NTS 64C/14, /15); *in* Report of Activities 2001, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 86–93.

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 (parts of NTS 64C/14, /15); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 51–56.

Manitoba Energy and Mines 1986: Granville Lake, NTS 64C; Manitoba Energy and Mines, Minerals Division, Bedrock Geology Compilation Map Series, NTS 64C, scale 1:250 000.

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

Mumin, A.H. 2002: Discovery of a carbonatite complex at Eden Lake (NTS 64C9); *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 187–197.

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

Olson, P.E. 1987: The stratigraphy, structural geology and geochemistry of the Fox Lake massive sulphide deposit; M.Sc. thesis, University of Manitoba, Winnipeg, 220 p.

Park, A.F., Beaumont-Smith, C.J. and Lentz, D.R. 2002: Structure and stratigraphy in the Agassiz Metallotect, Lynn Lake greenstone belt (NTS 64C/14 and /15), Manitoba; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 171–186.

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, C/11, C/15); *in* Report of Activities 1998, Manitoba Energy and Mines, Geological Services, p. 69–74.

Pinsent, R.H. 1980: Nickel-copper mineralization in the Lynn Lake gabbro; Manitoba Department of Energy and Mines, Mineral Resources Division, Economic Geology Report ER79-3, 138 p.

Stauffer, M.R. 1984: Manikewan: an Early Proterozoic ocean in central Canada, its igneous history and orogenic closure; Precambrian Research, v. 25, p. 257–281.

Syme, E.C. 1985: Geochemistry of metavolcanic rocks in the Lynn Lake belt; Manitoba Energy and Mines, Geological Services, Geological Report GR84-1, 84 p.

Turek, A., Woodhead, J. and Zwanzig, H.V. 2000: U-Pb age of the gabbro and other plutons at Lynn Lake (parts of NTS 64C); *in* Report of Activities 2000, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 97–104.

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 accompanying map and diskette.