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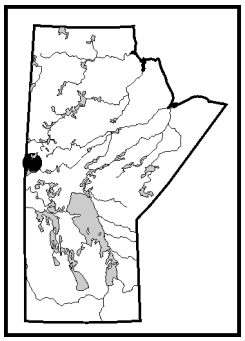
GS-3 Platinum group element investigations in the Flin Flon greenstone belt: Mikanagan Lake and Tartan Lake gabbroic complexes, Manitoba (NTS 63K13)

by P. Theyer and T.H. Heine



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Summary

Recent discoveries of platinum group elements (PGE) within and near gabbroic bodies intruded into mafic volcanic rocks of the Bear Lake Block highlight the potential of the Flin Flon greenstone belt to contain economically significant PGE mineralization. Geological traverses in 2003 across the northern segment of the Mikanagan Lake sill, the Tartan Lake gabbro complex and the Tartan Lake gabbro sill indicate that these three intrusions differ markedly from each other but all contain a remarkable abundance of sulphide minerals and an attendant potential to host PGE mineralization.

The Mikanagan Lake sill, which is a well-differentiated, layered igneous body in the south, is reduced to an undifferentiated, fine-grained homogeneous gabbro, approximately 250 m thick and ubiquitously mineralized with pyrrhotite, near Tartan Lake in the north. The northern segment of the sill is cut by several prominent, closely spaced (20–30 m), east-northeast-striking faults that contain in excess of 5% sulphides. These faults were sampled to investigate their possible association with elevated concentrations of PGE.

The Tartan Lake gabbro complex is a multiphase, hybrid, gabbroic to granitoid, plug-shaped intrusion. It is characterized by 1) a complex intrusive history, including at least four discrete intrusive phases; 2) significant occurrences of sulphide-bearing mafic igneous breccia and mafic pegmatite; and 3) major sulphide-bearing shear zones, 1 to 2 m wide and up to 0.5 km long. Many of these attributes characterize contact-type PGE deposits (Peck et al., 2002) and also resemble the salient characteristics of the Lac des Isles PGE mine in Ontario (Watkinson et al., 2002), making the Tartan Lake gabbro complex a PGE exploration target of note.

The Tartan Lake gabbro sill is well differentiated and layered. Outstanding exposures allowed detailed documentation of the geology and collection of closely spaced rock samples during 2003 investigations. An evaluation of geochemical and petrographic characteristics of the sill will allow inferences on the nature, sequence and geochemistry of the intrusive phases, and the type of sulphidic mineralization. These data are important not only for assessing the PGE potential of the sill but also for regional geological syntheses.

Previous work and introduction

The geology in the Tartan and Mikanagan lakes area (Fig. GS-3-1) has been investigated by a number of workers, including Tanton (1941), Bateman and Harrison (1945) and Bailes and Syme (1989), who provided a regional geological framework and synthesis for this part of the Flin Flon greenstone belt. Gilbert (1986, 1990, 1997, 1999, and references therein) undertook detailed and systematic geological mapping of this area at 1:15 840 scale.

The Tartan Lake gold mine (in production from 1987 to 1989) attracted the attention of several workers. The geological setting was investigated by Peloquin and Gale (1985), with detailed follow-up mapping and tectonic analysis by Peloquin (1985), Peloquin et al. (1986) and Gale and Ferreira (1988). Fedorowich et al. (1991) presented an in-depth study of the mineralization, its structural control and its paragenesis, and noted that PGE alloys occur in association with the gold ore.

The recently discovered McBratney Lake PGE-Au occurrence, containing exceptionally high PGE and Au concentrations (up to 31 g/t Pd and 9 g/t Pt; Fort Knox Gold Resources Inc., press release, Aug. 13, 2001) that occur either at or near the contact of gabbro and basaltic andesite of the Bear Lake Block, highlighted the potential of the Flin Flon greenstone belt to contain economically significant PGE mineralization (Theyer, 2001; Olivo et al., 2002; Theyer and Heine, 2002). Subsequent discoveries of elevated PGE occurrences within other gabbroic bodies of the Bear Lake Block, such as the Wonderland Lake gabbro (Theyer, 2001) and the Mikanagan Lake sill (Theyer and Heine, 2002), focused attention on several mafic intrusive bodies in this tectonostratigraphic region that are considered to be of similar age and geological provenance.

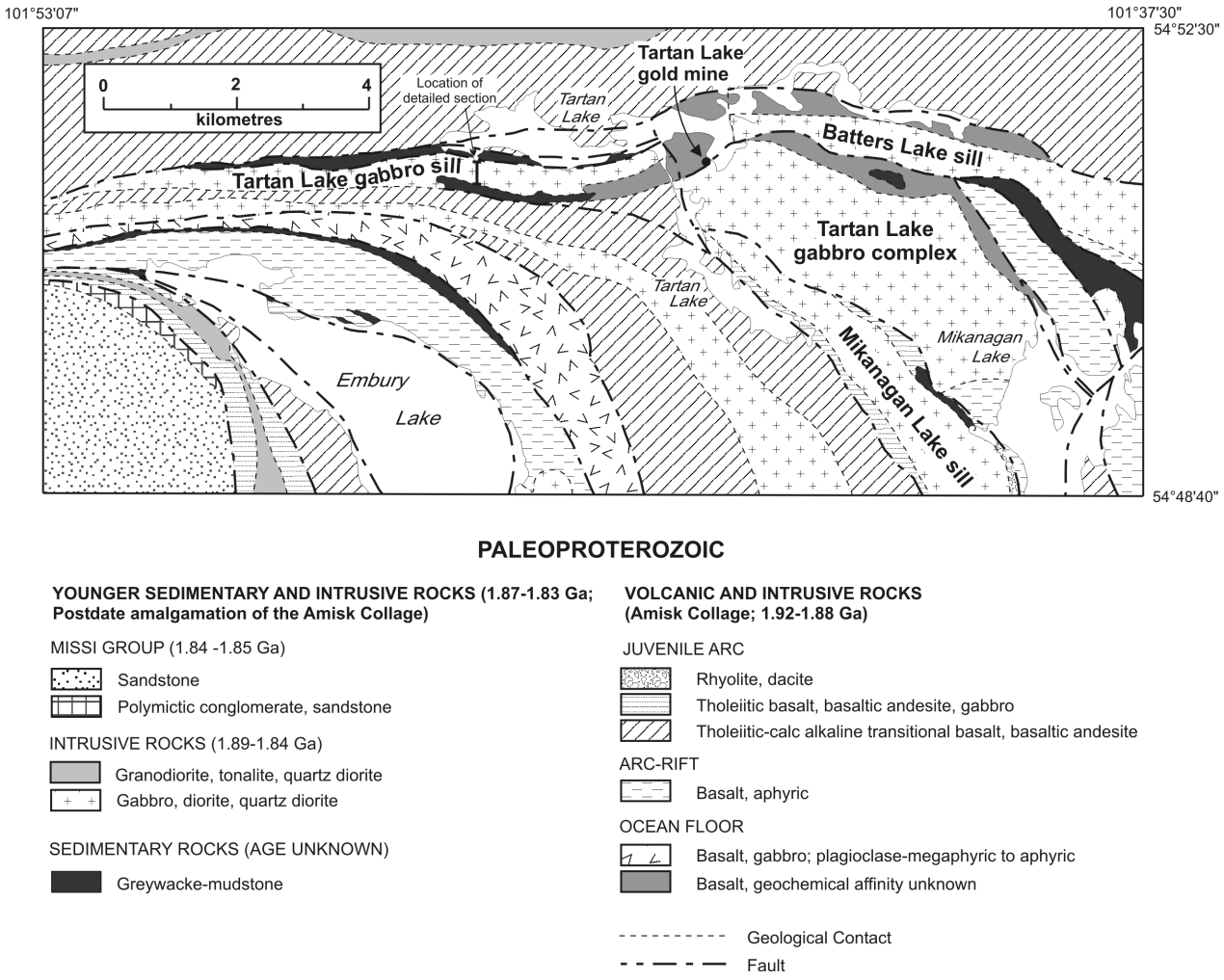

Figure GS-3-1: Geology of the Tartan-Embury-Mikanagan lakes area (modified after Gilbert, 1999).

Present study

According to Gilbert (1990), the area examined during this study is largely underlain by mafic volcanic flows and derived schist and amphibolite, intruded by gabbroic to granitic igneous bodies. These intrusions are the focus of this investigation. Three weeks of the 2003 field season were dedicated to investigating the PGE potential of, and collecting rock samples from, 1) the northern part of the Mikanagan Lake sill, 2) the Tartan Lake gabbro complex, and 3) several sections of the Tartan Lake gabbro sill.

Mikanagan Lake sill

The Mikanagan Lake sill, a northwest-striking, subvertical, well-differentiated gabbroic sill of tholeiitic affinity (Bailes and Syme, 1989), terminates, according to Gilbert (1990), approximately 1 km south of the Tartan Lake gold mine. It extends for 13.5 km, attains a maximum thickness of 1.2 km, and comprises a well-developed, east-facing sequence of six fractionated units, characterized by progressively increasing felsic composition, ranging from gabbronorite in the southwest to quartz-eye tonalite in the northeast (Gilbert 1990). A comparable internal stratigraphy was also noted approximately 10 km farther south by Bailes and Syme (1989). Gilbert (1990), however, noted that only a part of this sequence of differentiated units is preserved in the northern part of the Mikanagan Lake sill near the Tartan Lake gold mine.

A traverse from Tartan Lake northeast to a small unnamed lake approximately 2.5 km northwest of Bartley Lake showed this area, which is considered to be the northernmost outlier of the Mikanagan Lake sill (Gilbert, 1990) to be underlain by massive, medium-grained gabbro to leucogabbro. At this locality, the intrusive rocks contain a conspicuous array of subparallel, east-northeast-striking faults characterized by shear zones, up to several metres thick, that are

either silicified or mineralized with pyrite, hematite and ankerite. Rock samples collected from these mineralized shears will be analyzed for PGE and Au.

Tartan Lake gabbro complex

Parbery and Gale (1984) and Gale and Eccles (1988), during examination of the Tartan Lake gold deposit, found the deposit to be hosted by quartz-chlorite schist in shear zones located at the contacts between a gabbro, volcanogenic sedimentary rocks and andesitic lavas. Peloquin and Gale (1985) and Peloquin et al. (1986) described the host gabbro as a "multiple intrusion of gabbroic and dioritic rocks." They distinguished between medium-grained and fine-grained gabbro and diorite. They described the medium-grained gabbro to be a multiphase intrusive rock, ranging from pyroxenite to olivine gabbro and coarse-grained diorite, and the fine-grained gabbro to diorite as intruding the medium-grained gabbro and locally forming igneous-breccia complexes.

Gilbert (1986) introduced the term 'Tartan Lake gabbro complex' to informally distinguish this chaotically arranged, multiphase, gabbroic to granophyric intrusive complex from the elongated, orderly, layered and differentiated sills in the vicinity. Gilbert (1990) distinguished four intrusive phases in the Tartan Lake gabbro complex. Phase IA consists of medium- to coarse-grained, in places pegmatitic, melagabbro to hornblendite; phase IB is a fine- to medium-grained gabbro to melagabbro. Phase II is volumetrically the most abundant and consists of fine- to coarse-grained, leucocratic to melanocratic gabbro that, in places, assimilates phase I rocks. Phase III consists of fine-grained diabase dikes and veins, and phase IV is white to pink granodiorite to granite. Intrusion breccia, consisting of angular fragments of medium- to coarse-grained melagabbro to hornblendite in leucocratic to mesocratic gabbro, occurs sporadically throughout the complex but is especially well developed in the northwestern part. The location, nature and configuration of the contact between the northern Mikanagan Lake sill and the Tartan Lake gabbro complex are poorly understood. The Mikanagan Lake sill is separated from the Tartan Lake gabbro complex locally by a septum of volcanic rocks and elsewhere by a structural break.

Tartan Lake gabbro sill

Gilbert (1987) subdivided this well-layered gabbroic sill, which extends west from the area between Tartan Lake and Ruby Lake, into four zones: 1) a lower zone of massive mesocratic gabbro; 2) a transitional zone of medium-grained to very coarse grained gabbro (recognized only in the western part of the sill); 3) a middle zone of gabbro, melagabbro and hornblendite; and 4) an upper zone of quartz-bearing leucogabbro and granophyric gabbro.

During the 2003 field season, extensive, clean and lichen-free outcrops were examined across the width of the Tartan Lake gabbro sill between Dubnick and Tartan lakes. This work provided a rare opportunity to document the lithology of the sill, its stratigraphy, and the nature and location of sulphidic and/or oxide mineralization on a metre-by-metre scale. The work will be published following petrographic and geochemical investigations. Such detailed documentation is needed because the most economically viable PGE concentrations are of the reef type (i.e., stratiform, sulphide-bearing ore zones), which rarely exceed 10 m in thickness.

Twenty-two rock samples collected on this traverse will be analyzed for PGE, Au and major, minor and rare earth elements. The results of these analyses, combined with lithological and thin-section descriptions, will be published as soon as the data are available.

Economic considerations

The Flin Flon greenstone belt is considered to have potential to host economic PGE deposits because significant PGE concentrations occur in gabbroic intrusions within the Bear Lake Block (e.g., the McBratney and Kennel PGE occurrences [Theyer, 2001]) and the Mikanagan Lake sill (Theyer and Heine, 2002). Data collected during the 2003 field season that support this hypothesis include the virtually ubiquitous presence of low concentrations (0.5 to 3%) of sulphides in most of the gabbroic intrusions examined.

The Tartan Lake gabbro complex appears to be an especially good candidate to host contact-type PGE mineralization (Peck et al., 2002) because it 1) is mineralized with abundant sulphides; and 2) contains substantial amounts of igneous breccia and mafic pegmatite, both of which, according to Barrie et al. (2002), characterize contact-type PGE deposits. Moreover, Fedorowich et al. (1991) had already established the existence of PGE in the Tartan Lake gabbro complex, reporting that ore in the Tartan Lake gold mine (hosted, at least in part, by rocks of the Tartan Lake gabbro complex) contains bismuth tellurides with minor PGE that appear to have coprecipitated with gold and also occur as inclusions in and rims on pyrite and chalcopyrite grains.

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