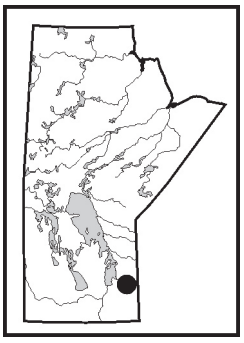
GS-14 Preliminary results from geological mapping of the Bernic Lake Formation, Bird River greenstone belt, southeastern Manitoba (NTS 52L6)

by P.D. Kremer[1]



Kremer, P.D. 2005: Preliminary results from geological mapping of the Bernic Lake Formation, Bird River greenstone belt, southeastern Manitoba (NTS 52L6); *in* Report of Activities 2005, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 140–145.

Summary

In June of 2005, a two-year M.Sc. study was initiated to examine the structural geology of the Bernic Lake Formation and provide constraints on the emplacement of rare-element granitic pegmatites that occur within it. The study is being completed at the University of Waterloo in cooperation with the Manitoba Geological Survey and Tantalum Mining Corporation of Canada Limited. Fieldwork in 2005 was focused on 1:10 000-scale geological mapping of the Bernic Lake Formation and collection of an extensive sample set for oriented thin-section and geochemical analyses. Preliminary results are described below.

Introduction

The Bird River greenstone belt is located in the Archean Superior Province of the Canadian Shield in southeastern Manitoba, approximately 100 km northeast of Winnipeg. It comprises metavolcanic and metasedimentary rocks, and associated synvolcanic intrusions. The belt hosts, in part, the Cat Lake–Winnipeg River pegmatite field, of which the Tanco pegmatite (hosted in the Bernic Lake Formation) is the most noteworthy. Although mineralogical studies of pegmatite bodies within the pegmatite field are numerous (Cerny and Turnock, 1971, 1975; Cerny, 1978; Lenton, 1979; Cerny et al., 1981), systematic exploration models for the discovery of new rare-element granitic pegmatites within the belt are lacking.

The Bird River greenstone belt comprises metasedimentary and metavolcanic rocks of the Rice Lake Group, which are exposed along the south margin of the English River Subprovince of the Superior Province. It is bounded to the north by the Manigotagan gneissic belt and to the south by the Winnipeg River batholithic belt. Trueman (1980) subdivided the Bird River greenstone belt into six lithostratigraphic formations, termed the Eaglenest Lake Formation, Lamprey Falls Formation, Peterson Creek Formation, Bernic Lake Formation, Flanders Lake Formation and Booster Lake Formation. Descriptions of each division can be found in Trueman (1980), Cerny et al. (1981) and Duguet (GS-12, this volume).

Bernic Lake Formation

General geology

Preliminary mapping of the Bernic Lake Formation around the Tanco mine site at a scale of 1:10 000 was undertaken during the summer of 2005. Rock types identified within the map area include metamorphosed basalt, andesite with minor andesitic volcanic breccia, dacite, volcanic conglomerate and sandstone, gabbro, diorite, granodiorite, quartz diorite, tectonite and pegmatite (Figure GS-14-1).

Basalt forms the most extensive unit in the map area and occurs primarily as pillowed flows, with minor massive flows. Basalt weathers dark grey to black and is generally aphyric, although feldspar-phyric occurrences are observed. Typically it is moderately to strongly foliated. Pillow structures are locally well preserved and, in places, show younging criteria (Figure GS-14-2). In many instances, however, the pillows are nearly or completely obliterated by the effects of deformation. Quartz±carbonate amygdules up to 3 cm across are present in the basalt. Pillow cores locally contain epidote alteration. Thin units of andesite and andesitic volcanic breccia occur within basaltic units.

Massive to fragmental dacite occurs as a thick, laterally discontinuous unit that is most prominent on the northeast shore of Bernic Lake. The dacite typically weathers buff white to grey and contains up to 15% euhedral to subhedral plagioclase crystals. North of Bernic Lake, occasional fragments of basalt occur in the dacite, suggesting proximal facies reworking. A moderate to strong schistosity is present within the dacite, and feldspar phenocrysts locally define a prominent downdip stretching lineation.

Volcanic conglomerate and sandstone form thin, laterally discontinuous units throughout the map area. Clasts in the conglomerate consist predominantly of intermediate to felsic metavolcanic rocks with occasional mafic clasts, vary from pebble to cobble size and occur within a strongly foliated black matrix. Primary layering can be locally distinguished, based on the size, abundance and/or character of the clast population. Where layering is present, elongate clasts are aligned slightly oblique to this direction, with a prominent downdip lineation (Figure GS-14-3). Fine- to medium-grained volcanic sandstone

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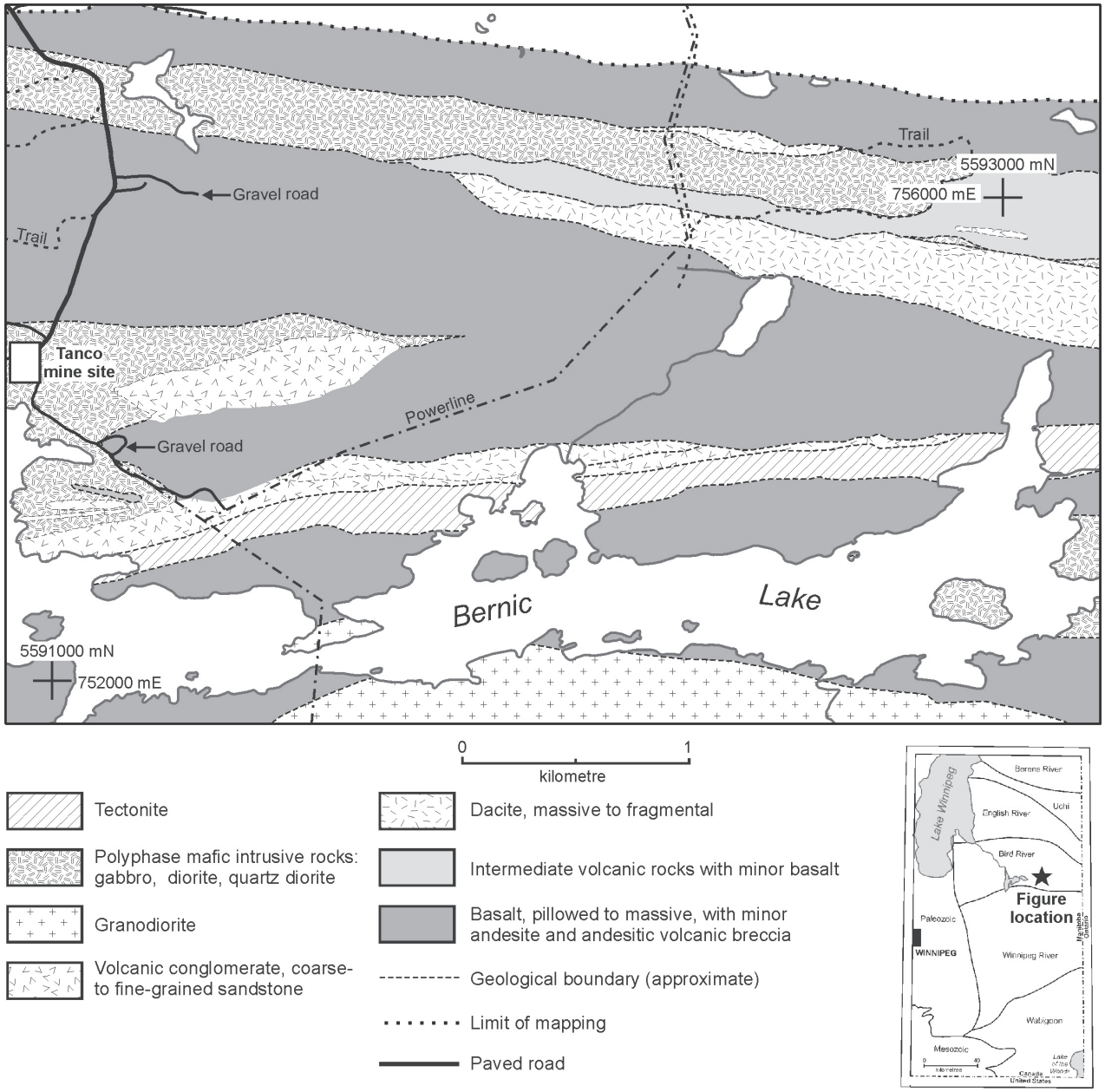

Figure GS-14-1: *Generalized geology of the Bernic Lake Formation around the Tanco mine site.*

containing detrital quartz and feldspar occurs intercalated with the conglomerate. Small, localized, discontinuous lenses of metasedimentary rocks also occur chaotically intermixed within metavolcanic piles.

A large tectonite zone, which occurs along the northern shore of Bernic Lake, ranges up to at least 200 m in thickness. Primary features are rarely preserved within the zone; however, there is textural evidence of both volcanic and clastic protoliths, suggesting that this zone may represent a tectonized contact between basalt to the south and volcanic conglomerate and sandstone to the north.

A large intrusive body, dubbed the Birse Lake granodiorite, occurs just south of Bernic Lake. It is medium grained with a well-defined foliation defined by the preferred alignment of hornblende. Locally, large xenoliths of basalt country rock up to 5 m wide occur near the margins of the intrusion. The contact between the granodiorite and the host basalt is strongly mylonitized.

Intrusions of medium- to coarse-grained, polyphase gabbro, diorite and quartz diorite occur throughout the map area. These rocks are massive and equigranular, with a subophitic texture. They range from small dikes (2–5 m thick) to large stock-like bodies that show evidence of forceful injection. At some locations southeast of the Tanco mine, angular fragments of brecciated basaltic country rock are supported within a gabbroic matrix.

Pegmatites exposed within the map area consist of

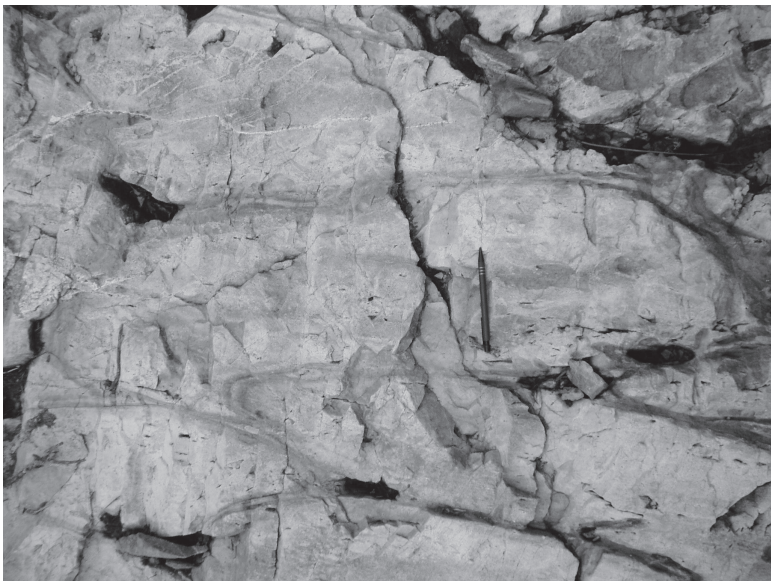

Figure GS-14-2: *Pillow basalt showing younging to the north, north shore of Bernic Lake.*

Figure GS-14-3: *Bedding in volcanic conglomerate and sandstone, power line north of Bernic Lake. Note clasts foliated slightly counter-clockwise to bedding.*

small bodies, typically no more than 5 m in thickness, that dip subvertically. These pegmatites are mineralogically simple, consisting of quartz, megacrystic K-feldspar and plagioclase feldspar, with minor muscovite, hornblende and tourmaline. Pegmatite contacts are sharp and locally irregular, and tend to crosscut primary bedding and foliation within the hostrock; locally, however, they are intruded along bedding or the dominant S_2 foliation plane. The relationship between vertically dipping, mineralogically simple pegmatites and the flat-lying Rare-element granitic pegmatites, which tend to be mineralogically complex, is currently unclear and will be the focus of field studies in 2006. Pegmatites generally show no clear affinity to hostrock and were found to occur within gabbro, deformed metavolcanic rocks, and metasedimentary rocks; the Tanco pegmatite is hosted in gabbro.

Structural geology and kinematics

The prominent structural feature of the Bird River greenstone belt is a large synform located in the northeastern portion of the belt. Map units in the Bernic Lake area trend west to west-northwest, dip subvertically and define the southern flank of this fold structure. Mapping has identified at least four generations of deformation in these rocks, which are herein termed D_1, D_2, D_3, and D_4.

D_1 deformation

Evidence of D_1 deformation is rare and is best preserved as an early planar fabric in the hinges of minor F_2 isoclinal folds. On the limbs of these folds, the S_1 fabric is rotated and completely transposed into the prominent S_2 fabric, making the distinction of S_1 difficult (Figure GS-14-4).

Figure GS-14-4: *Small-scale, isoclinal F_2 fold in volcanic conglomerate north of Bernic Lake, showing rotation of S_1 schistosity into S_2. Pencil points west.*

D_2 deformation

Structures of the D_2 deformation are the most prominent within the Bernic Lake Formation. The S_2 planar fabric consists of a pervasive, closely spaced, biotite-amphibole±chlorite schistosity that is present to varying degrees in all rock types (with the exception of certain intrusive bodies). The trend of the S_2 schistosity ranges from 80° to 120° and generally dips steeply to the south (Figure GS-14-5). Where found in association, S_2 is consistently oriented slightly counter-clockwise to primary layering in the map area.

At one location where a small-scale isoclinal F_2 fold was identified, the S_1 foliation was folded into parallelism with S_2, suggesting complete transposition of S_1 into S_2, making the distinction of the two fabrics locally ambiguous.

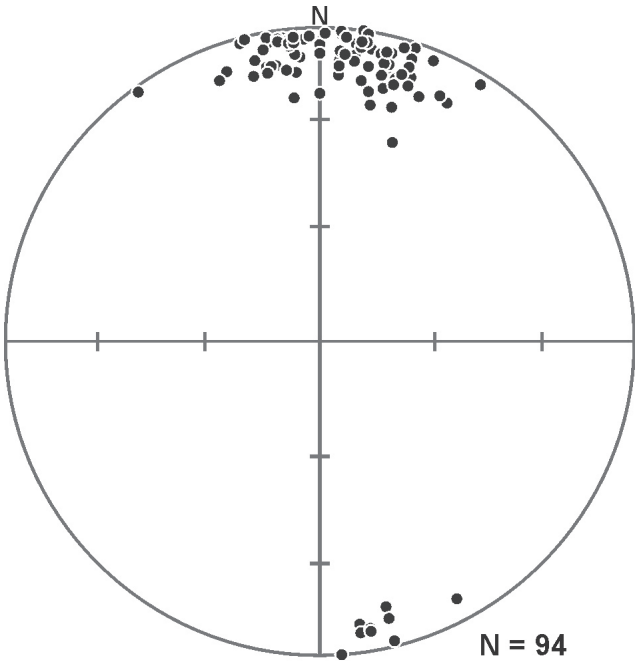

Figure GS-14-5: *Equal-area, lower-hemisphere stereographic projections of D_2 structural elements in the Bernic Lake Formation.*

The D_2 deformation is also characterized by a prominent downdip stretching lineation, defined by elongate clasts within volcanic conglomerate and plagioclase-feldspar phenocrysts within the dacite unit. Locally, a hornblende mineral lineation is coincident with the stretching lineation. Sense-of-shear criteria are abundant in the Bernic Lake Formation, and include asymmetric boudins, asymmetric flattened clasts and asymmetric tails around garnet porphyroblasts. Shear criteria on vertical outcrop surfaces parallel to the stretching lineation consistently show a south-side-up sense of displacement (Figure GS-14-6). Evidence for both dextral and sinistral displacement was observed in the horizontal plane.

Numerous, discrete, west- to west-northwest-trending shear zones, parallel to S_2 and present throughout the map area, include a large tectonite zone on the north shore of Bernic Lake. These zones display evidence of south-side-up displacement and are attributed to D_2 deformation. Samples of basalt from both sides of this zone were collected, and will be compared petrographically and geochemically to evaluate the possible significance of this structure.

D_3 deformation

Structural features attributed to D_3 deformation occur only locally. Where present, they occur as a weakly to moderately developed, spaced fracture cleavage oriented slightly (15–30°) counter-clockwise to the main S_2 schistosity. In some instances, this cleavage imposes small-scale, open, z-asymmetric flexures on preexisting planar fabrics. It is possible that reactivation of D_2 structures during D_3 is responsible for some of the strike-slip movement observed along D_2 structural planes.

Figure GS-14-6: *Asymmetric clast (left of scale card) showing south-side-up sense of displacement, north of Bernic Lake.*

D_4 deformation

Deformation D_4 is a late, brittle event that is manifest as conjugate fracture sets throughout the Bernic Lake Formation. The horizontal fracture set that hosts the Tanco pegmatite is tentatively attributed to this deformation event. The predominant fracture set trends north, is subvertical and locally displays evidence of minor slip. Associated fractures have various orientations, and stereographic analysis is underway.

Future work

Future work will consist of detailed petrographic studies of thin sections of the various rock types mapped in 2005, with an emphasis on microstructural fabric elements and characterization of surface alteration. The geochemistry of certain basalt samples from various locations within the map area will be examined to determine tectonic affinity. Field studies in 2006 will focus on examination of specific pegmatite occurrences within the Bird River greenstone belt, in the context of the structural framework outlined above. The emplacement history of selected pegmatite occurrences will be examined using U-Pb and Ar-Ar geochronology.

Economic considerations

The Bird River greenstone belt is, in part, host to the Cat Lake–Winnipeg River pegmatite field. Included in this field is the world-class Tanco pegmatite, a Rare-element granitic body being mined for lithium, cesium and tantalum. The Tanco pegmatite and other related bodies (i.e., Dibs and Buck pegmatites) occur in late subhorizontal fractures and are rarely exposed, if at all, on surface. The surface expression of these pegmatite bodies appears to locally coincide with surface areas where north-trending, subvertical fracture sets are more pronounced. In some instances, where these vertical fractures are associated with a horizontal fracture set, pervasive potassium-epidote-silica alteration is observed in the country rock. This alteration may be due to pegmatite degassing from bodies located in similar environments nearby.

Acknowledgments

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