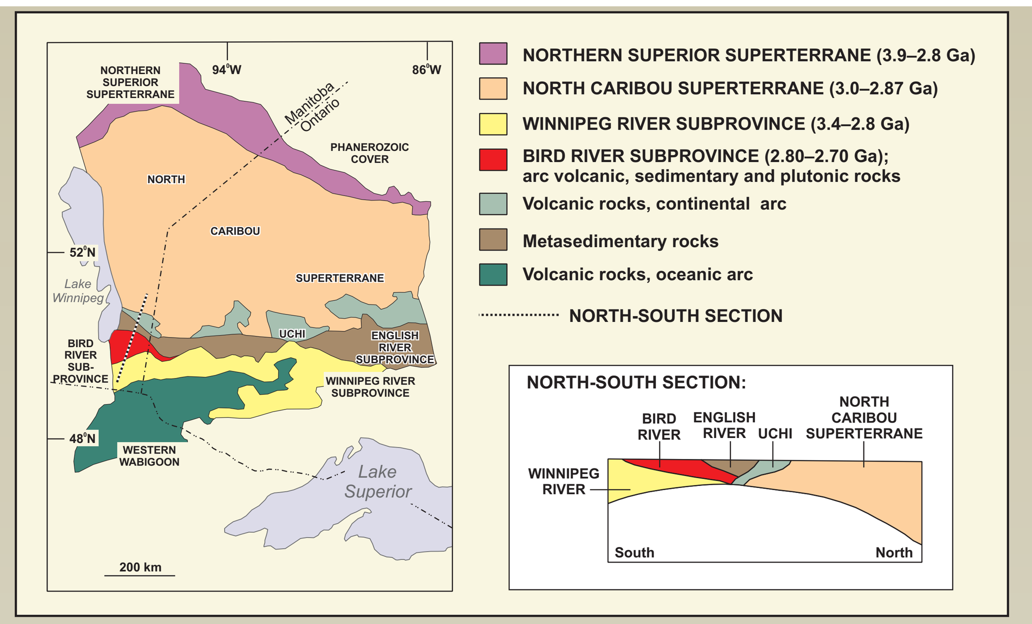


Figure 1: Geology of the western Superior Province showing the location of the Bird River Subprovince.

Introduction

The Neoarchean Bird River Belt (BRB) in southeastern Manitoba (***Figure 1***), host to both base-metal (Maskwa-Dumbarton mine) and rare-element-bearing pegmatite (TANCO mine) ore deposits, is currently the focus of several mineral exploration projects. To support this exploration, Manitoba Geological Survey (MGS) initiated a collaborative mapping project in 2005. The BRB project included detailed stratigraphic mapping and geochemical investigations (H.P. Gilbert) as well as focused research projects by postgraduate students at the University of Waterloo. These projects, which have now been completed, consisted of

(**1**) an investigation of the tectonic setting and structural-metamorphic history of the Bird River area (M. Duguet);

(**2**) a study of the setting of rare-element-bearing pegmatite bodies in the Bernic Lake area (P.D. Kremer), and

(**3**) mapping and economic investigation of the PGE-bearing Bird River Sill (C.A. Mealin).

The three postgraduate projects received financial support from both NSERC and the following exploration companies: Gossan Resources Ltd., Marathon PGM Corp., North American Palladium Ltd., Mustang Minerals Corp. and Tantalum Mining Corporation of Canada Ltd. (TANCO). Geochronological investigations, concurrent with the mapping, yielded U-Pb zircon ages for key geological units. The new age data, together with the geochemical, tectonic and metamorphic studies, have led to reappraisals of the stratigraphy, structure and regional setting of the BRB. A 1: 50 000 scale compilation map of the BRB with extensive notes, based on 2005-2007 mapping, is now available (Gilbert et al., 2008).

Field work in 2008 focused largely on the southwest part of the greenstone belt. The 1: 20 000 scale geological mapping planned at the outset of the BRB project is now complete (Mealin, 2006; Kremer and Lin 2006; Gilbert, 2008; Gilbert and Kremer, 2008). Major findings of the project include the following ~

(**1**) The BRB occurs in a transitional oceanic-continental-margin setting between older cratonic blocks - the North Caribou Superterrane to the north and the Winnipeg River Subprovince to the south.

(**2**) The predominant arc-type rocks in the BRB are separated into north and south panels by the Booster Lake Formation. This turbiditic sequence occurs as a major fault-bound enclave and several smaller fault slivers that occupy a tectonic zone extending laterally for over 40 km through the central part of the greenstone belt.

(**3**) The south panel arc-type rocks are geochemically and stratigraphically distinctive from those in the north panel (***Table 1***). In addition to the contrasting geochemical affinities, the panels are also distinguished by differences in their overall volcanic rock composition: basalt-andesite constitutes over half of the south panel but less than 10% of the north panel, in which rhyolite and dacite make up over 80% of the volcanic rock component.

(**4**) Volcanogenic massive sulphide (VMS) type mineralization has not yet been positively identified in the BRB, but numerous stratigraphically-controlled base-metal sulphide occurrences and zones of hydrothermal alteration are positive indicators in favour of the potential for VMS mineralization within the BRB.

Table 1: Comparison of north and south panels of the Bird River Belt.

North panel of Bird River Belt					South panel of Bird River Belt				
	Geochemical affinity	Litho-stratigraphy	Structure	Age		Geochemical affinity	Litho-stratigraphy	Structure	Age
Diverse Arc assemblage	Calc-alkaline; convergent tectonic regime	Mafic to felsic, massive to fragmental volcanic rocks; turbidite, conglomerate, chert and oxide-facies iron formation	Central part of BRB: repeated folding at north margin; major, overturned anticlinal fold in section farther to south	< 2706 ±23 Ma[1]	**Bernic Lake Fm**	Transitional tholeiitic to calc-alkaline. Progression from lower to upper stratigraphic levels coincident with transition from convergent to extensional crustal settings (incipient arc-rift)	Mafic to felsic, massive to fragmental volcanic rocks; minor oxide-facies iron formation. In western BRB: 3-fold subdivision: lower –- felsic volcanic rocks; middle –- mainly basalt-andesite flows; upper (limited lateral extent) –- diverse mafic-felsic flows and fragmental rocks	Overall north-facing sequence. In western BRB: anticlinal to anticlinorial structure in middle subdivision of Bernic Lake Fm.	2724.6 ±1.1 Ma[2]
Peterson Creek Fm		Felsic volcanic rocks, massive to fragmental. Monolithic to heterolithic felsic crystal-tuff ± lapilli		2731.1 ±1 Ma[2]					
Geochronology references: [1] Gilbert, unpublished data, 2007; [2] Gilbert et al., 2008									

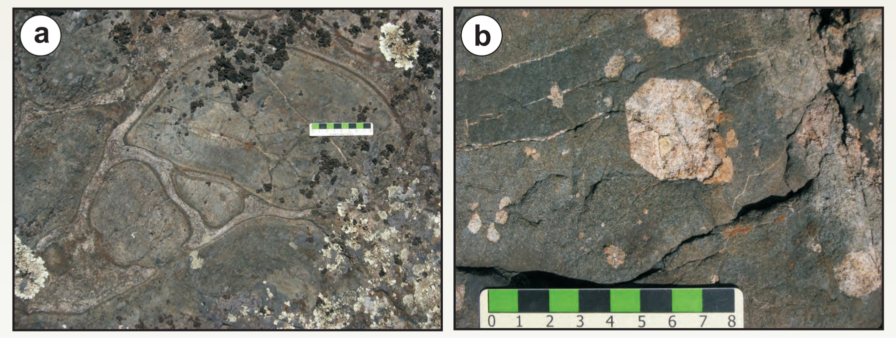


Figure 3: Outcrop photographs of MORB-type volcanic rocks: a) aphyric pillowed basalt with interpillow hyaloclastite, typical of Northern MORB-type basalt; b) plagioclase-megacrystic pillowed basalt, a rare flow type in the upper part of the Northern MORB-type basalt; c) polygonal, metasomatic alteration pattern in pillowed basalt in Southern MORB-type basalt at the Winnipeg River. Chloritic and/or epidotic alteration occurs sporadically but most flows in the section are unaltered.

Regional setting

The BRB, located in the southern part of the Bird River Subprovince, is part of an east-trending supracrustal belt that extends for 150 km from Lac du Bonnet in the west to Separation Lake (Ontario) in the east (***Figure 1***). The BRB occurs in a transitional oceanic-continental-margin setting between flanking older cratonic blocks - the North Caribou Superterrane to the north and the Winnipeg River Subprovince to the south. The northern part of the Bird River Subprovince consists of a granitoid terrane (Maskwa Lake Batholith) that contains intrusive phases ranging from 2.85 to 2.73 Ga (***Table 2***). Continental-arc magmatism and orogenic sedimentation in the Bird River Subprovince spanned approximately 100 Ma (2.80-2.70 Ga; Percival et al., 2006). In contrast, a protracted 300 Ma history of similar magmatism and sedimentation has been documented in the Uchi Subprovince to the north (***Figure 1***; Lemkow et al., 2006; Percival et al., 2006). Whereas early (>2.87 Ga) supracrustal assemblages in the Uchi Subprovince have no known counterparts in the Bird River Subprovince, correlations may exist between younger supracrustal sequences of the two subprovinces. For example, the >2722 Ma Gem assemblage in the Rice Lake greenstone belt of the Uchi Subprovince (Anderson, 2005) is possibly correlative with the 2724.6 ±1.1 Ma Bernic Lake Formation in the Bird River Subprovince (***Table 2***). Volcanic rocks in the Gem assemblage and Bernic Lake Formation are geochemically similar and appear to document incipient rifting of the continental-arc sequences.

Orogenic sedimentation (2712-2697 Ma) subsequent to continental-arc volcanism resulted in the deposition of turbidites (Booster Lake Formation) and penecontemporaneous fluvial-alluvial deposits (Flanders Lake Formation). The turbidites may be stratigraphically equivalent but more distal than the fluvial-alluvial rocks. These orogenic sedimentary rocks have been widely assumed to be equivalent to epiclastic deposits and metamorphic derivatives in the west- to northwest-trending English River Subprovince, which lies between the Bird River Subprovince and the Uchi Subprovince to the northeast (***Figure 1***; Hrabi and Cruden, 2006). Turbidites of the Booster Lake Formation are invariably fault bounded, but a possibly analogous turbidite sequence in the Rice Lake belt (Edmunds Assemblage, Anderson 2005) locally rests unconformably on older volcanic strata.

Subduction-related volcanic activity and orogenic sedimentation came to an end due to collision of the Uchi continental-margin succession with the Winnipeg River Subprovince, which followed 2.72-2.71 Ga convergence of the North Caribou and Winnipeg River cratonic blocks (Lemkow et al., 2006). The tectonic collision was associated with regional deformation, metamorphism and granitoid plutonism.

Table 2: Principal geological formations, their ages and contact relations in the Bird River Belt.

Late intrusive rocks

Granite, pegmatite, granodiorite, tonalite, quartz diorite

(TANCO pegmatite, **2640 ±7 Ma**[1]; Marijane Lake pluton, **2645.6 ±1.3 Ma**[2]; Lac du Bonnet Batholith, **2660 ±3 Ma**[3]

Sedimentary rocks

FLANDERS LAKE FORMATION (**2697 ±18 Ma**[4])
Lithic arenite, polymictic conglomerate

=========== ***Fault, inferred*** ===========

BOOSTER LAKE FORMATION (**2712 ±17 Ma**[4])
Greywacke-siltstone turbidite, conglomerate

~~~~~~~~~~~ ***Unconformity, inferred*** ~~~~~~~~~~~

Intrusive rocks

MISCELLANEOUS INTRUSIONS
Gabbro, diorite, quartz-feldspar porphyry; granodiorite

(Birse Lake pluton, **2723.2 ±0.7 Ma**[2]; Maskwa Lake Batholith II, **2725 ±6 Ma**[3]; Pointe du Bois Batholith, **2729 ±8.7 Ma**[3] TANCO gabbro, **2723.1 ±0.8 Ma**[2])

Metavolcanic and metasedimentary rocks

BERNIC LAKE FORMATION (**2724.6 ±1.1 Ma**[2])
Basalt, andesite, dacite and rhyolite (massive to fragmental); related intrusive rocks and heterolithic volcanic fragmental rocks

PETERSON CREEK FORMATION (**2731.1 ±1 Ma**[2])
Dacite, rhyolite (massive to fragmental); felsic tuff and heterolithic felsic volcanic fragmental rocks

DIVERSE ARC ASSEMBLAGE (**2706 ±23 Ma**[5])
Basalt, andesite, rhyolite, related fragmental and intrusive rocks; heterolithic volcanic fragmental rocks; greywacke-siltstone turbidite, chert, iron-formation; polymictic conglomerate (contains clasts derived from Bird River Sill)

~~~~~~~~~~~ ***Unconformity, inferred*** ~~~~~~~~~~~

Intrusive rocks

BIRD RIVER SILL (**2744.7 ±5.2 Ma**[3])
Dunite, peridotite, picrite, anorthosite and gabbro

=========== ***Fault, inferred*** ===========

Metavolcanic and metasedimentary rocks

MORB-type VOLCANIC ROCKS
Basalt (aphyric to plagioclase-phyric; locally pillowed, amygdaloidal or megacrystic); related volcanic breccia; oxide-facies iron formation

=========== ***Fault, inferred*** ===========

EAGLENEST LAKE FORMATION
Greywacke-siltstone turbidite

Older intrusive rocks

Granodiorite, diorite (Maskwa Lake Batholith I, **2782 ±11 Ma**[3], **2852.8 ±1.1 Ma**[2], **2844 ±12 Ma**[3])

References for geochronological data:[1] Baadsgaard and Cerny, 1993; [2] Gilbert et al., 2008; [3] Wang, 1993; [4] Gilbert, 2006; [5] Gilbert, unpublished data, 2007

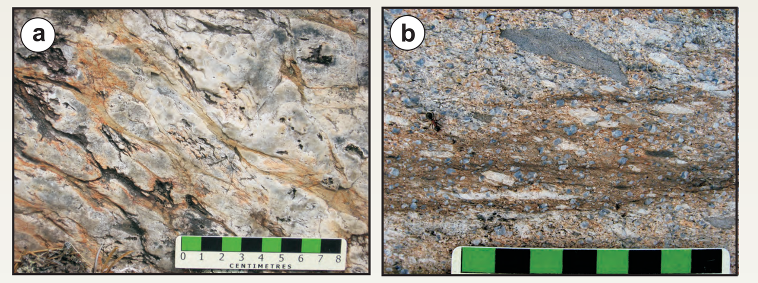


Figure 7: Outcrop photographs of massive and fragmental volcanic rocks in the BRB north panel: a) anastomosing fractures attributed to thermal contraction during cooling of a massive rhyolite flow, Peterson Creek Formation; b) heterolithic crystal-lithic tuff with mainly felsic clast types, Peterson Creek Formation; c) mass-flow deposit with pyroclastic and epiclastic detritus, Diverse Arc assemblage.

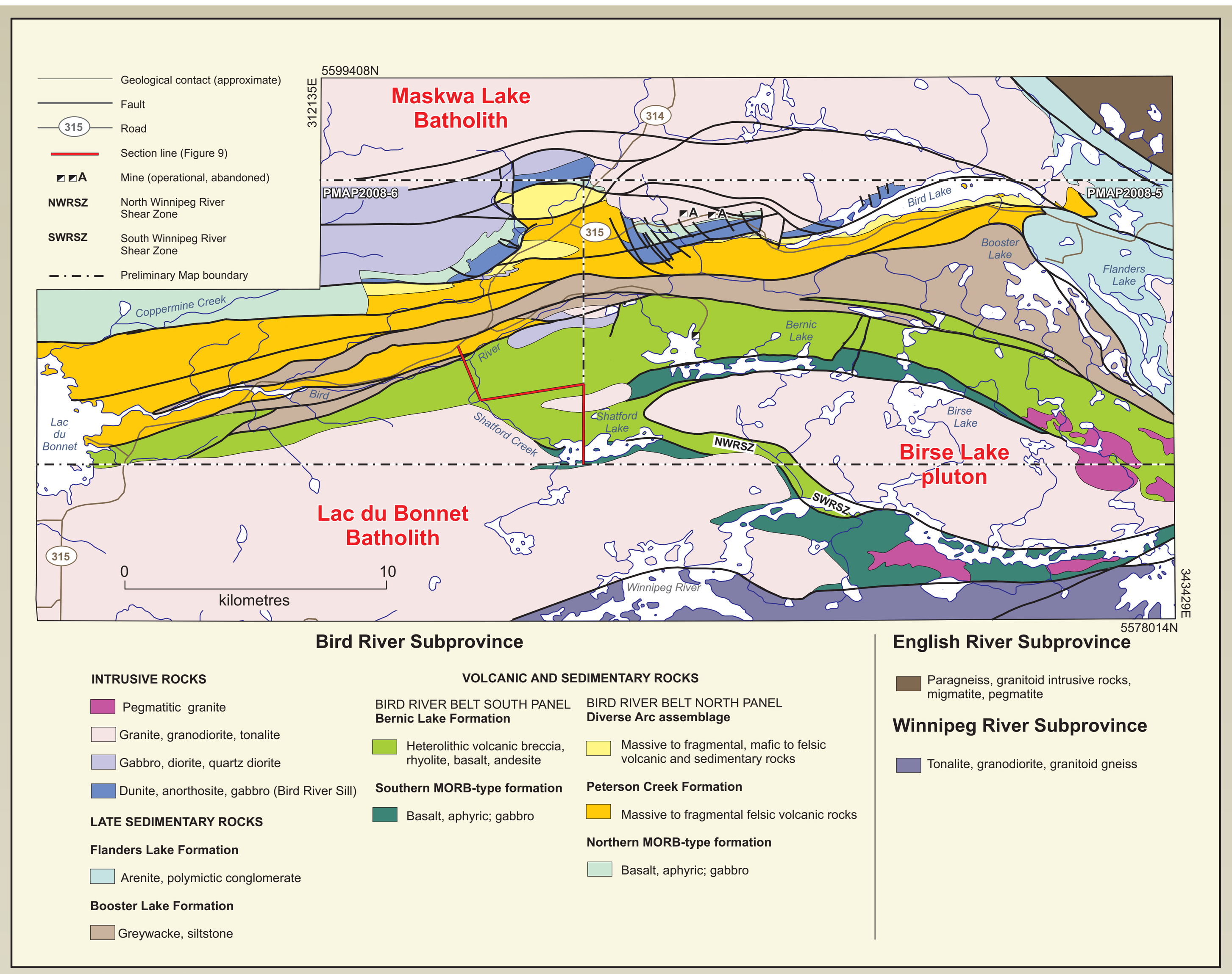


Figure 2: Geology of the Bird River Belt, showing the main stratigraphic and structural features.

Geology of the Bird River area

The BRB, extending for over 50 km from Lac du Bonnet in the west to Flanders Lake in the east, consists mainly of ca. 2.73 Ga arc-type volcanic rocks (***Figure 2***). These rocks are divided into north and south panels by the relatively younger, turbiditic Booster Lake Formation (<2712 ±17 Ma; Gilbert, 2006). Mid-ocean-ridge basalt (MORB)-type volcanic rocks (Lamprey Falls Formation of Cerný et al., 1981) extend along both the north and south margins of the belt. The regional, east-trending synclinorial structural model for the BRB (Cerný et al., 1981), which implies that the north and south panels are stratigraphically equivalent fold limbs, is discounted on the basis of new data that suggest these two components differ both in age and in geochemical composition. A corollary of this revision is that the MORB-type volcanic rocks (former Lamprey Falls Formation) that occur along both the northern and southern margins of the arc-type rocks, although lithologically and geochemically similar, are unlikely to be parts of the same stratigraphic unit; hence, these basaltic formations are termed 'Northern MORB-type' and 'Southern MORB-type', respectively.

MORB-type formations

The 2-3 km wide Northern MORB-type formation is a south-facing, monoclinal sequence of pillowed basalt (***Figure 3a, b***) and extensive, synvolcanic gabbroic intrusions associated with localized base-metal sulphide mineralization (e.g., Coppermine zone; Marathon PGM Corporation, 2007). The Southern MORB-type formation is similar both geochemically and lithologically; aphyric pillowed basalt (***Figure 3c***) and related gabbro account for over 95% of the sequence, which also contains minor siltstone-chert formations (± base-metal sulphide mineralization). The approximately 2.5 km wide Southern MORB-type sequence is predominantly north facing, except for a syncline-anticline fold pair delineated by pillow tops close to the upper (northern) margin of the sequence at the Winnipeg River. Both Northern and Southern MORB-type basalts exhibit flat, slightly depleted rare-earth-element (REE) patterns, consistent with a back-arc basin environment of eruption (***Figure 4a, b***). The Northern MORB-type formation is characterized by relatively juvenile Nd values (+1.3 at 2.7 Ga), suggesting the basalt was derived from a primitive, depleted mantle source.

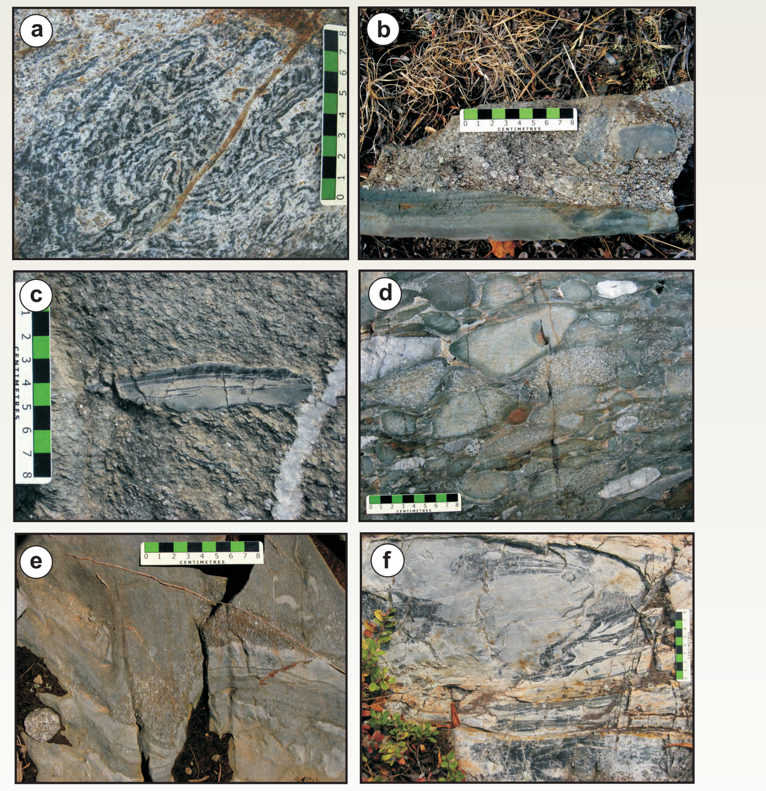


Figure 8: Outcrop photographs of massive to fragmental volcanic and epiclastic rocks in the Diverse Arc assemblage, BRB north panel: a) spherulitic rhyolite flow with contorted flow lamination; b) laminated tuff scoured by mass-flow that deposited the overlying lapilli-tuff bed; c) chert rip-up in lapilli tuff, interpreted as a reworked volcaniclastic deposit; d) polymictic conglomerate with volcanic, sedimentary, gabbroic and sporadic anorthositic fragments; e) greywacke-siltstone turbidite showing graded bedding, scour and synsedimentary deformation; f) laminated chert, partly disrupted by synsedimentary deformation.

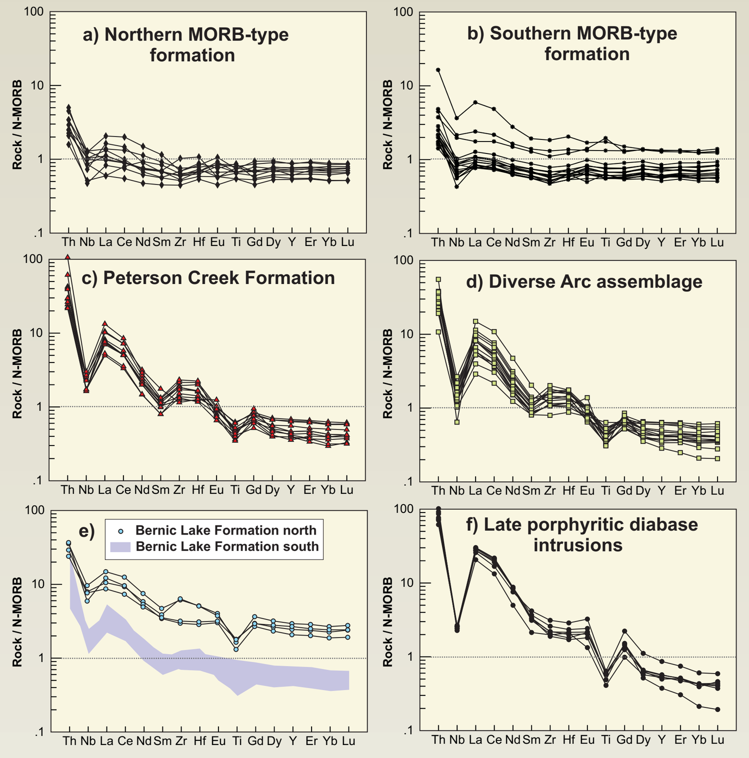
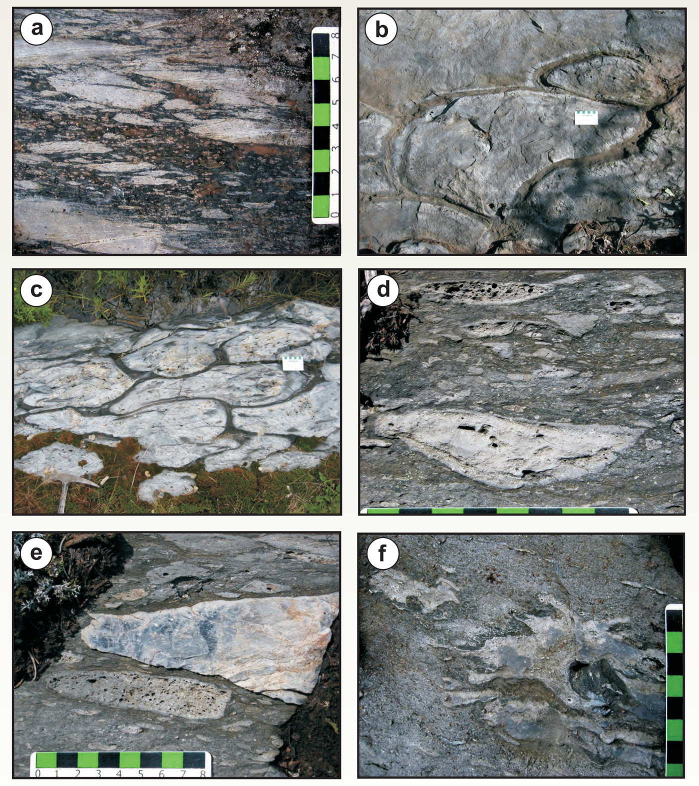


Figure 4: Normal mid-ocean-ridge basalt (N-MORB)-normalized incompatible element plots of mafic to intermediate volcanic rocks from the Bird River Belt (normalizing values from Sun and McDonough, 1989): a) Northern MORB-type formation; b) Southern MORB-type formation; c) Peterson Creek Formation; d) Diverse Arc assemblage; e) Bernic Lake Formation (north and south); f) late porphyritic diabase intrusions.



North panel arc-type rocks

The north panel of arc-type rocks consists largely (>75%) of massive and fragmental, intermediate to felsic volcanic rocks of calcalkaline geochemical affinity (***Figure 5a, b***), associated with subordinate basaltic flows and epiclastic deposits. The abundance of dacite and rhyolite, and various geochemical trace-element indices in the north panel rocks indicate that they have a continental-arc affinity and correlate well with modern arc-type rocks in an 'active continental-margin' (ACM) setting (***Figure 6a, b***). The Nd values (+1.0 to -1.1 at 2.7 Ga) indicate that a limited amount of recycled continental lithosphere was incorporated into the mantle source magma. The incompatible element profiles of north panel rocks (Peterson Creek Formation and Diverse Arc assemblage) also suggest that the mantle source was modified by subduction-zone processes (***Figure 4c, d***). An interval of at least 14 Ma separated arc volcanism (2731.1 ±1 Ma Peterson Creek Formation, ***Table 2***) from the cessation of MORB-type extrusion that occurred prior to the emplacement of the Bird River Sill (2744.7 ±5.2 Ma; Wang, 1993).

North panel arc-type rocks are subdivided into the felsic volcanic Peterson Creek Formation (***Figure 7a, b***) and the volcano-sedimentary Diverse Arc assemblage (Gilbert, 2007). The latter includes a wide variety of mafic to felsic volcanic rocks, reworked volcanic fragmental deposits, epiclastic detritus, sporadic chert and iron formation (***Figures 7c, 8a-f***). The relative age relationship between the Diverse Arc assemblage and Peterson Creek Formation is uncertain. Litho-stratigraphic and structural data indicate the Diverse Arc assemblage may be contemporaneous with the upper part of the Peterson Creek Formation, but geochronological data suggest the Diverse Arc assemblage is relatively younger. A concordant 2706 ±23 Ma age (2σ error) obtained for the youngest detrital zircon grain in greywacke within the Diverse Arc assemblage (Gilbert, unpublished data, 2007) indicates the volcano-sedimentary north panel spanned at least 25 Ma, and may thus overlap with the age of the turbiditic Booster Lake Formation (2712 ±17 Ma; Gilbert, 2006). Volcanic and granitoid rocks with ages between 2785 and 2725 Ma appear to be the main sources for the greywacke, based on frequency plots of detrital zircon U-Pb ages.

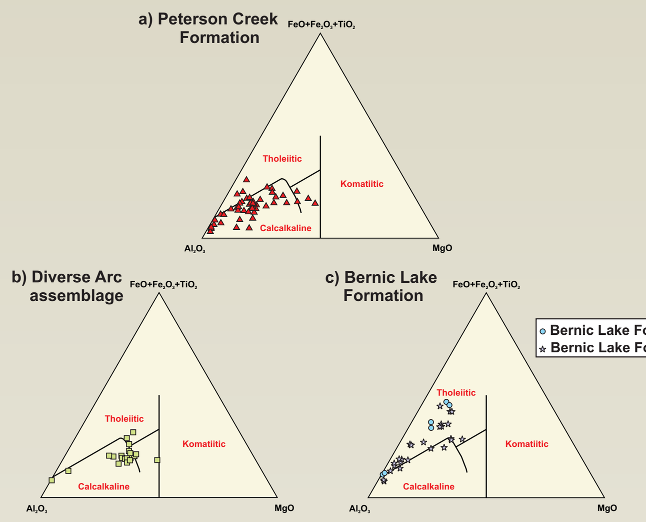


Figure 5: Al_2O_3-$[FeO^T+TiO_2]$-MgO ternary diagram (Jensen, 1976) of mafic to felsic volcanic rocks from the Bird River Belt: a) Peterson Creek Formation; b) Diverse Arc assemblage; c) Bernic Lake Formation.

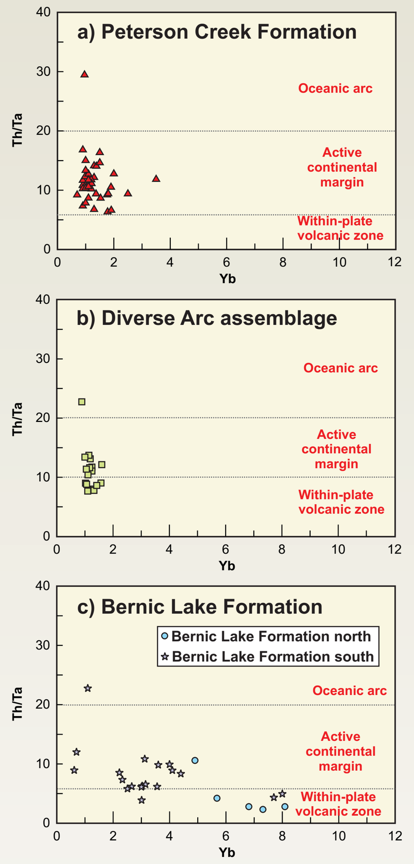


Figure 6: Th/Ta versus Yb diagram (Gorton and Schandl, 2000) of intermediate to felsic volcanic rocks from the BRB: a) Peterson Creek Formation; b) Diverse Arc assemblage; c) Bernic Lake Formation.

Figure 11: Outcrop photographs of massive and fragmental volcanic rocks in Bernic Lake Formation, BRB south panel: a) monolithic felsic volcanic breccia with garnetiferous, chloritic matrix, gradational with fragmental to massive rhyolite (lower BLF, close to the west end of the Birse Lake pluton); b) undeformed pillows in moderately altered basalt (middle BLF); silicification occurs at pillow margins and locally within pillows; c) white-weathered, silicified pillowed basalt at the top of the middle BLF. Base of photo is the upper (north) part of the flow unit. The flow is gradational with dark-weathered hyaloclastic tuff; d) pyroclastic breccia with a pale-weathered clast showing both rounded and pointed terminations, suggesting a projectile origin (upper BLF). The fragment margin is gray (possibly chilled). Clasts in this breccia deposit are variously massive to vesicular; e) angular felsic clast in heterolithic breccia, showing truncation of both the marginal bleached zone and the internal structure of the fragment (upper BLF). This unit is interpreted to contain pyroclastic detritus derived from previous volcanic rocks as well as primary, magma-derived clasts; f) irregular amoeboid clasts, possibly deformed while still hot and plastic during transportation by a debris flow (upper BLF). The unit is interpreted as pyroclastic in origin, derived from previously deposited volcanic rocks as well as primary, magma-derived clasts.

South panel arc-type rocks

The BRB south panel arc-type sequence consists of abundant felsic and mafic volcanic rocks, unlike the mainly intermediate to felsic north panel. Geochemically, south panel rocks have a transitional, tholeiitic to calcalkaline affinity, in contrast to the calcalkaline affinity of the north panel sequence (***Figure 5c***). As in the north panel, geochemical indices of the volcanic rocks suggest a continental-arc affinity. The Nd values of the south panel rocks (+0.7 to -2.4 at 2.7 Ga) indicate limited contamination by continental lithosphere during ascent of the source magma through the crust. New mapping in the south panel of the western BRB suggests the BLF in that area is a mainly north-facing sequence consisting of 3 stratigraphic subdivisions - 'lower', 'middle' and 'upper' (***Figures 9, 10***). The 'upper' subdivision, located in the vicinity of the junction of Bird River with Shatford Creek (***Figure 2***) is of limited lateral extent (<5 km) and has no known counterpart in the eastern BRB. Geochemical data from 2008 sampling is not yet available, but based on existing data, the 'lower' and 'middle' stratigraphic BLF subdivisions in the western BRB are provisionally correlated with the 'south' and 'north' parts of the BLF in the eastern BRB (Gilbert, 2006, 2007).

The lower BLF subdivision in the western BRB is best developed at Shatford Lake, where a felsic volcanic terrane up to 1.7 km wide extends from the north shore of the lake to the area north of Sarapu Lake (***Figure 11a***). This section, interpreted as a north-facing monocline, locally contains coarse-grained garnet amphibolite and massive garnetite units up to 10 m thick, interpreted as original hydrothermal alteration zones. These rocks may be derived from chloritic schist that was recrystallized to amphibolite at medium metamorphic grade; the zones are characterized by disseminated pyrite-pyrrhotite mineralization. Elsewhere, oxide-facies iron formation within the felsic volcanic section is associated with a conspicuous aeromagnetic positive anomaly at the west margin of the Birse Lake pluton (Geological Survey of Canada, 1966).

The middle BLF subdivision, up to 1.5 km wide, consists very largely of pillowed basalt-andesite, with minor subordinate felsic volcanic units. Pillows are widespread (***Figure 11b***) and serve to delineate an anticlinorial structure consisting of three major folds. Alteration (silicification ± feldspathic alteration) is locally conspicuous in the mafic volcanic sequence (***Figure 11c***) and diffuse zones of porphyroblastic hornblende, possibly derived from earlier chloritic alteration, are locally pervasive.

The upper BLF subdivision in the western BRB is a north-facing, 0.75 km thick sequence of diverse, massive to fragmental volcanic rocks that intersects the north part of Shatford Creek and extends laterally for approximately 5 km (***Figure 10***). The section contains felsic pyroclastic breccia, heterolithic volcanic fragmental rocks, massive to pillowed basalt-andesite and associated breccia, and rhyolite with related felsic sills. Textures indicate some breccia deposits were associated with explosive pyroclastic volcanism that shattered a pre-existing volcanic edifice, resulting in abundant coarse detritus. This detritus was then incorporated into the deposit, together with still-plastic fragments derived from the rapidly ejected, volatile magma (***Figure 11d-f***). Coarse, intraformational mass-flow deposits in the upper BLF may have been trigged by gravity-induced slumping of volcanic detritus, possibly deposited originally as an emergent topographic feature in a subaqueous to subaerial environment. No epiclastic rocks are preserved in upper BLF subdivision, but ephemeral subaqueous conditions are indicated by the presence of pillowed mafic volcanic flows both within and at the top of the sequence.

Orogenic sedimentary formations

Turbiditic rocks of the Booster Lake Formation occur in a 1-2 km wide, fault-bounded structural enclave that extends through the centre of the BRB, as well as several minor fault slices in the western BRB (***Figure 2***). The eastern part of the Booster Lake Formation displays a wide variety of turbidite features (***Figure 12a, b***). Cyclic bedding is commonly accentuated by stratabound cordierite porphyroblasts that are widespread throughout the formation (***Figure 12c***). The turbiditic rocks are characterized by a structural pattern of repeated folds in which the axial traces are locally discordant to, and truncated by, the faults along the margins of the turbidite enclaves; the folds are thus interpreted as relatively older than the faults.

Arkosic sandstone and conglomerate of the Flanders Lake Formation truncate the main stratigraphic formations in the eastern part of the BRB and structurally overlie the BRB north panel, due to northeast-directed thrusting (***Figure 2***). Arenaceous rocks of the Flanders Lake Formation are characterized by widespread crossbedding and pebbly horizons, locally associated with graded bedding and scour-and-fill structures. These rocks are intercalated with polymictic conglomerate that contains a wide variety of volcanic, sedimentary and granitoid cobbles and boulders, typical of a fluvial-alluvial depositional environment (***Figure 12d***).

Detrital zircon data indicate that both the Booster Lake and Flanders Lake formations were derived mainly from two sources distinguished by differences in age (ca. 2720 and 3020 Ma) - probably corresponding to BRB supracrustal rocks and older granitoid rocks of the contiguous cratonic blocks (***Figure 1***). Detrital zircon data indicate the Booster Lake and Flanders Lake formations are coeval and may be related to turbiditic and fluvial-alluvial rocks in the Neoarchean (ca. 2.7 Ga) English River Subprovince northeast of the BRB (Gilbert, 2006). The Flanders Lake Formation may also be correlative with cover sequences elsewhere along the southern margin of the North Caribou Superterrane (e.g. San Antonio assemblage; Anderson, 2004).

Stratigraphy and volcanic geochemistry of the Bird River greenstone belt, Manitoba (part of NTS 52L5, 6)

H.P. Gilbert

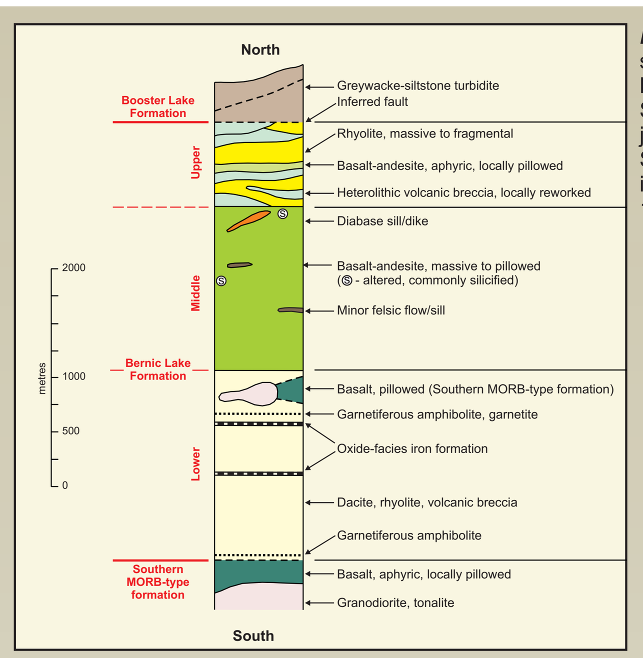


Figure 9: Composite section through the Bernic Lake Formation from Shatford Lake to junction of Bird River and Shatford Creek (section line is shown in Figures 2 and 10).

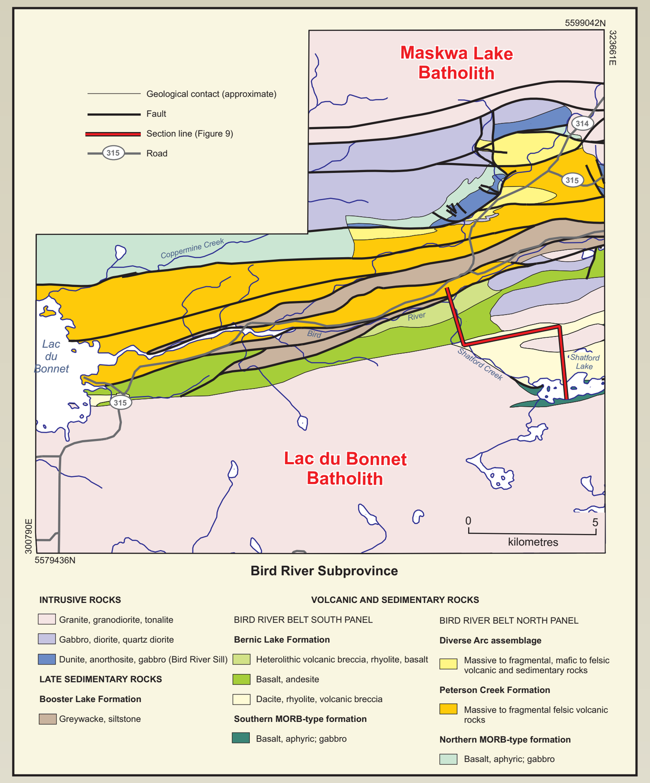


Figure 10: Geology of the western part of the Bird River Belt, showing the subdivisions in the Bernic Lake Formation.

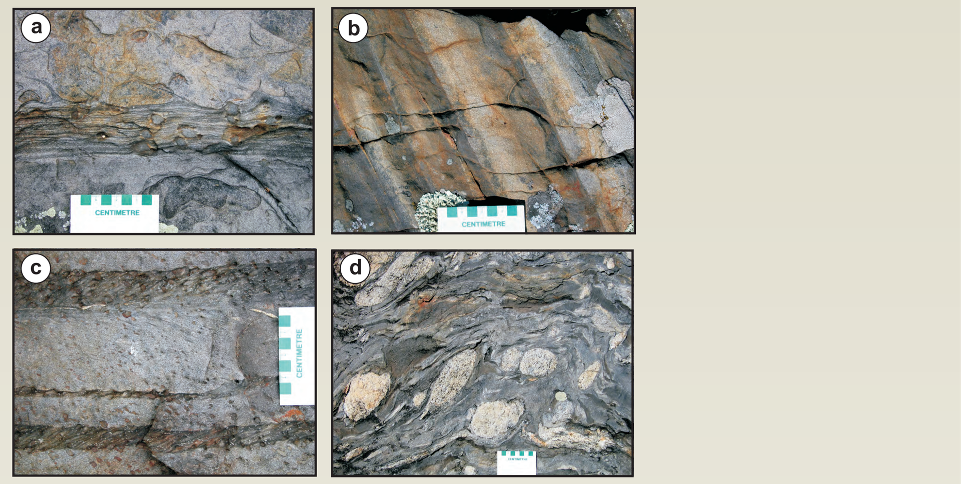


Figure 12: Outcrop photographs of orogenic sedimentary rocks in the eastern part of the BRB: a) feldspathic greywacke with diffusely laminated siltstone unit, characterized by flame structures and cordierite porphyroblasts, Booster Lake Formation; b) cyclic layering with graded bedding in turbidite, Booster Lake Formation; c) cordierite-porphyroblastic siltstone beds within graded feldspathic greywacke of the Booster Lake Formation, displaying S_0/S_2 discordance as well as a discordant metamorphic fabric (S_1) confined to the feldspathic greywacke layer, apparently overprinted by S_2 only within the siltstone beds; d) polymictic conglomerate of the Flanders Lake Formation, with volcanic, sedimentary and plutonic fragments. The foliation in granitoid clasts predates conglomerate deposition, but flattening and crenulation of mafic fragments are relatively later.

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