Towards a new stratigraphy of the Bird River Belt

H.P. Gilbert (MGS)
Bird River Belt projects initiated in 2005

1. Paul Gilbert (MGS)
   Regional mapping (1: 20 000 scale) with focus on stratigraphy and geochemistry of supracrustal rocks.

2. Manuel Duguet (post doctoral student, Univ. of Waterloo)
   Regional mapping (1: 20 000 – 1: 50 000 scale) with focus on structural geology and tectonic history.

3. Paul Kremer (MSc graduate student, Univ. of Waterloo)
   Geological mapping (1: 10 000 scale) of Bernic Lake area with focus on the setting of granitic pegmatite intrusions.

4. Caroline Mealin (MSc graduate student, Univ. of Waterloo)
   Detailed mapping of mafic-ultramafic Bird River Sill with focus on PGE mineralization potential.
Bird River Belt projects rationale

- Area last mapped over 25 years ago
- Previous mapping known to be inconsistent
- Since the previous mapping, advances in the geological sciences and new techniques (geochemistry and geochronology) now provide the opportunity to gain significant advances in our understanding of the geology of the area
- Provide support for current active exploration
Road map

1. Setting of Neoarchean Bird River greenstone belt

2. Geological overview

3. Results of mapping 2005-2006 ~ Geochemistry Stratigraphy

4. Summary
Geological Domains in southwest Superior Province

Bird River Belt
Geological overview
The Bird River Belt consists mainly of an volcanosedimentary arc-type assemblage (2740 Ma) in two tectonostratigraphic components ~ a south-facing calc-alkaline north panel and a north-facing tholeiitic south panel.

Older (> 2745 Ma) MORB-type volcanic rocks (Lamprey Falls Formation) occur along the north and south margins of the belt.

Late intrusive rocks
Granite, (Lac du Bonnet batholith, 2660 ±3 Ma)

Sedimentary rocks
FLANDERS LAKE FORMATION (2697 ±18 Ma)
Arenite, polymictic conglomerate
Fault, inferred

BOOSTER LAKE FORMATION (2712 ±17 Ma)
Greywacke-siltstone turbidite
Unconformity, inferred

Intrusive rocks
Granodiorite, tonalite gabbro, quartz-feldspar porphyry (2725 ±6 Ma ; 2729 ±9 Ma)

Metavolcanic and metasedimentary rocks – arc assemblage (2740 ±4 Ma)
Mafic to felsic volcanic rocks; turbidite, chert, iron-formation, conglomerate; derived gneiss and schist

Intrusive rocks
BIRD RIVER SILL (2745 ±5 Ma)
Dunite, peridotite, picrite, anorthosite and gabbro
Fault, inferred

MORB-type basalt and metasedimentary rocks
LAMPREY FALLS FORMATION
Fault, inferred
**BRB – postvolcanic sedimentary rocks**

- **Flanders Lake Formation** (2697 ± 18 Ma)
- **Booster Lake Formation** (2712 ± 17 Ma)

New detrital zircon data indicate these two formations postdate the volcanism by approx. 30 m.y.

- Arc-type volcanic and sedimentary rocks
  - Bird River Belt, north panel
  - Bird River Belt, south panel

- MORB-type mafic volcanic rocks
  - Lamprey Falls Formation in Bird River Belt north panel
  - Lamprey Falls Formation in Bird River Belt south panel
  - Lamprey Falls Formation in the Winnipeg River area

- Sedimentary rocks
  - Arenite, conglomerate (Flanders Lake Formation)
  - Greywacke, siltstone (Booster Lake Formation)
  - Greywacke, siltstone (Eaglenest Lake Formation)

- Intrusive rocks
  - Pegmatitic granite
  - Granite, granodiorite, tonalite
  - Tonalite, orthogneiss (Winnipeg River Domain)
  - Dunite, anorthosite, gabbro (Bird River Sill)

- Geological contact
- Fault (inferred)
Bird River Belt is known for the TANCO Mine (Cs and Ta), Maskwa-Dumbarton Mine (Cu-Ni) and PGE potential of the Bird River Sill. Additional exploration targets include (1) arc-type rocks (2) Lamprey Falls Fm at BRB north flank (Cu, Zn, Ni and PGE in gabbro) and (3) Lamprey Falls Fm at Winnipeg River (iron formation with base-metal mineralization).
Mineralization in iron formation within Lamprey Falls basalt, Winnipeg River area
Bird River Belt Geochemistry
Maskwa Lake Batholith
BLS
Lac du Bonnet Batholith
Birse Lake pluton
Birse Lake section
BRLS
Birse Lake section

775000mE.
5600000mN.
740000mE. 5582500mN.

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0 km

Booster Lake
Formation

Bird River Belt – north and south panels

BRB north panel

Booster Lake
Formation

BRB south panel

Arc-type volcanic and sedimentary rocks
- Bird River Belt, north panel
- Bird River Belt, south panel

MORB-type mafic volcanic rocks
- Lamprey Falls Formation in Bird River Belt north panel
- Lamprey Falls Formation in Bird River Belt south panel
- Lamprey Falls Formation in the Winnipeg River area

Sedimentary rocks
- Arenite, conglomerate (Flanders Lake Formation)
- Greywacke, siltstone (Booster Lake Formation)
- Greywacke, siltstone (Eaglenest Lake Formation)

Intrusive rocks
- Pegmatitic granite
- Granite, granodiorite, tonalite
- Tonalite, orthgneiss (Winnipeg River Domain)
- Dunite, anorthosite, gabbro (Bird River Sill)

Geological contact
Fault (inferred)

Highway Junction section
Bird Lake section
BLS Bird Lake section
BRLS Birse Lake section
Bird River greenstone belt – east part

Archean Intrusive rocks
- Pegmatitic granite
- Granite, granodiorite, tonalite
- Tonalite, orthogneiss (Winnipeg River Domain)
- Dunite, anorthosite, gabbro (Bird River Sill)

Sedimentary rocks
- Arenite, conglomerate (Flanders Lake Formation)
- Greywacke, siltstone (Booster Lake Formation)
- Greywacke, siltstone (Eaglenest Lake Formation)

Arc-type volcanic and sedimentary rocks
- Bird River Belt, north panel
- Bird River Belt, south panel

MORB-type mafic volcanic rocks
- Lamprey Falls Formation in Bird River Belt north panel
- Lamprey Falls Formation in Bird River Belt south panel
- Lamprey Falls Formation in the Winnipeg River area

Geological contact
- Fault (inferred)

Highway Junction section (HJS)
Bird Lake section (BLS)
Birse Lake section (BRLS)
MORB-type basalt localities in the Bird River Belt

Lamprey Falls Formation (BRB North Flank)

Lamprey Falls Formation (Winnipeg River)

Birse Lake section south part (= Lamprey Falls Fm. ?)

Lamprey Falls Formation (BRB North Flank as well as Winnipeg River)

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Birse Lake pluton

Maskwa Lake Batholith

Lac du Bonnet Batholith

Birse Lake section south - MORB type basalt

Lamprey Falls Formation (BRB north flank and Winnipeg River suites)
Arc-type volcanic rocks

Birse Lake Section

BRB North panel

Birse Lake section ~ north central

Birse Lake Section

BRB north panel arc-type rocks

Birse Lake section north
Birse Lake section central

Rock/N-MORB Stern et al., 1995 (FFB Ocean Floor paper)
BRB arc-type volcanic rocks – north and south panels

Jensen cation diagram
Bird River greenstone belt – all volcanic rocks

- **BRB north panel arc**
- **BRB south panel arc**
- **Birse Lake south - MORB type basalt**
- **Lamprey Falls Formation (total)**

**A** = N-MORB

**B** = E-MORB

**C** = OIB (Rift)

**D** = Arc-basalts
Bird River Belt Stratigraphy

1. MORB-type volcanic rocks
2. Arc-type assemblage
3. Booster Lake Formation
Bird River Belt

Stratigraphy

1. MORB-type volcanic rocks
2. Arc-type assemblage
3. Booster Lake Formation
MORB-type basalt localities in the Bird River Belt

Lamprey Falls Fm (BRB north flank)

Birse Lake section south part

Lamprey Falls Formation (Winnipeg River)
Bird River Belt Stratigraphy

1. MORB-type volcanic rocks
2. Arc-type assemblage
3. Booster Lake Formation
Highway Junction section

Bird Lake section

Birse Lake section

Arc-type volcanic and sedimentary rocks
- Bird River Belt, north panel
- Bird River Belt, south panel

MORB-type mafic volcanic rocks
- Lamprey Falls Formation in Bird River Belt north panel
- Lamprey Falls Formation in Bird River Belt south panel
- Lamprey Falls Formation in the Winnipeg River area

Sedimentary rocks
- Arenite, conglomerate (Flanders Lake Formation)
- Greywacke, siltstone (Booster Lake Formation)
- Greywacke, siltstone (Eaglenest Lake Formation)

Archean Intrusive rocks
- Pegmatitic granite
- Granite, granodiorite, tonalite
- Tonalite, orthogneiss (Winnipeg River Domain)
- Dunite, anorthosite, gabbro (Bird River Sill)
Inferred fault

Booster Lake Formation

Greywacke-siltstone turbidite

Felsic tuff, locally re-deposited by turbidity currents
Aphyric basalt flow/sill
Pegmatite
Felsic tuff
Aphyric basalt, derived laminated gneiss
Greywacke-siltstone turbidite (Booster Lake Formation fault slice)
Pegmatite
Aphyric basalt, related mafic gneiss

Garnetiferous amphibolite, mafic schist, mineralized with pyrite
Greywacke-siltstone + cordierite (Booster Lake Formation fault slice)
Felsic tuff, wacke
Rhyolite breccia, monolithic
Rhyolite, massive
Aphyric basalt, pillowed basalt
Rhyolite breccia, monolithic
Pegmatite
Garnet-hornblende gneiss, basalt-derived
Rhyolite, massive
Pegmatite
Rhyolite breccia, monolithic
Altered felsic volcanic rocks, extensive hornblende blastesis
Aphyric basalt
Rhyolite, related breccia; felsic tuff
Gabbro, medium-grained to very coarse grained, diabase
Aphyric basalt
Felsic volcanic breccia, monolithic
Altered felsic volcanic rocks, extensive hornblende blastesis
Felsic volcanic breccia, heterolithic
Diabase
Felsic volcanic breccia, heterolithic; locally reworked by mass flows
Mafic schist and gneiss, basalt-derived
Felsic volcanic rocks
Aphyric basalt, pillowed basalt (up to 500 m thick) - MORB type

Tonalite, granodiorite, equigranular to porphyritic

Base-metal mineralization
Highway Junction section

Arc-type volcanic and sedimentary rocks
- Bird River Belt, north panel
- Bird River Belt, south panel
- Lamprey Falls Formation in Bird River Belt north panel
- Lamprey Falls Formation in Bird River Belt south panel
- Lamprey Falls Formation in the Winnipeg River area

MORB-type mafic volcanic rocks
- Dunite, anorthosite, gabbro (Bird River Sill)
- Lamprophyre Falls Formation in the Winnipeg River area

Sedimentary rocks
- Arenite, conglomerate (Flanders Lake Formation)
- Greywacke, siltstone (Booster Lake Formation)
- Greywacke, siltstone (Eaglenest Lake Formation)

Intrusive rocks
- Pegmatitic granite
- Granite, granodiorite, tonalite
- Tonalite, orthogneiss (Winnipeg River Domain)
- Dunite, anorthosite, gabbro (Bird River Sill)
BRB north panel - Highway Junction section

5W
Synsedimentary folds in laminated chert

3W
Scoured chert laminae and rip-ups in feldspathic greywacke turbidite

1W
Laminated green-weathering tuff and overlying lapilli tuff mass-flow deposit
BRB north panel - Highway Junction section

7W
- Polymictic conglomerate with basalt and gabbro fragments

7W
- Bedded chert boulder in polymictic conglomerate

5W
- Bedded chert within 25 m thick member

No exposure

Greywacke-siltstone turbidite

Dacite, massive

Felsic volcanic breccia, tuff

Intermediate to felsic tuff (possible ash-flow origin)
Heterolithic volcanic breccia and tuff, reworked

Felsic tuff (possible ash-flow origin)

Rhyolite breccia († chert clasts)

Massive to fragmental rhyolite

Aphyric basalt, locally quartz-amygdaloidal

Felsic volcanic breccia, reworked

Aphyric basalt, locally amygdaloidal

Greywacke-siltstone turbidite

Chert

Aphyric basalt

Greywacke-siltstone turbidite

Dunite, peridotite, plintonite, anorthosite & gabbro

Bird River Sill

North

Volcanosedimentary arc-type sequence

Stratigraphic unit numbers

0 500 1000 1500 metres

15W

14W

13W

12W

11W

10W

9W

8W

7W

6W

5W

4W

3W

2W

1W

No exposure
BRB north panel - Highway Junction section

14W
Chert rip-up in reworked lapilli tuff

13W
Felsic clasts in tuff of possible ash-flow origin

11W
Thermal contraction fractures in massive rhyolite
Bird River greenstone belt – east part

Pegmatitic granite
Granite, granodiorite, tonalite
Tonalite, orthogneiss (Winnipeg River Domain)
Dunite, anorthosite, gabbro (Bird River Sill)

Arenite, conglomerate (Flanders Lake Formation)
Greywacke, siltstone (Booster Lake Formation)
Greywacke, siltstone (Eaglenest Lake Formation)

Arc-type volcanic and sedimentary rocks
Bird River Belt, north panel
Bird River Belt, south panel
MORB-type mafic volcanic rocks
Lamprey Falls Formation in Bird River Belt north panel
Lamprey Falls Formation in Bird River Belt south panel
Lamprey Falls Formation in the Winnipeg River area

Geological contact
Fault (inferred)

Bird Lake section

HJS Highway Junction section
BLS Bird Lake section
BRLS Birse Lake section
**BRB north panel - Bird Lake section**

**Southwest Bird Lake area**

- Greywacke-siltstone turbidite (8E)
- Heterolithic volcanic breccia (7E)

**Bird Lake section**

- Greywacke-siltstone turbidite (South)
- Mylonite (rhyolite-derived) (SE)
- Rhyolite, massive to fragmental; subordinate felsic tuff, porphyry, and garnet gneiss derived from altered rhyolite (SE)
- Oxide-facies iron formation (SE)
- Basalt, pillow basalt (SE)

**Stratigraphic unit numbers**

1E: Quartz grit channel deposit within turbidite sequence
2E: Pillow basalt weathers out in spires, due carbonatized domains
3E: Rhyolite breccia of autoclastic origin
BRB north panel - Bird Lake section

Southwest Bird Lake area

Bird Lake section

Greywacke-siltstone turbidite

Mylonite (rhyolite-derived)

Rhyolite, massive to fragmental; subordinate felsic tuff, porphyry, and garnet gneiss derived from altered rhyolite

Oxide-facies iron formation

Oxide-facies iron formation, mafic gneiss, cordierite-garnet-bearing siltstone

Aphyric basalt, pillowed basalt, variously altered (± garnet)

Greywacke-siltstone (turbidite) 650 m thick

Rhyolite, massive to fragmental

Greywacke-siltstone, rare grit (turbidite)

Tonalite, granodiorite

Base-metal mineralization

Stratigraphic unit numbers

4E

Garnet and oval cordierite porphyroblasts in meta-siltstone (associated with iron formation)

5E, 6E

Layered chert and magnetiferous siltstone

Mylonitic rhyolite close to the faulted contact with Booster Lake Formation
BRB north panel – southwest Bird Lake area

Southwest Bird Lake area

Bird Lake section

Greywacke-siltstone turbidite
Mylonite (rhyolite-derived)
Rhyolite, massive to fragmental; subordinate felsic tuff, porphyry and garnet gneiss derived from altered rhyolite
Oxide-facies iron formation
Oxide-facies iron formation, mafic gneiss, cordierite-garnet-bearing siltstone
Aphyric basalt, pillowed basalt, variously altered (± garnet)
Greywacke-siltstone (turbidite) 650 m thick
Rhyolite, massive to fragmental
Greywacke-siltstone, rare grit (turbidite)
Tonalite, granodiorite

Base-metal mineralization
Stratigraphic unit numbers

7E Dark blue cordierite porphyroblasts in volcanic breccia matrix

7E Rhyolite boulder in heterolithic mass flow deposit

7E Angular mafic and felsic fragments in volcanic breccia
Bird River Belt Stratigraphy

1. MORB-type volcanic rocks
2. Arc-type assemblage
3. Booster Lake Formation
Booster Lake Formation

Bird River greenstone belt – east part

- Bird River Belt, north panel
- Bird River Belt, south panel
- Lamprey Falls Formation in Bird River Belt north panel
- Lamprey Falls Formation in Bird River Belt south panel
- Lamprey Falls Formation in the Winnipeg River area
- Geological contact
- Fault (inferred)

- Highway Junction section
- Bird Lake section
- Birse Lake section

Archean Intrusive rocks
- Pegmatitic granite
- Granite, granodiorite, tonalite
- Tonalite, orthogneiss (Winnipeg River Domain)
- Dunite, anorthosite, gabbro (Bird River Sill)

Sedimentary rocks
- Arenite, conglomerate (Flanders Lake Formation)
- Greywacke, siltstone (Booster Lake Formation)
- Greywacke, siltstone (Eaglenest Lake Formation)
- Greywacke, siltstone (Booster Lake Formation)

Arc-type volcanic and sedimentary rocks

- Bird River Belt, north panel
- Bird River Belt, south panel
- Lamprey Falls Formation in Bird River Belt north panel
- Lamprey Falls Formation in Bird River Belt south panel
- Lamprey Falls Formation in the Winnipeg River area
- Geological contact
- Fault (inferred)
Graded bedding in Booster Lake Fm. turbidite

Flame structure in Booster Lake Fm. turbidite
Bedding-foliation discordance and cordierite porphyroblasts in Booster Lake Fm. turbidite
Summary

- Neoarchean Bird River Belt consists of an arc-type calc-alkaline north panel (> 2740 ± 4 Ma) and tholeiitic south panel. Older (> 2745 Ma) MORB-type volcanic rocks (Lamprey Falls Formation) occur along the north and south margins of the belt.

- The arc-type panels are separated by infaulted Booster Lake Formation turbidites that extend through the centre of the belt. Flanders Lake Formation fluvial-alluvial rocks overlie the arc-type assemblage at east end of the belt.

- New data indicate an age of 2697 ± 18 Ma for the Flanders Lake Formation and 2712 ± 17 Ma for Booster Lake Formation, indicating these formations postdate the volcanism by approximately 30 m.y.

- Bird River Belt is known primarily for TANCO Mine (Cs and Ta), Maskwa-Dumbarton Mine (Cu-Zn) and the PGE potential of the Bird River Sill. Additional base-metal and Au exploration targets exist within arc-type volcanic rocks and iron formation in the Bird River Belt. North of the arc assemblage, base-metal and PGE mineralization occurs in gabbros in the Lamprey Falls Formation; equivalent rocks at the Winnipeg River contain mineralized oxide-facies iron formation.
Please visit posters T7 to T10 for more information about the Bird Lake area