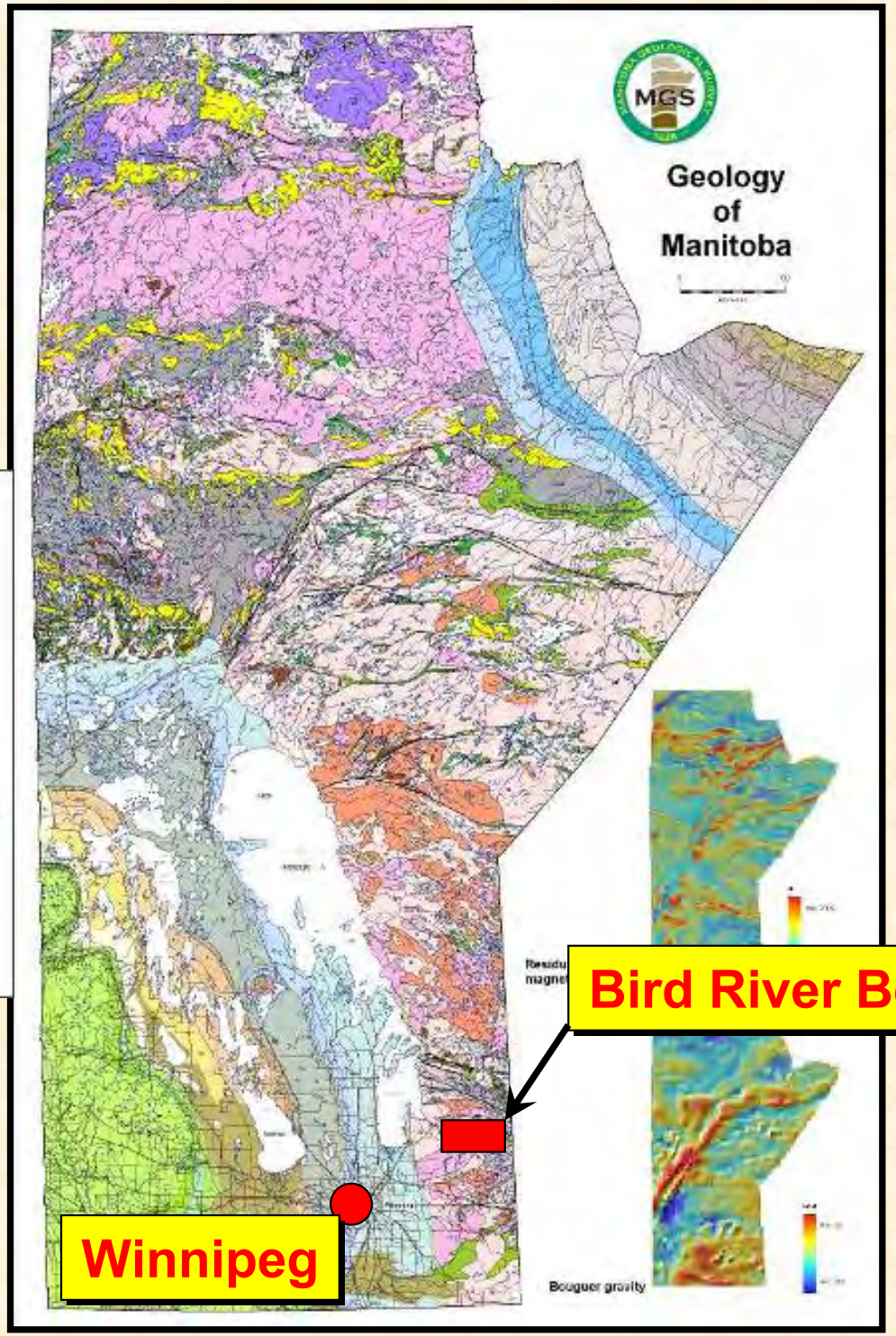
Bird River Belt in southeastern Manitoba: a Neoarchean volcanic arc in the Western Superior Province

Paul Gilbert
Manitoba Geological Survey

Location of Bird River Belt



MANITOBA GEOLOGICAL SURVEY
MGS
1928

Bird River Belt projects initiated in 2005

Paul Gilbert (Manitoba Geological Survey) ~
1: 20 000 scale mapping

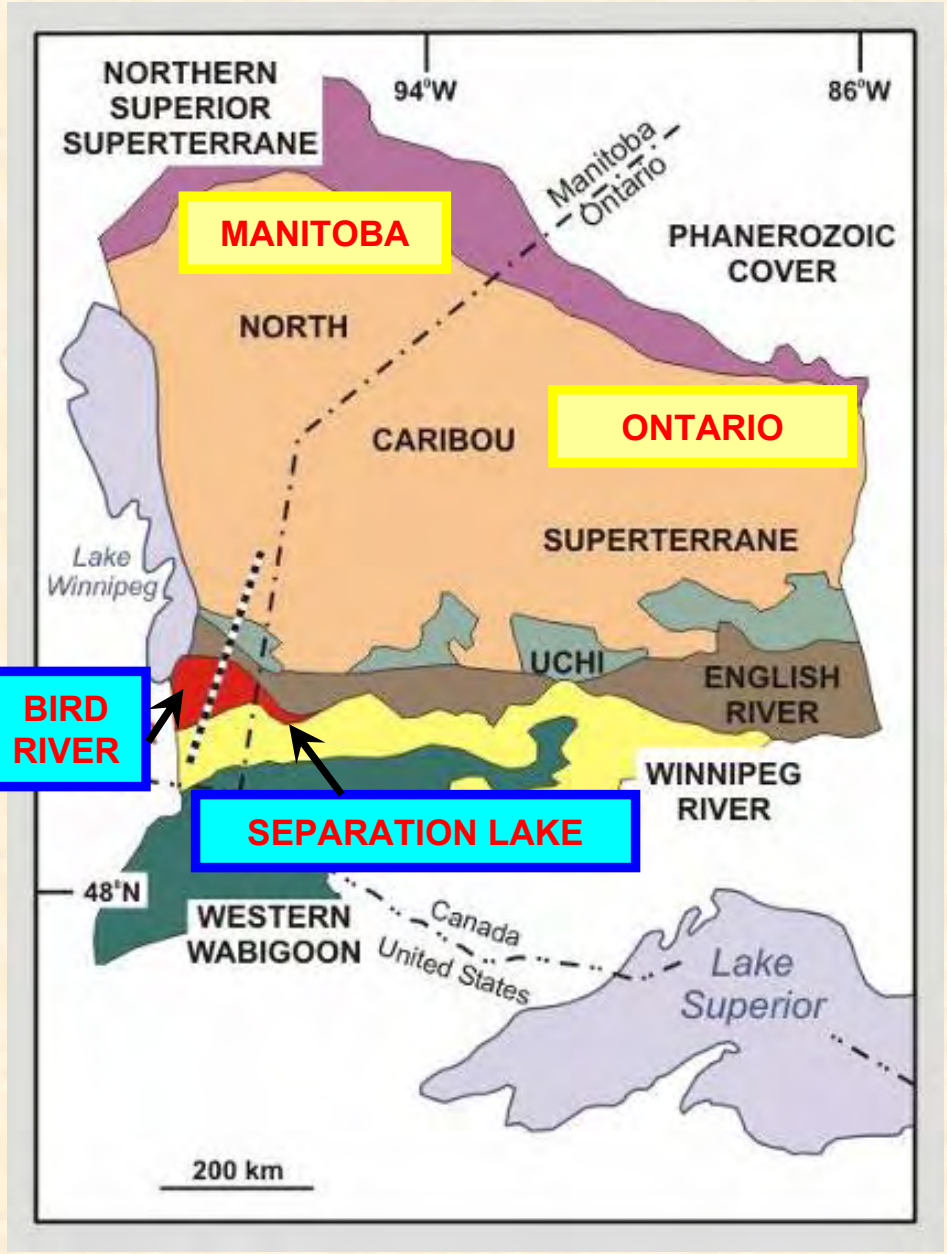
Manuel Duguet (Post doctoral student, Univ. of Waterloo) ~
Regional mapping (1: 50 000 scale) with focus on structural geology

Paul Kremer (MGS), Caroline Mealin ~
Economic geology theses (MSc Univ. of Waterloo)
TANCO pegmatite, Bird River Sill

Outline of presentation

1. Regional setting and stratigraphy of BRB
2. Volcanic geochemistry
3. Regional tectonic evolution
4. Economic geology

Bird River Belt regional setting



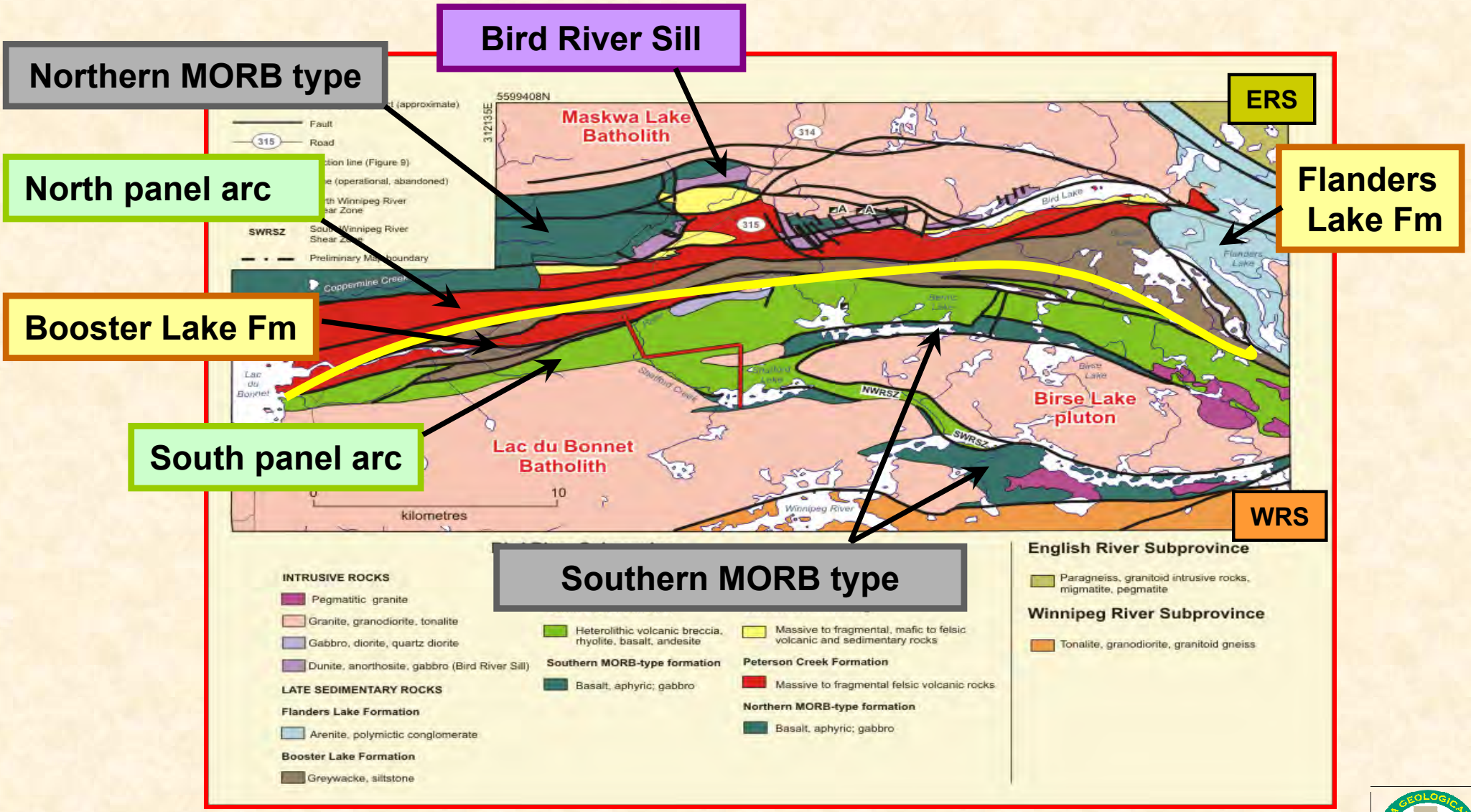
Bird River Belt stratigraphy

1. MORB-type volcanic rocks [>2745 Ma]

2. Continental arc-type sequence [~2730 Ma]

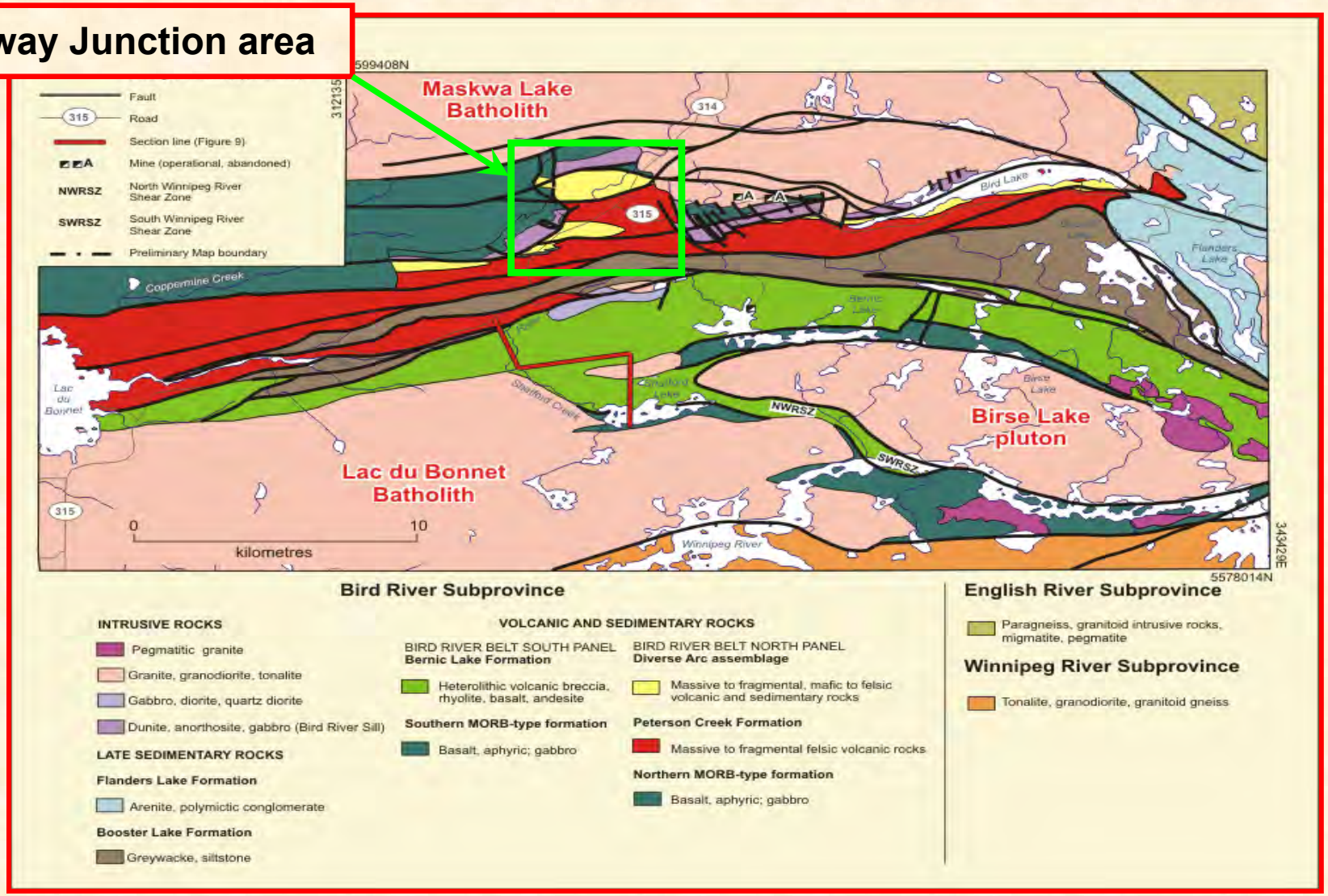
3. Younger sedimentary rocks [~ 2704 Ma]

Bird River Belt stratigraphy

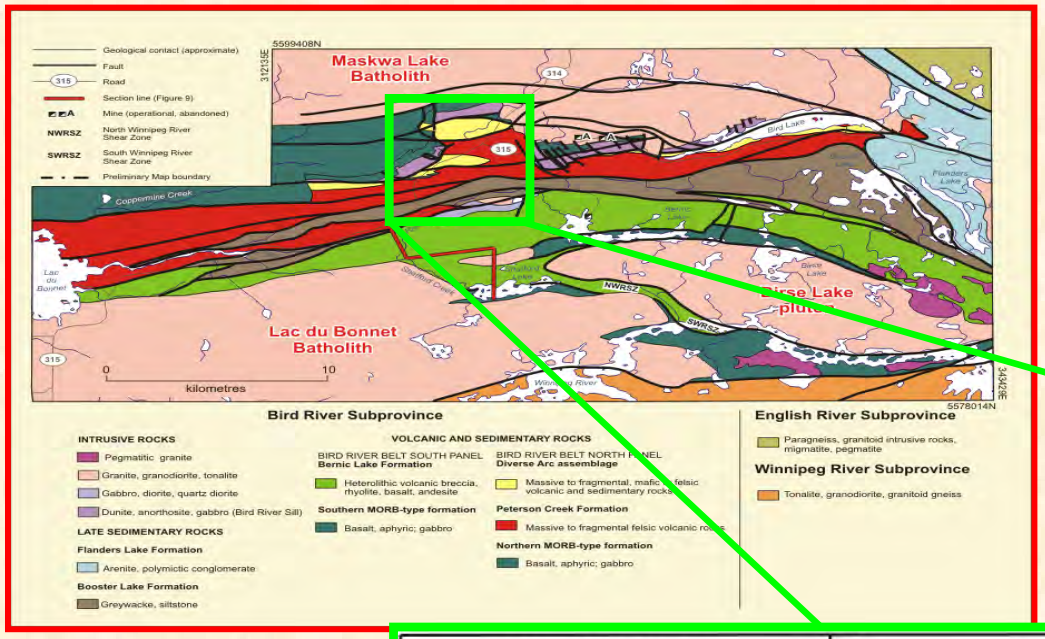


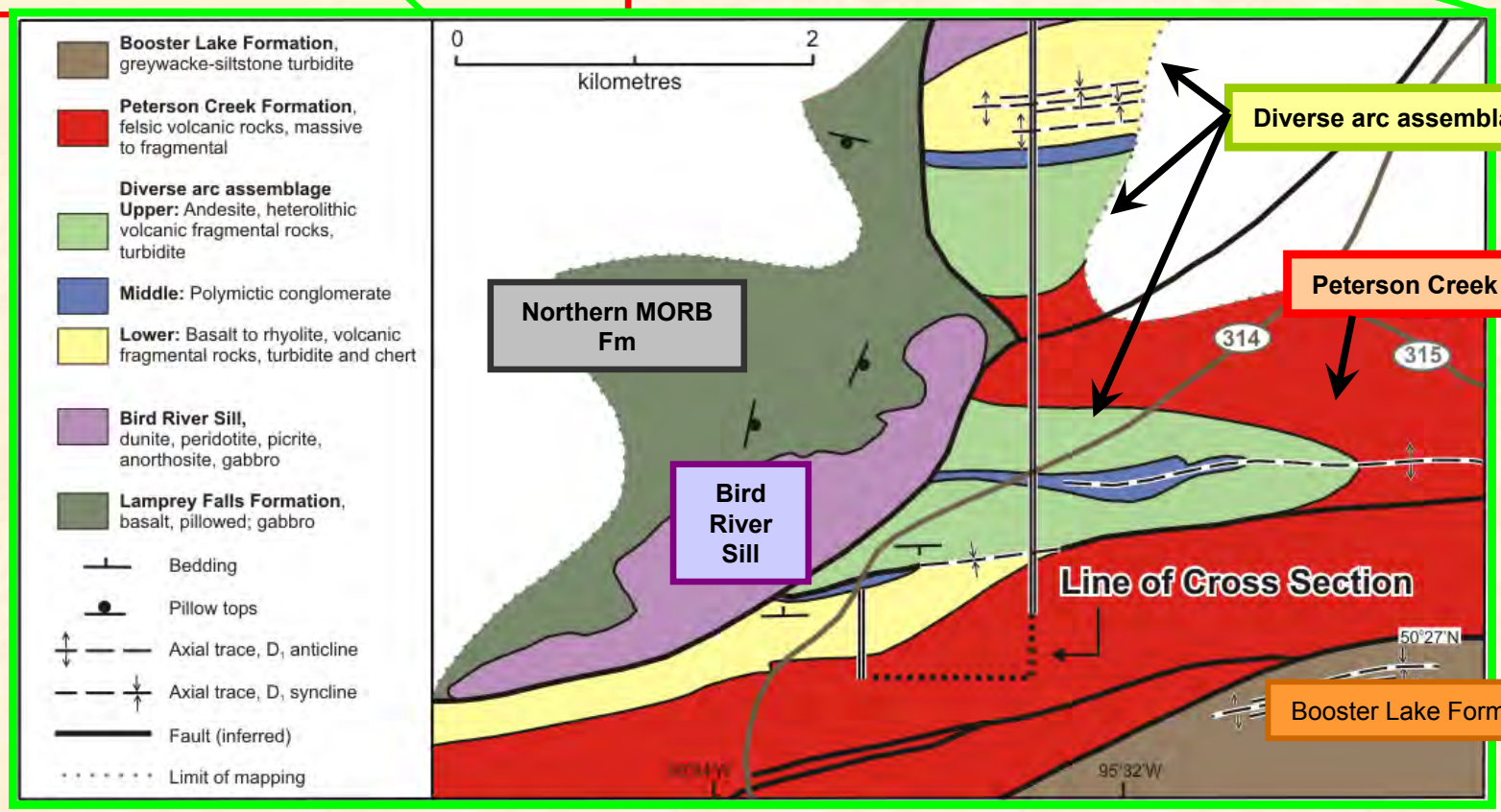
Bird River Belt North Panel

Highway Junction area

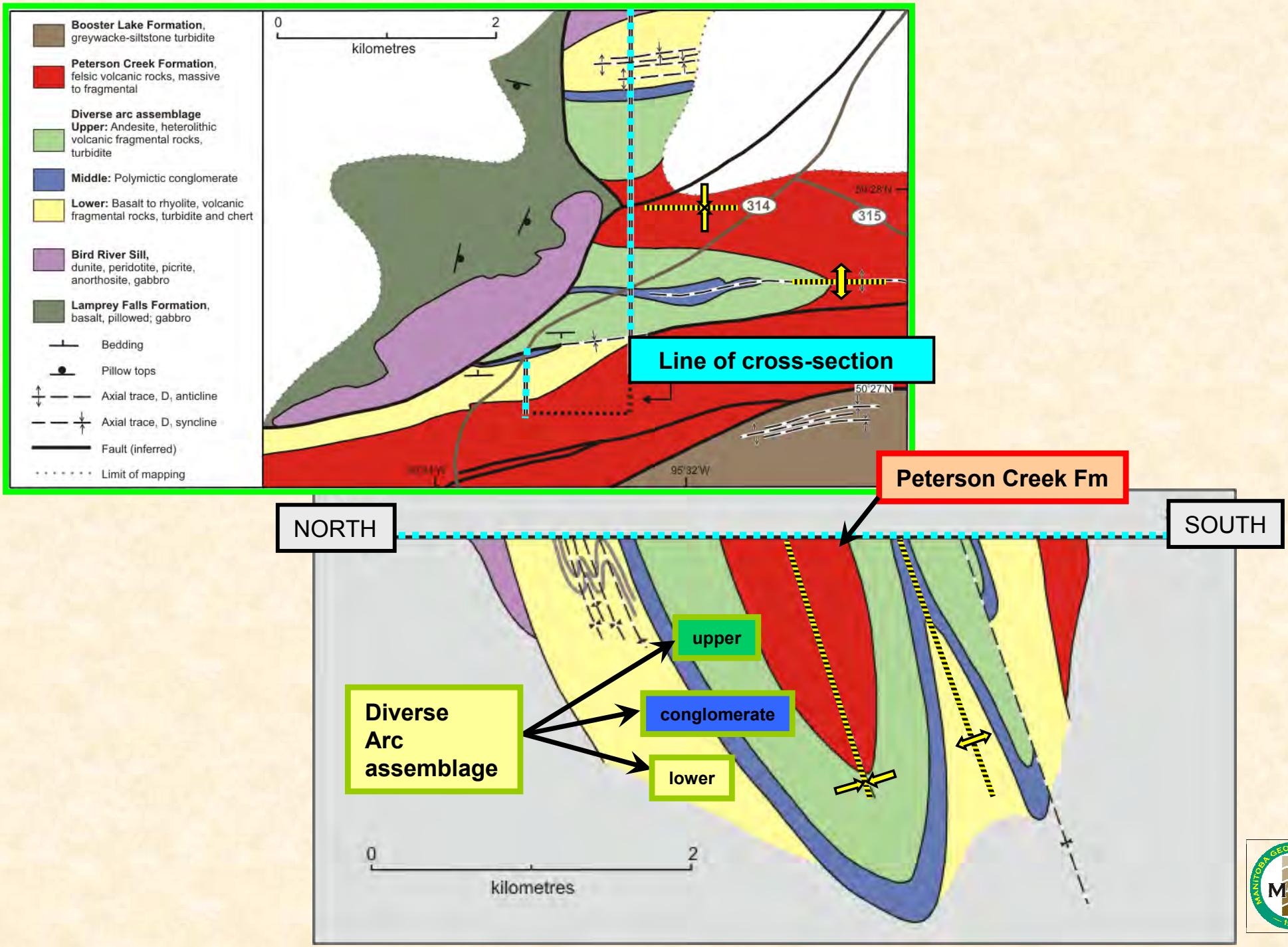


BRB North Panel – highway junction area

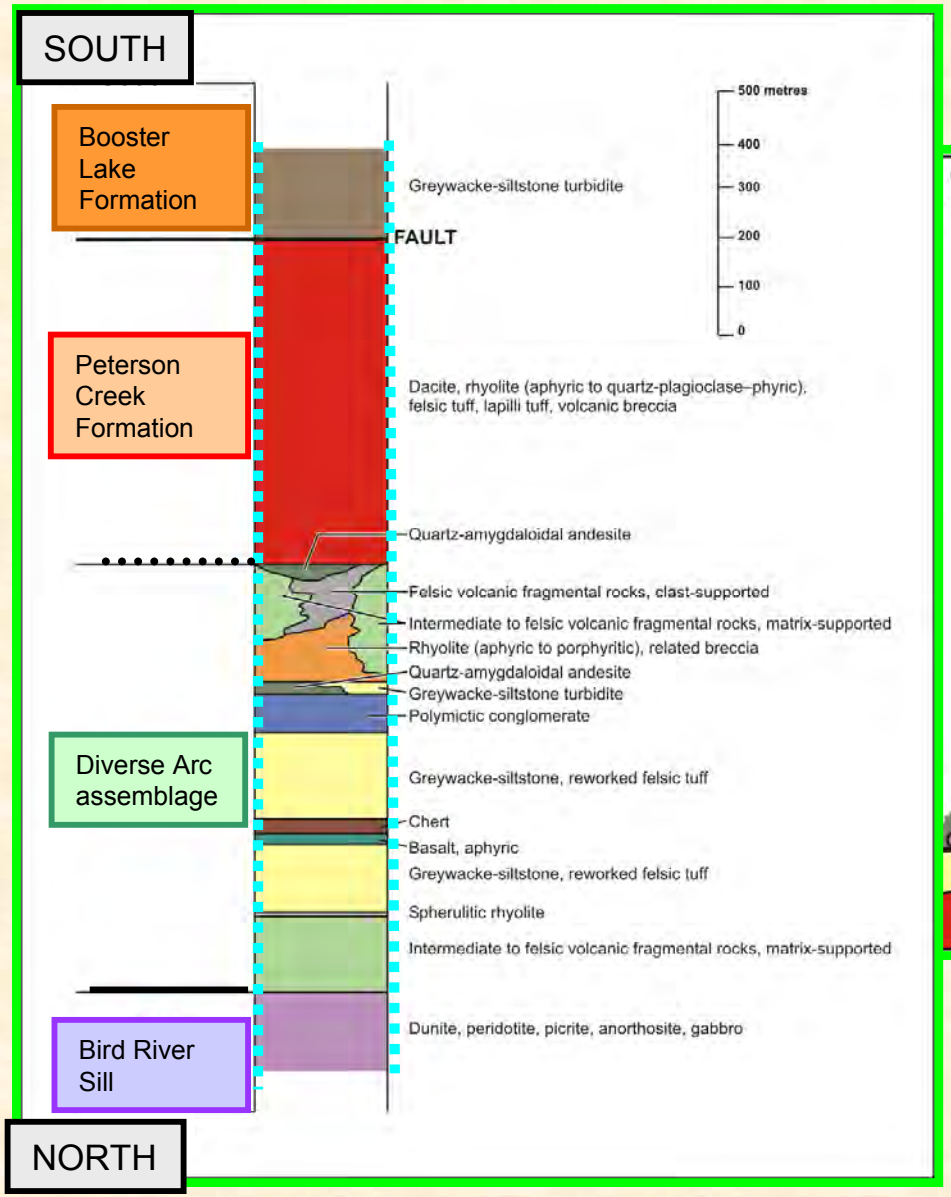


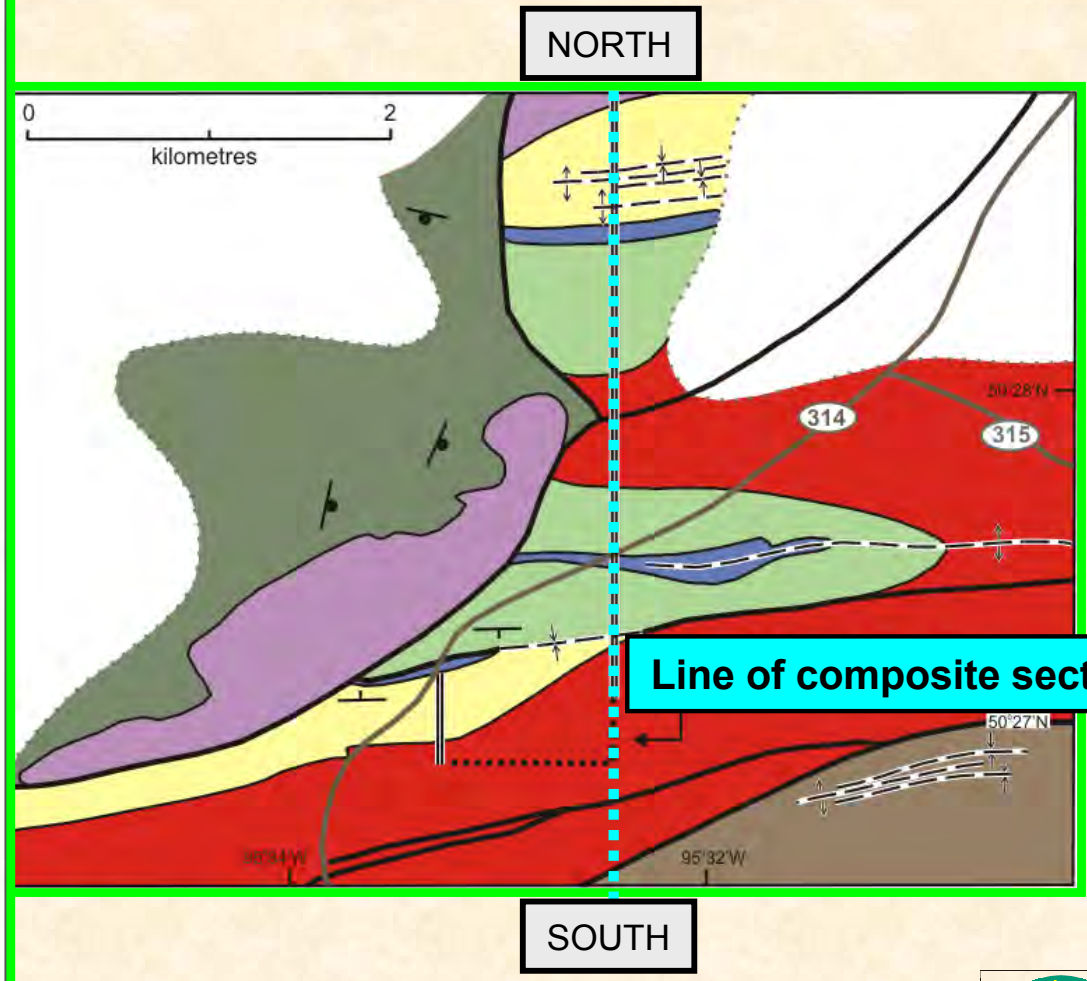


BRB North Panel – cross-section

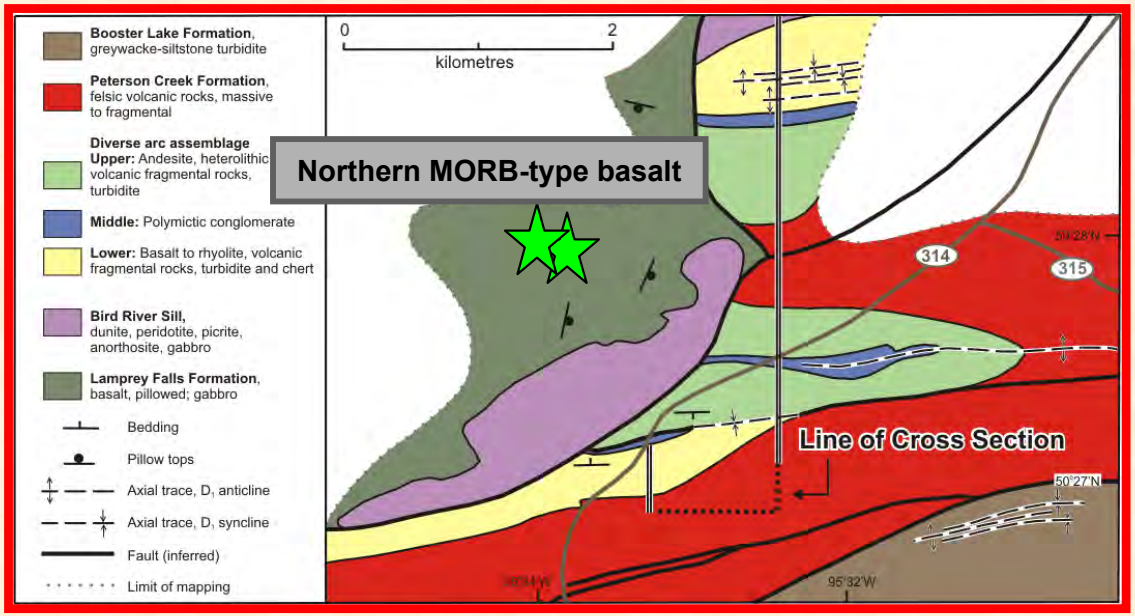


BRB North Panel – composite stratigraphic section

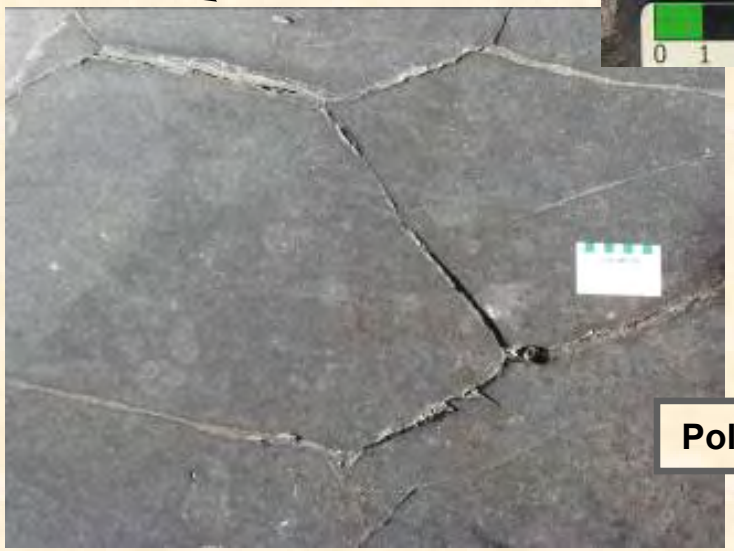




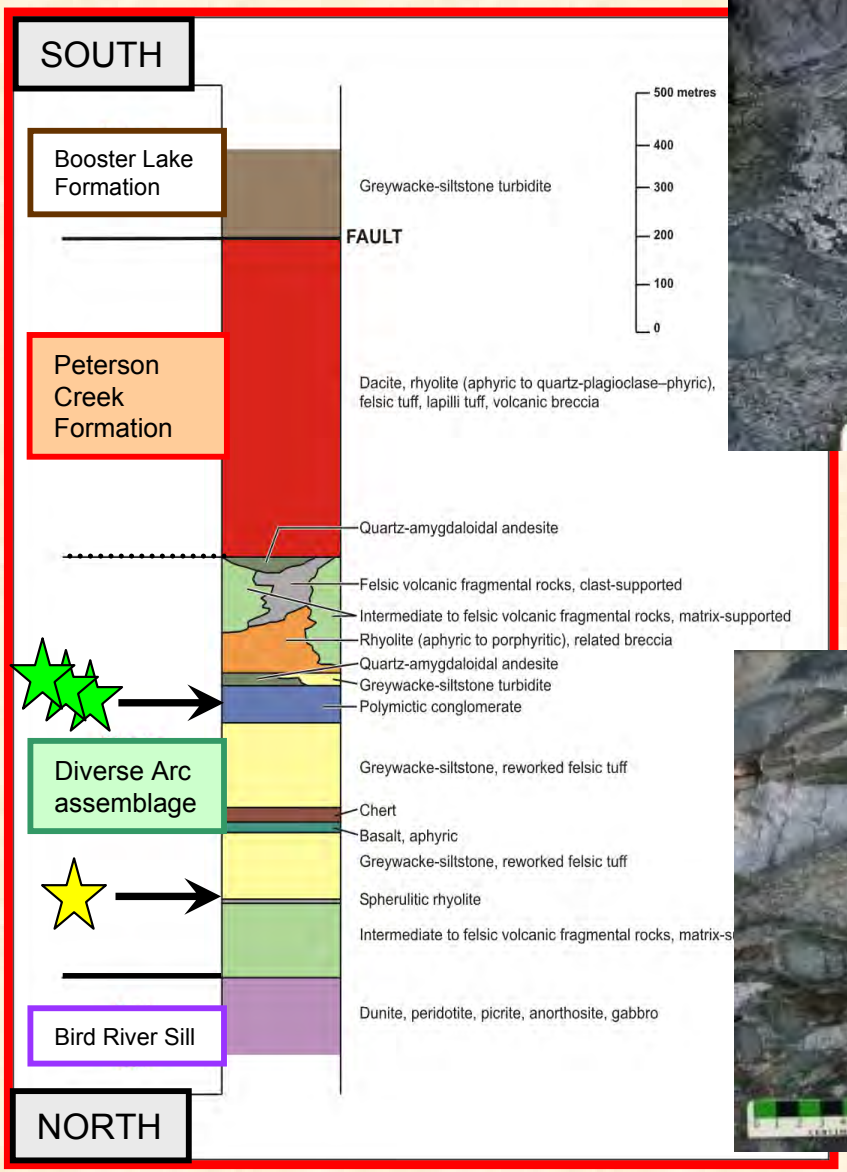
MORB-type basalt formations



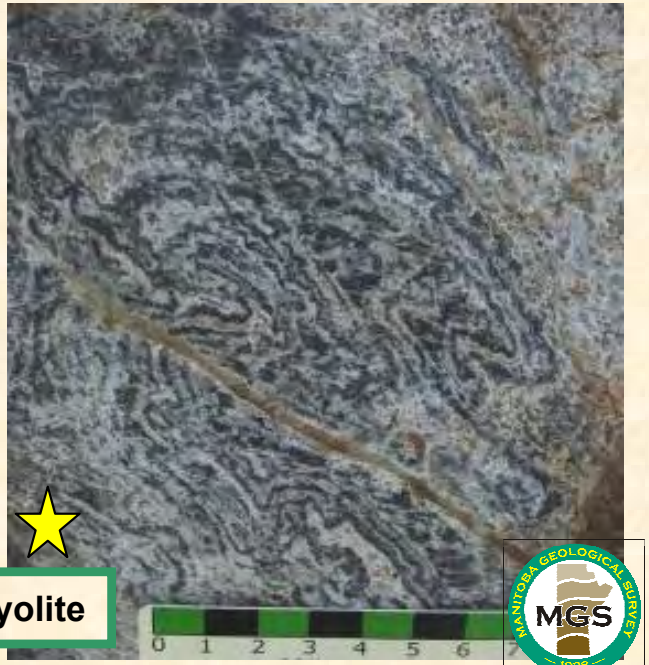
Southern MORB-type basalt at Winnipeg River



Arc-type rocks (highway junction area)

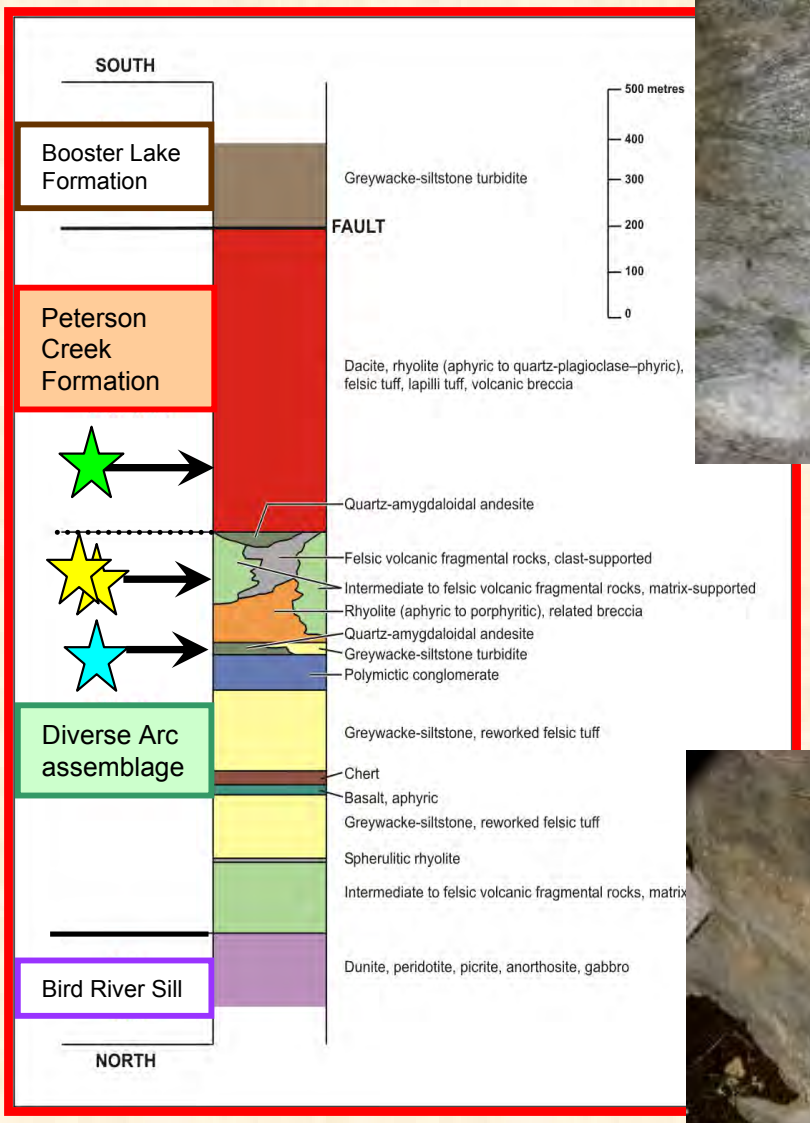


Polymictic conglomerate



Spherulitic rhyolite

Arc-type rocks (highway junction area)



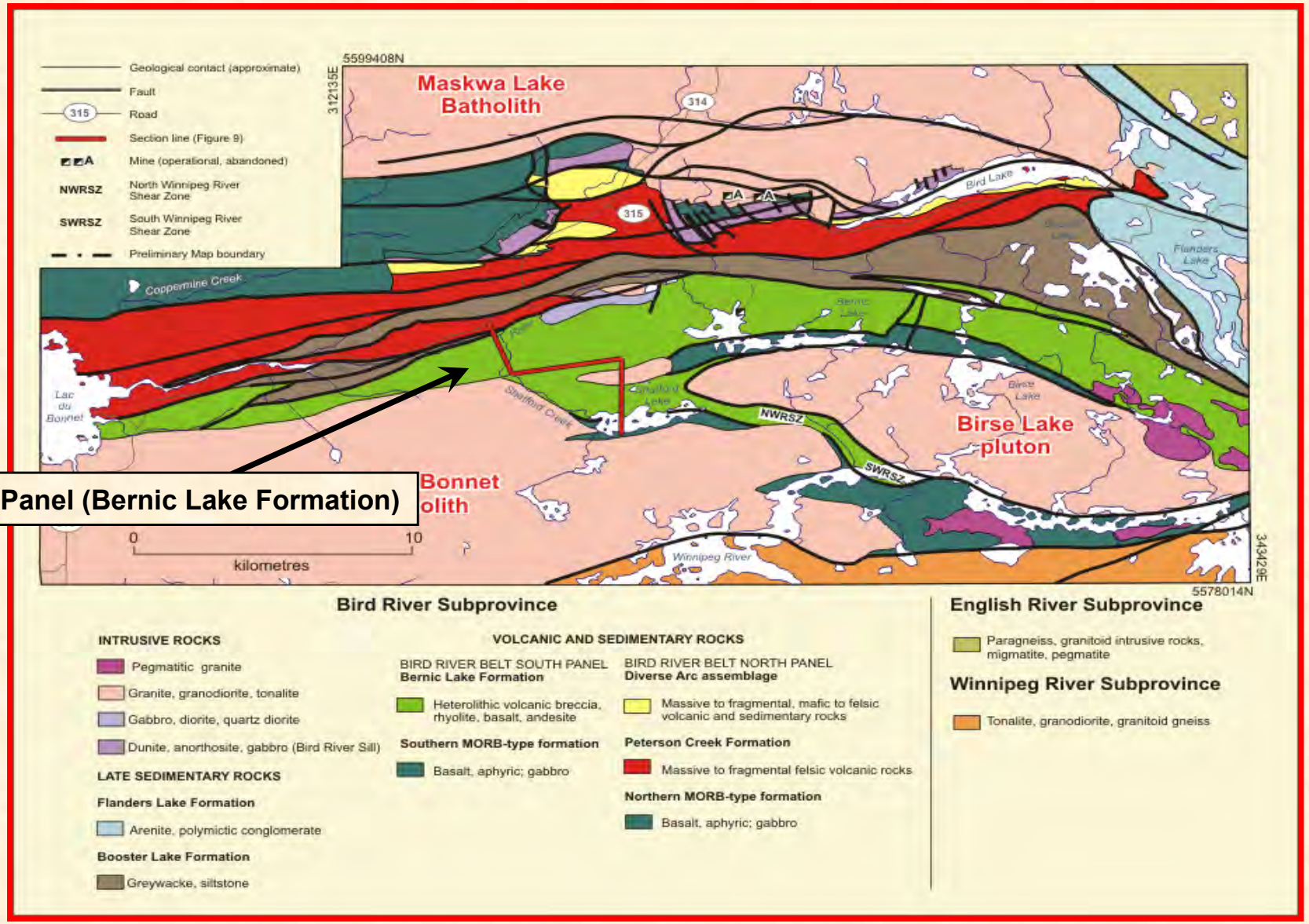
In-situ breccia, flow lamination

Heterolithic volcanic breccia

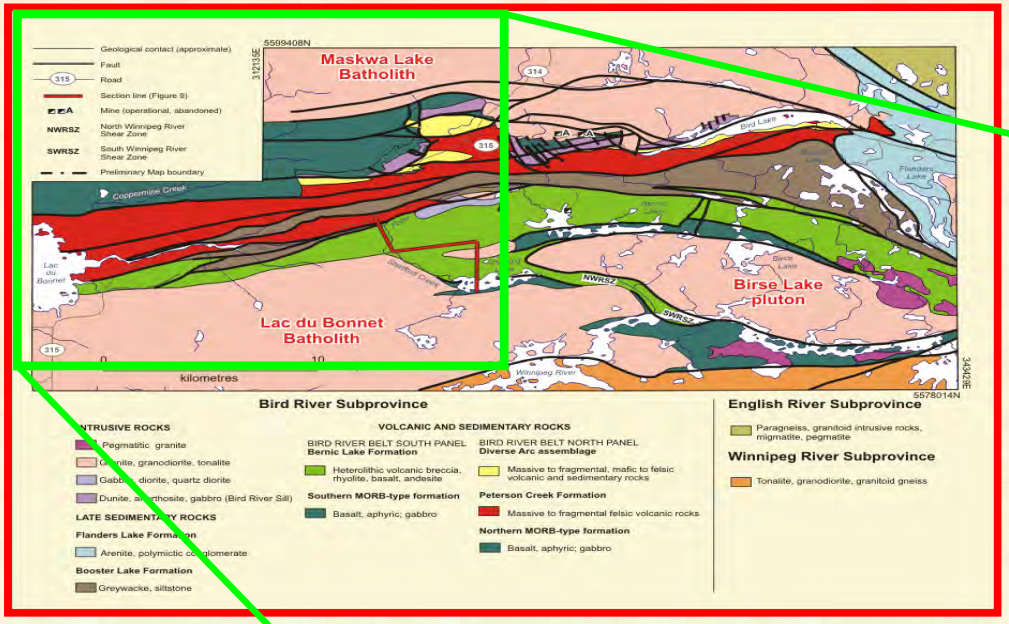
Volcaniclastic mass-flow

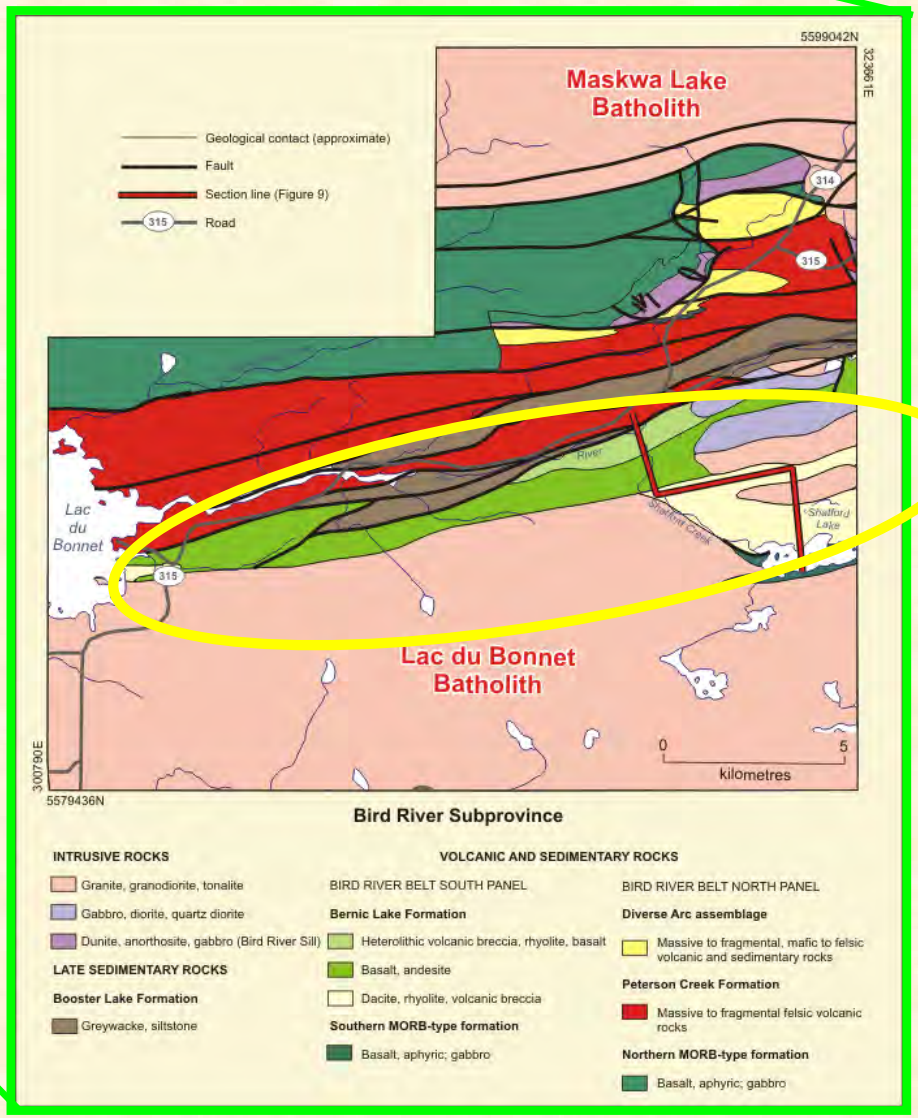
Turbidite

Bird River Belt South Panel (= Bernic Lake Formation)

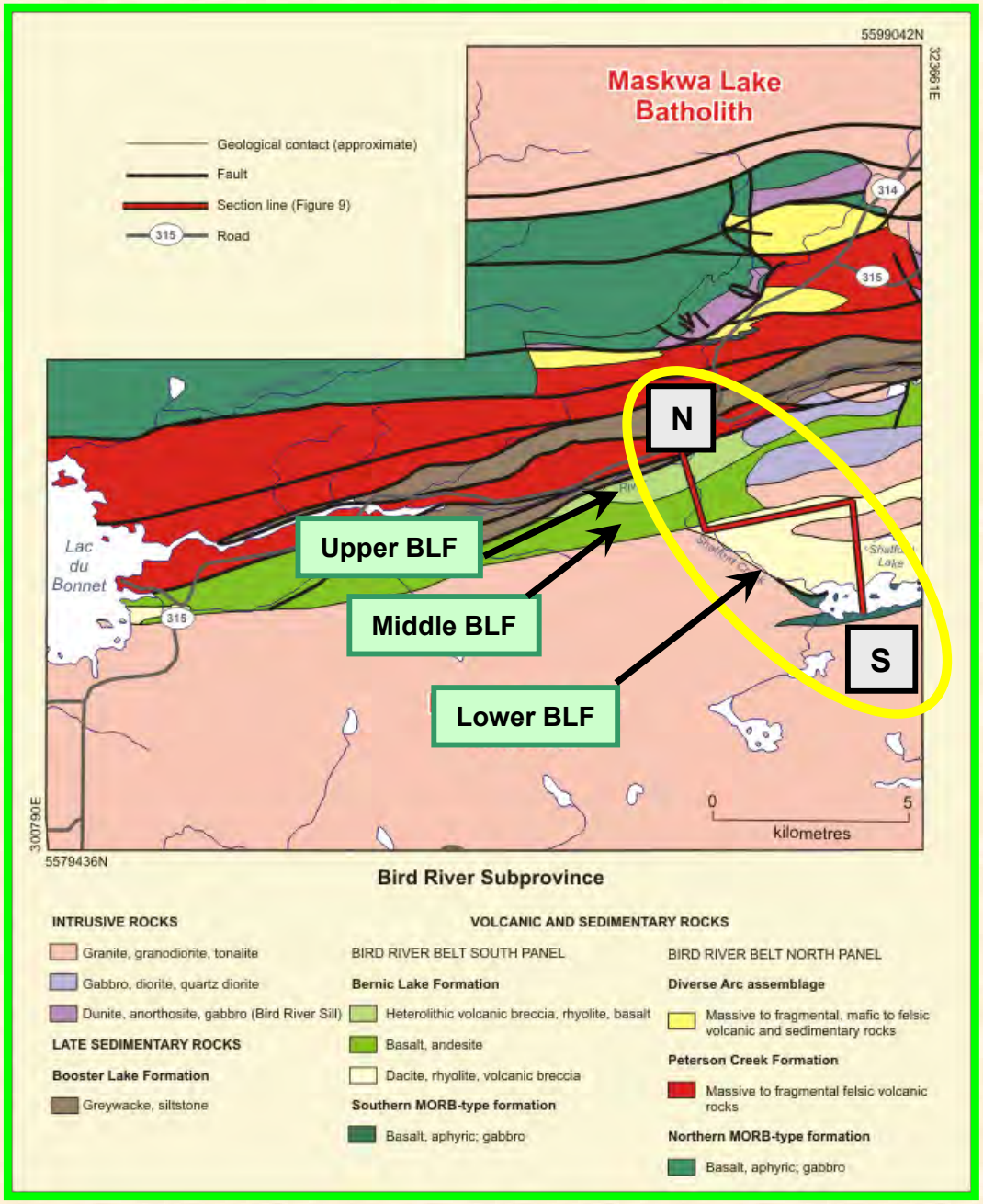


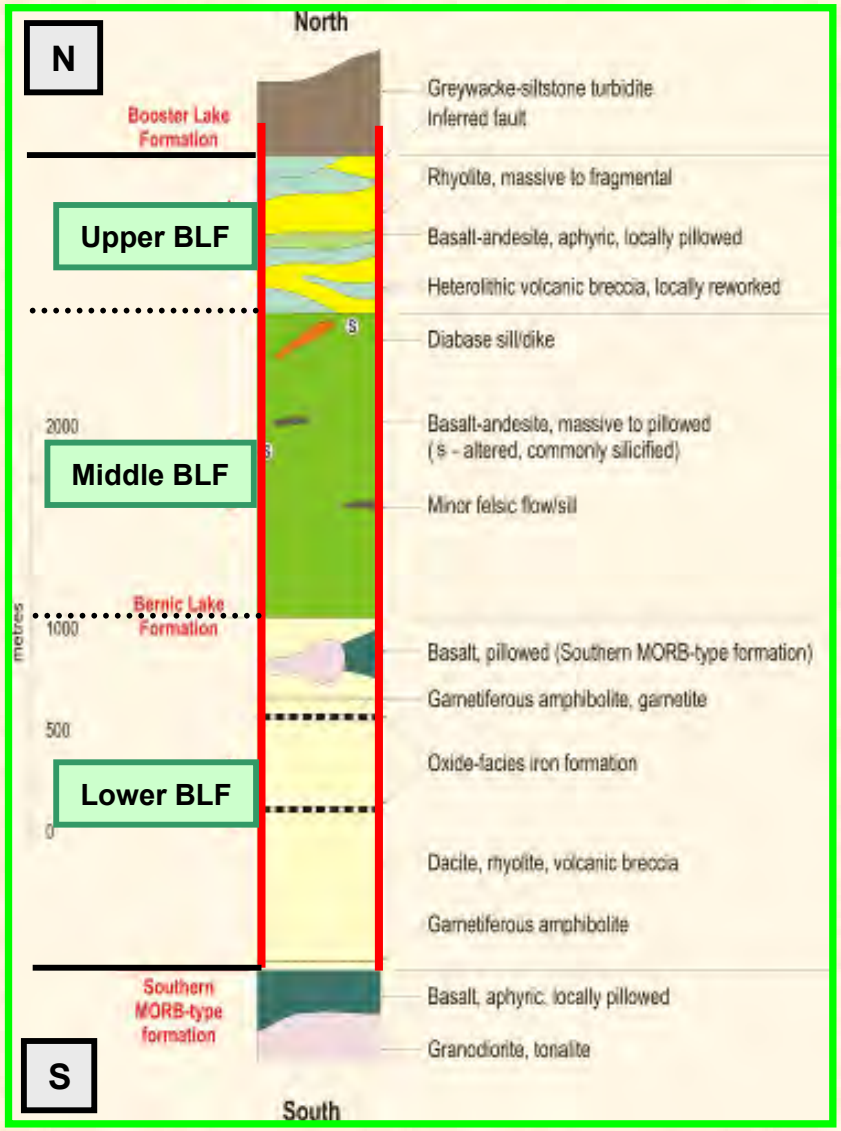
Western Bird River Belt: Bernic Lake Formation



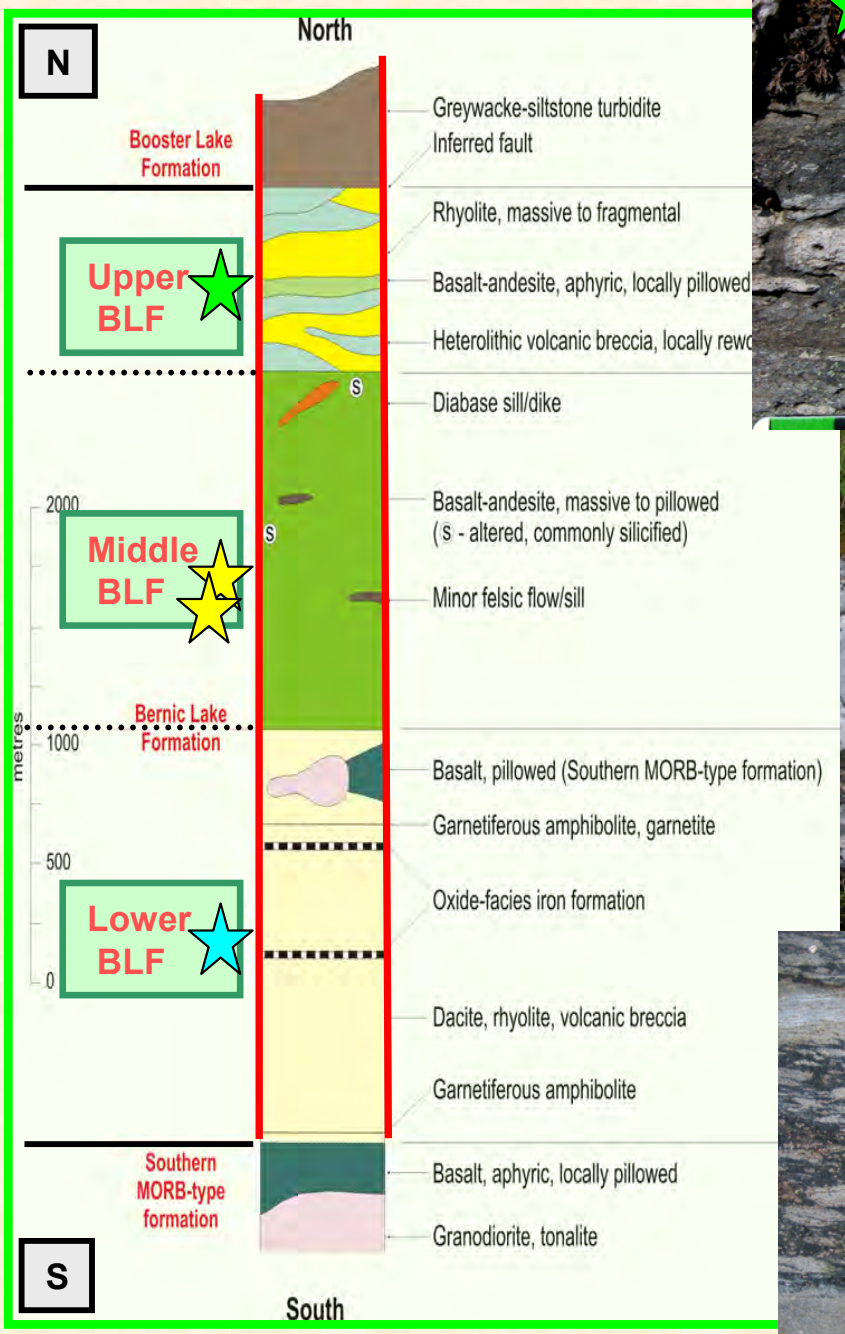


Bird River Belt south panel ~ Bernic Lake Formation

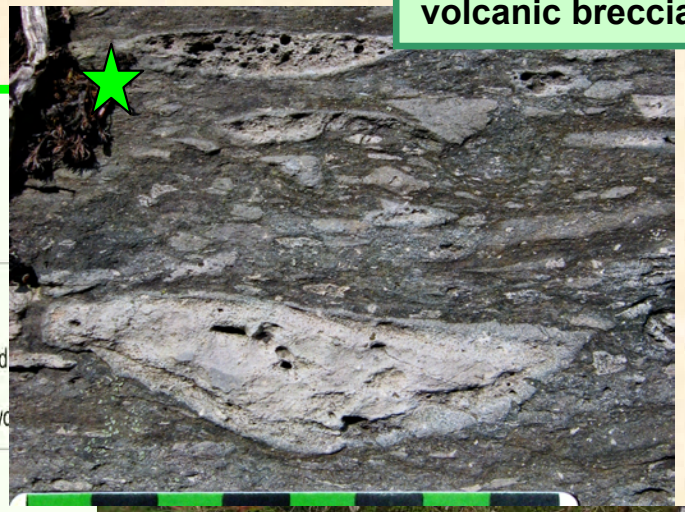




Bernic Lake Formation



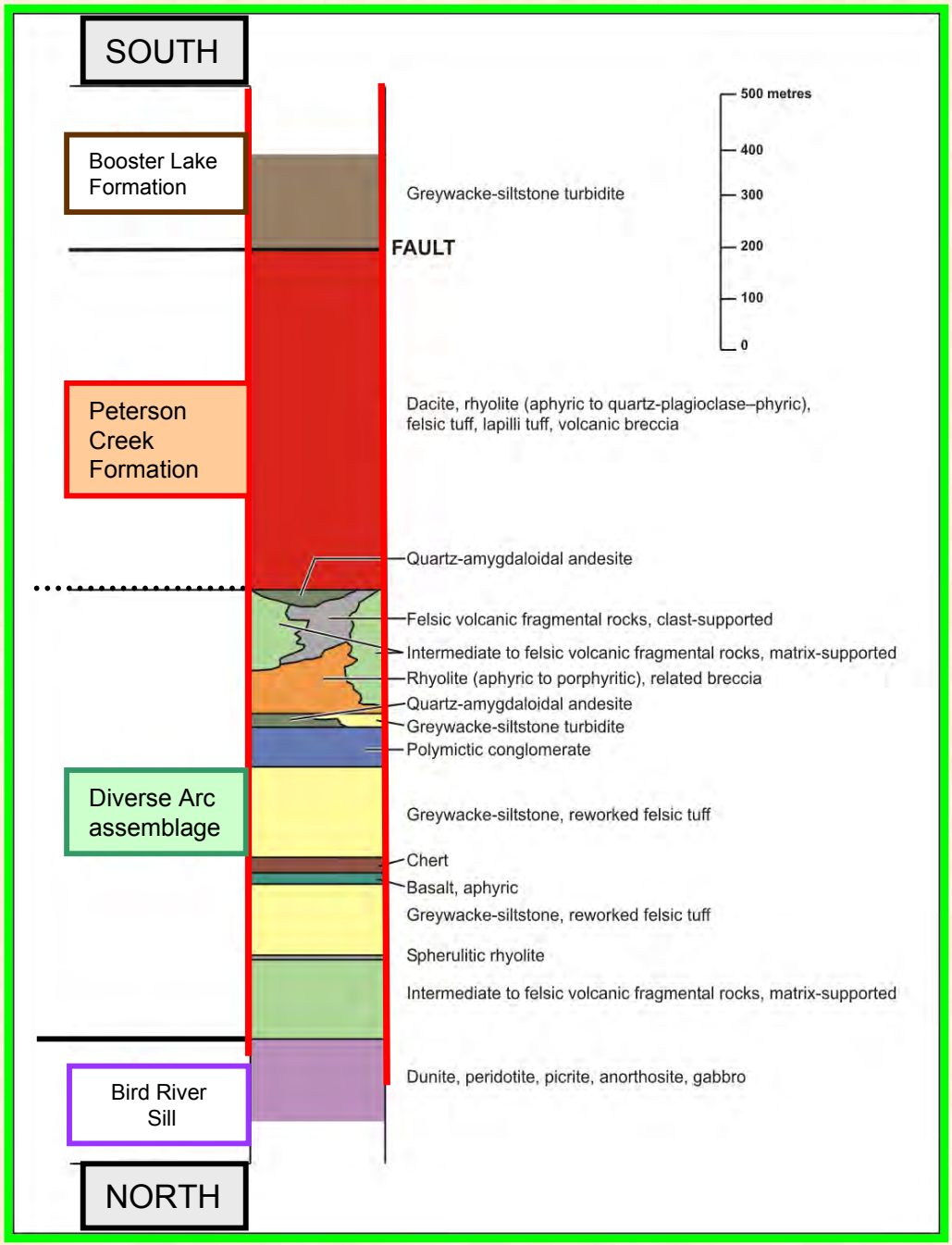
Upper BLF
volcanic breccia



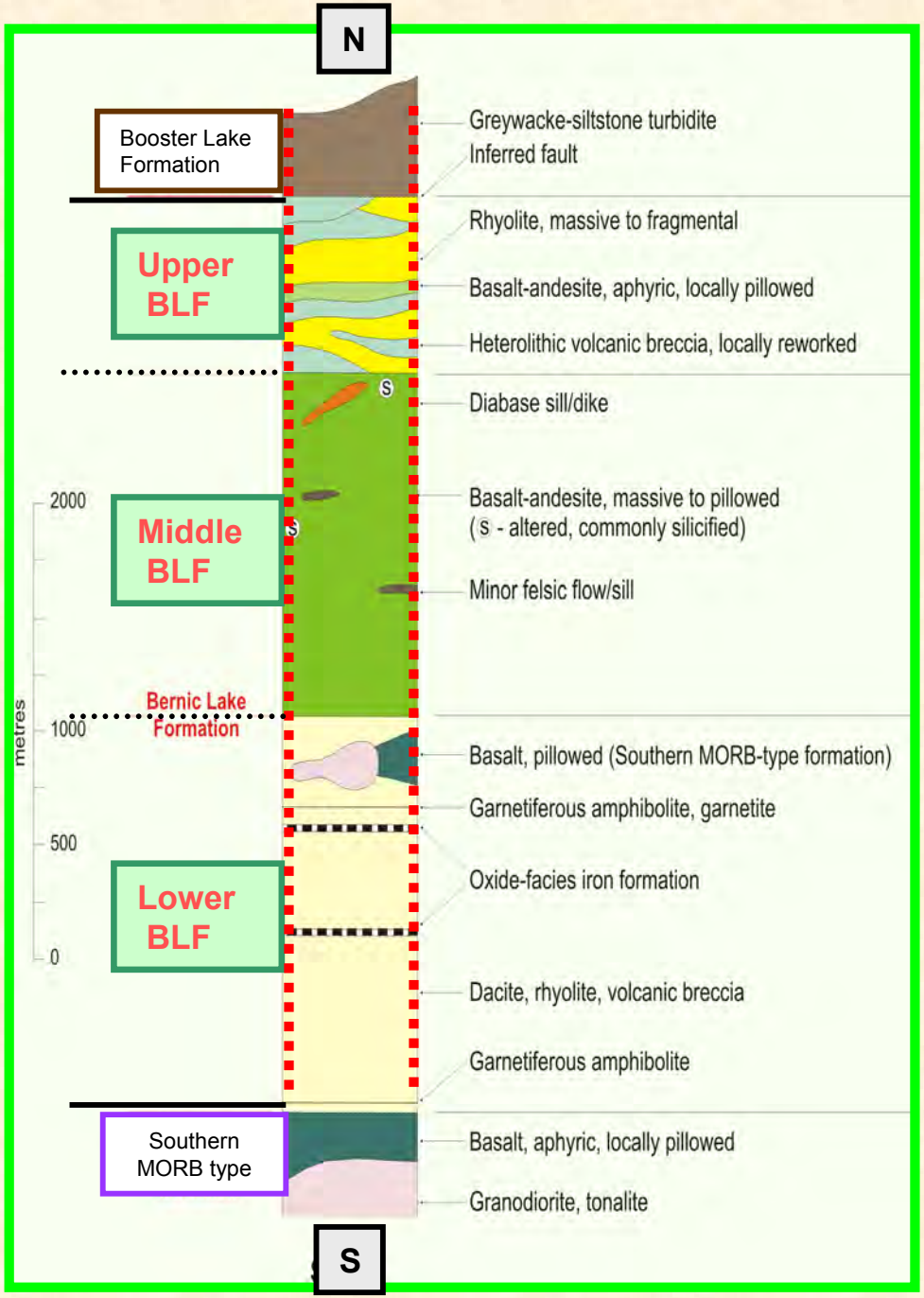
Middle BLF
pillow basalt & alteration

Lower BLF **altered felsic volcanic bx**

BRB North Panel



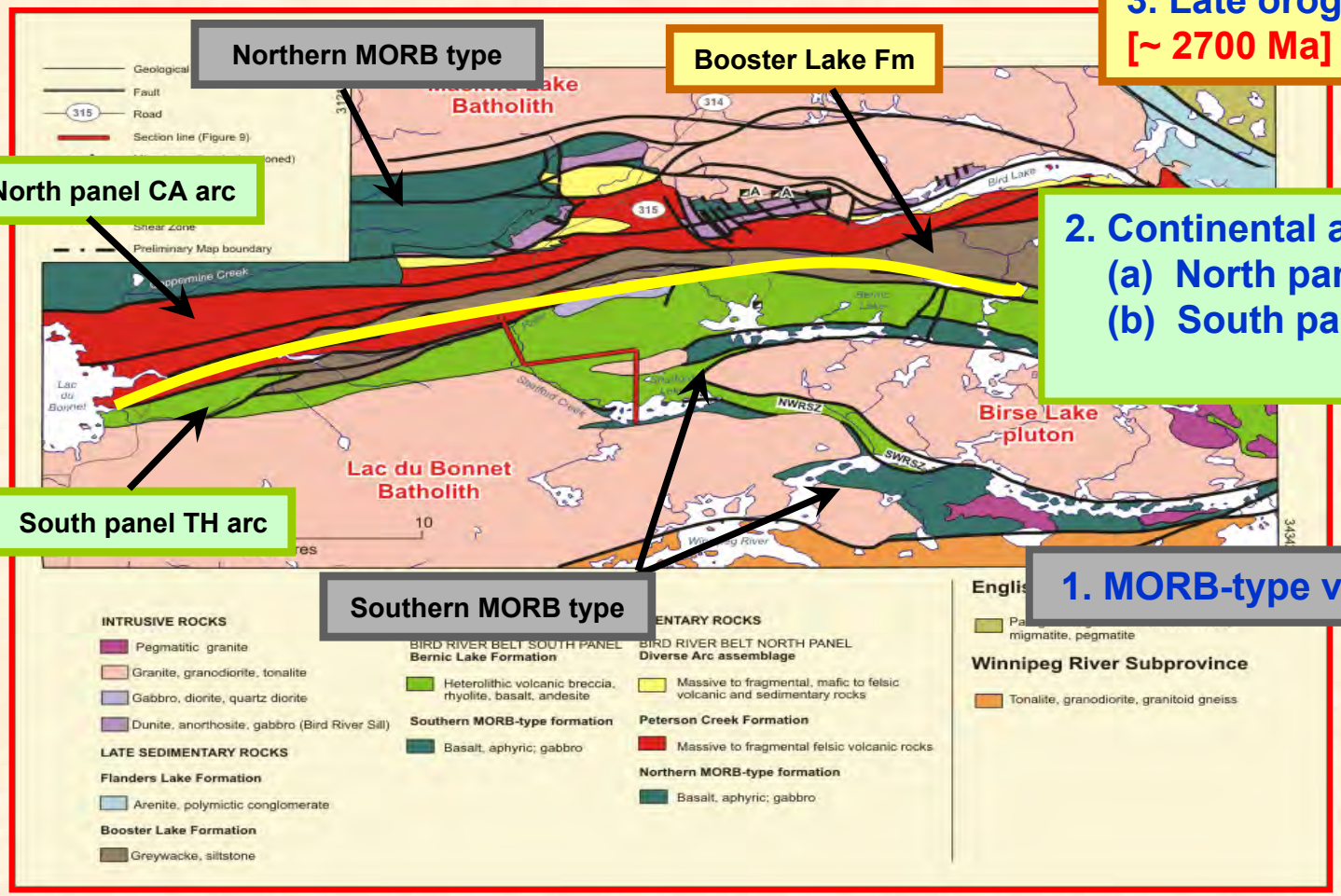
BRB South Panel



Bird River Belt ~

Geochemistry of volcanic rocks

Bird River Belt ~ main tectonostratigraphic components

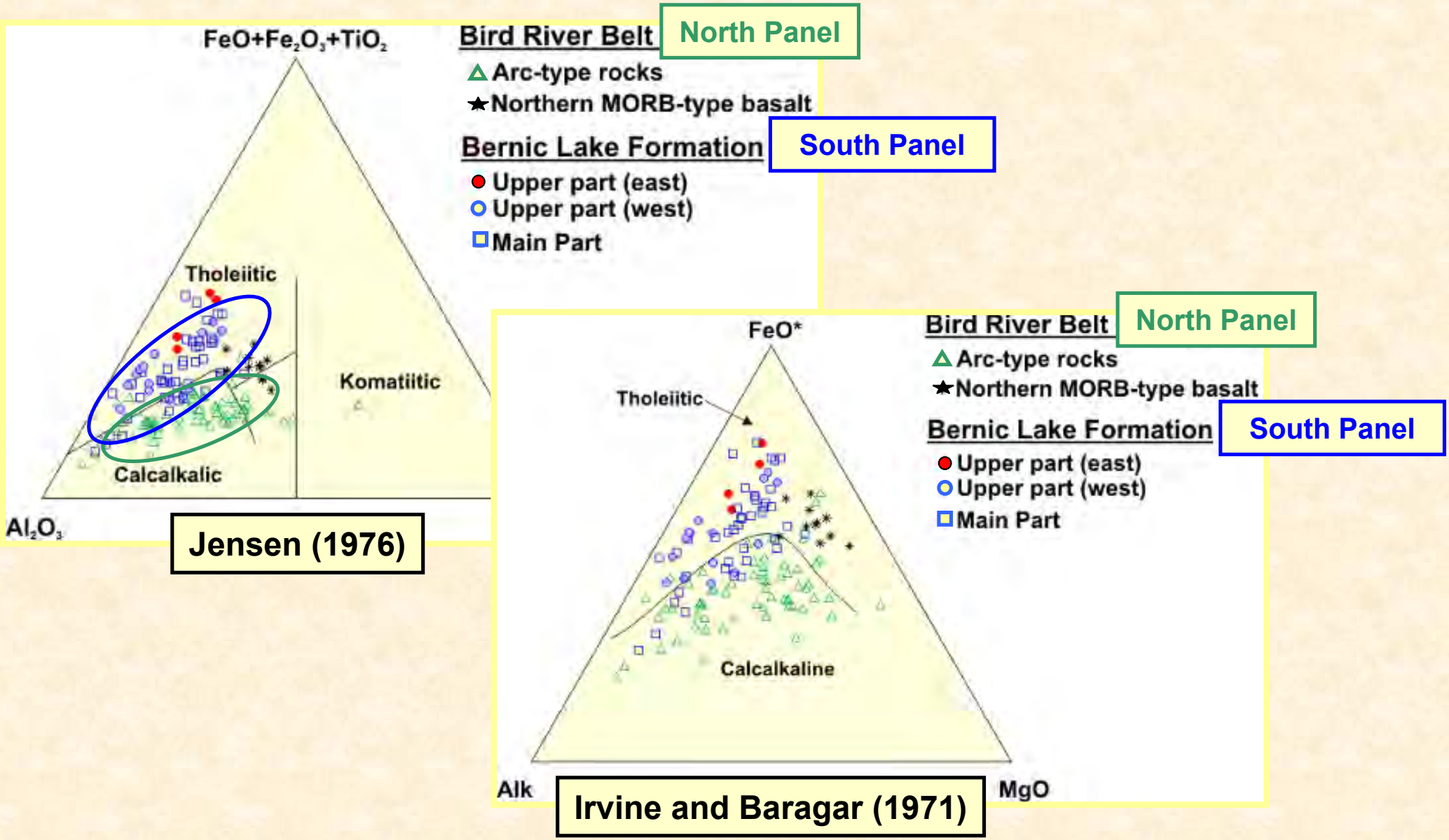


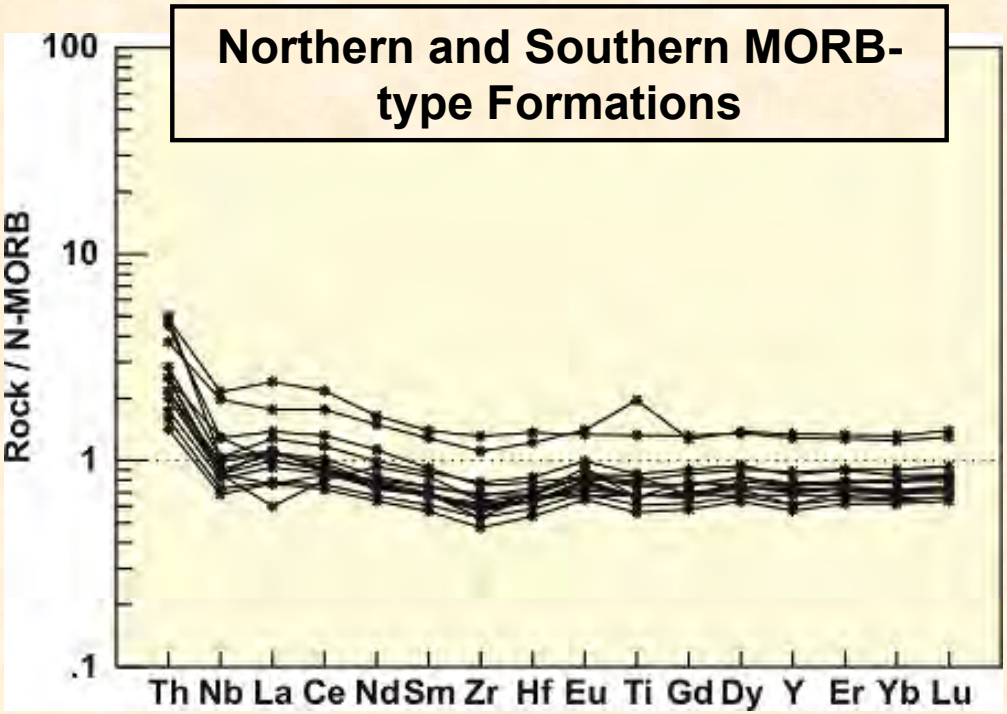
3. Late orogenic sedimentary rocks [~ 2700 Ma]

2. Continental arc-type sequence ~
- **(a) North panel calcalkaline [2731 ±1 Ma]**
- **(b) South panel tholeiitic [2725 ±1]**

1. MORB-type volcanic rocks [>2745 ±5 Ma]

Bird River Belt ~
All volcanic rocks

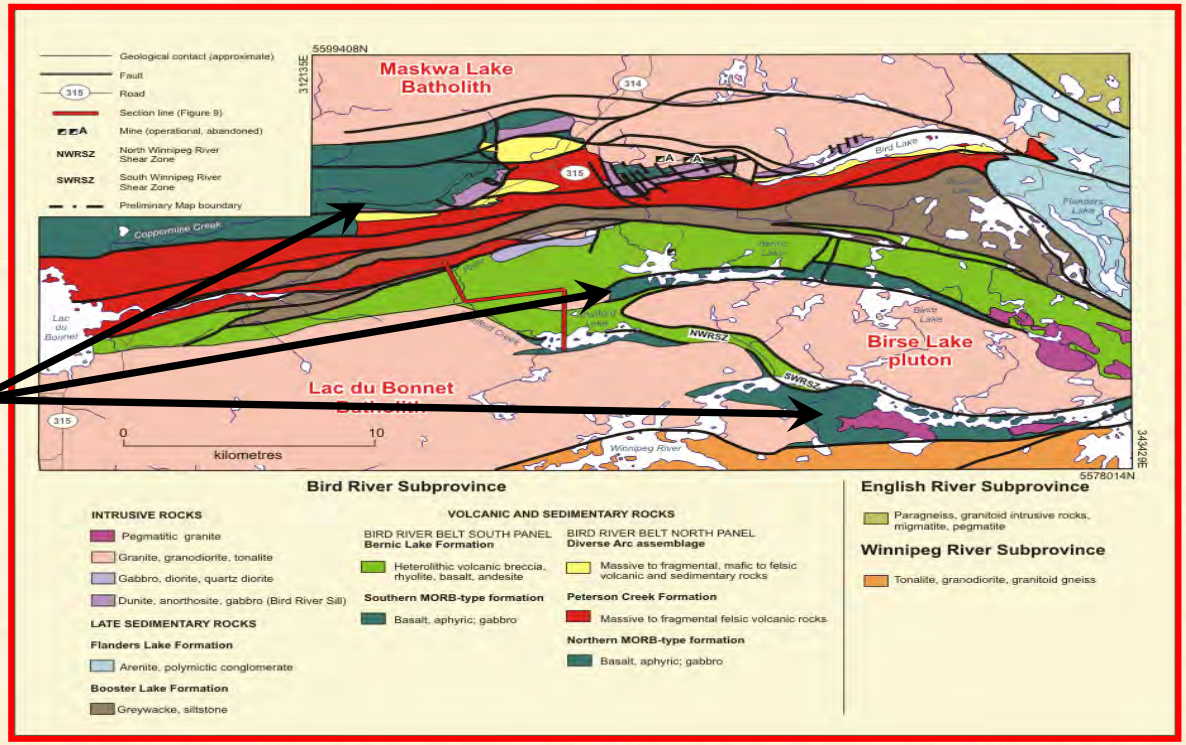


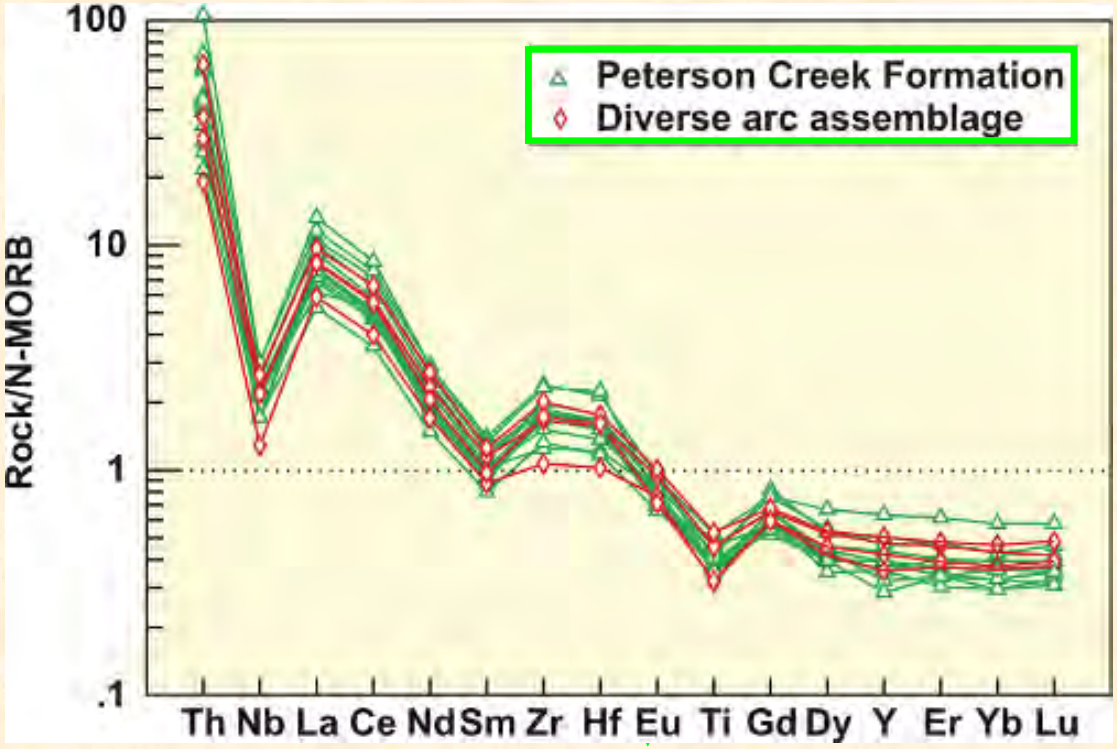


MORB-type Formations ~

- Oldest volcanics
- Intruded by 2745 Ma Bird River Sill
- Back-arc, rift-associated

Northern and Southern MORB-type Formations

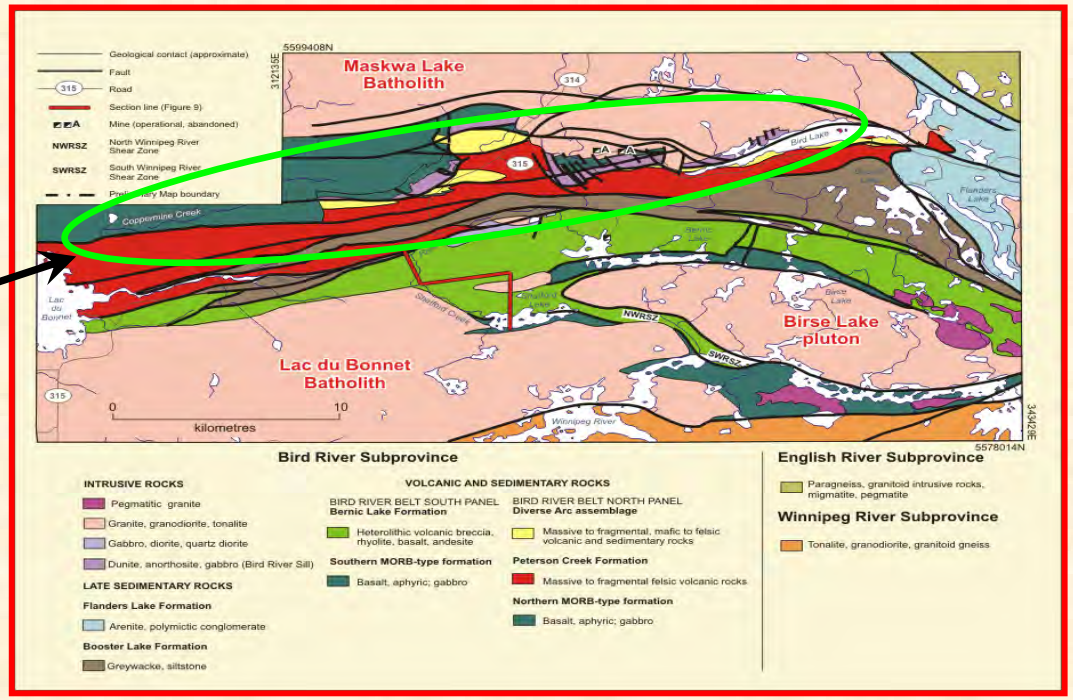


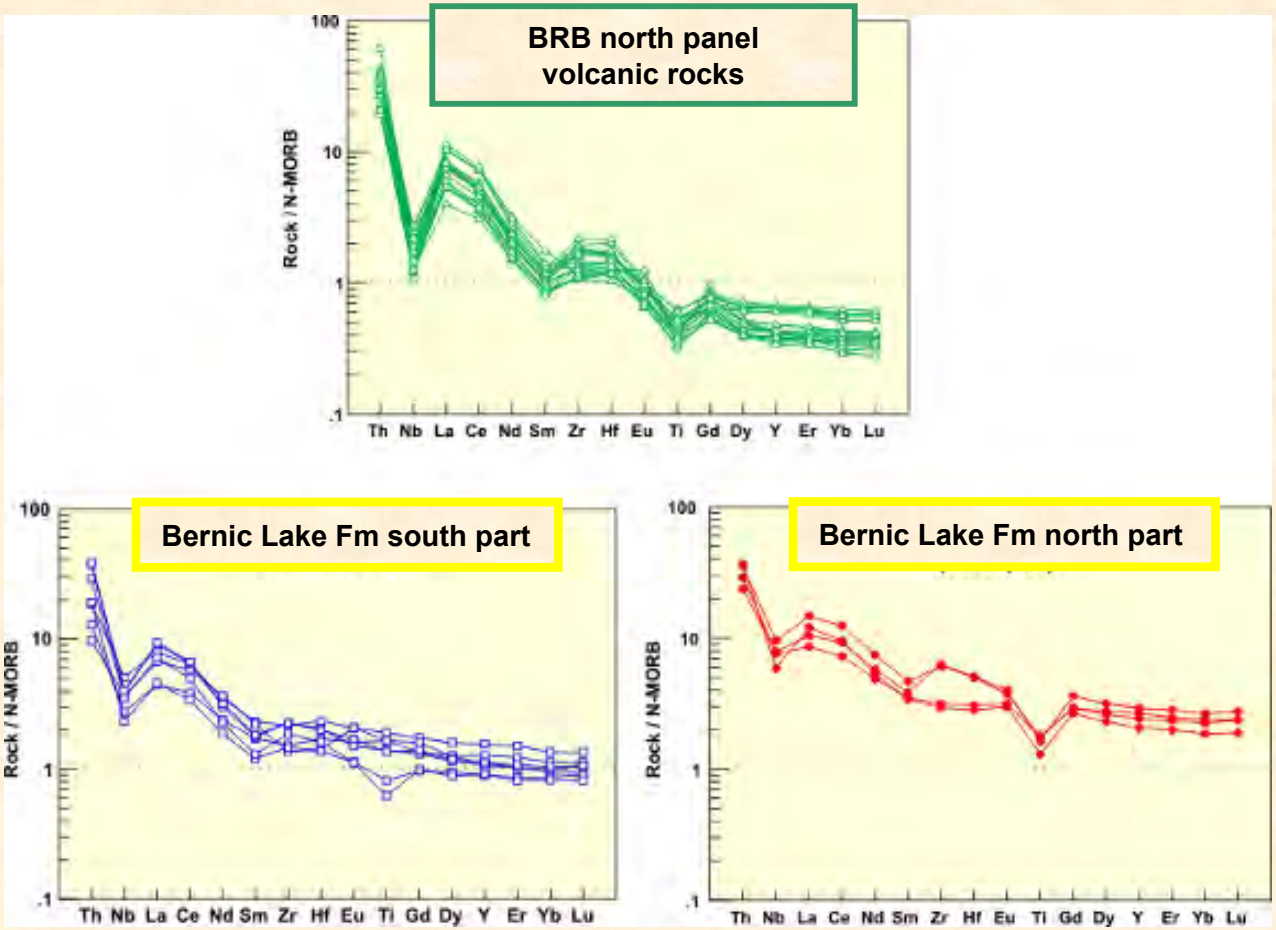


Bird River Belt
North Panel

mafic to intermediate volcanic rocks

BRB North Panel
Mafic to intermediate volcanic rocks



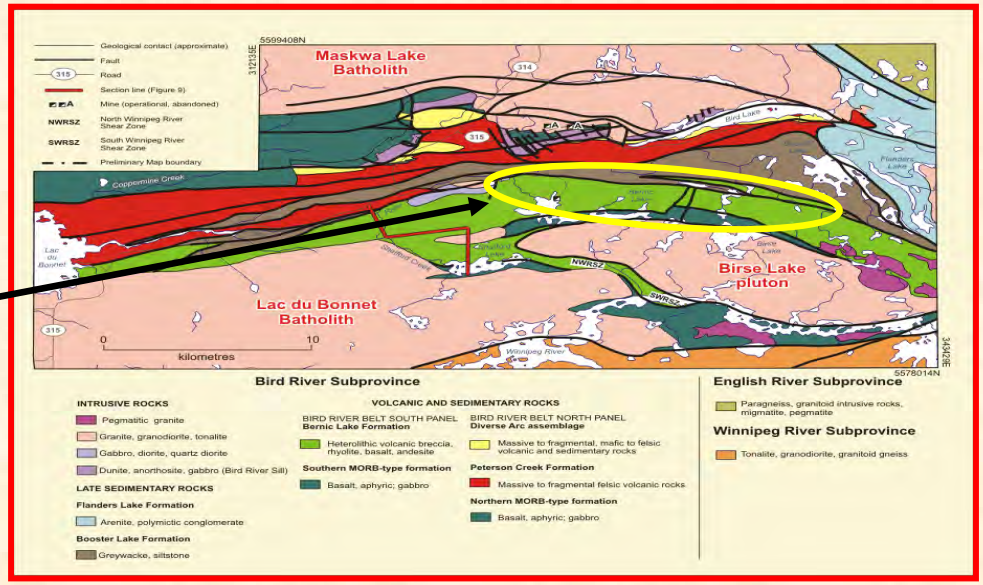


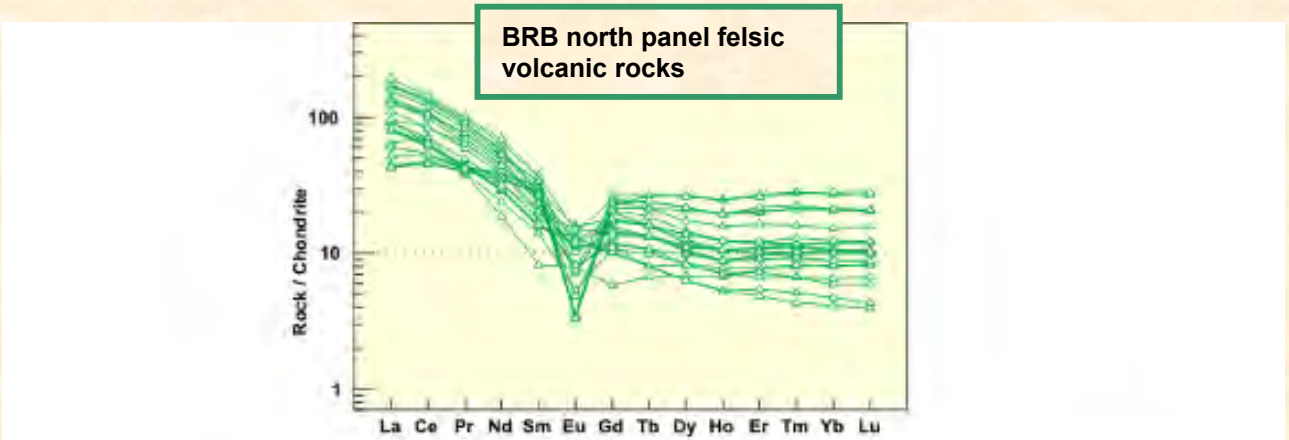
← North Panel

Mafic to intermediate volcanic rocks

← South Panel

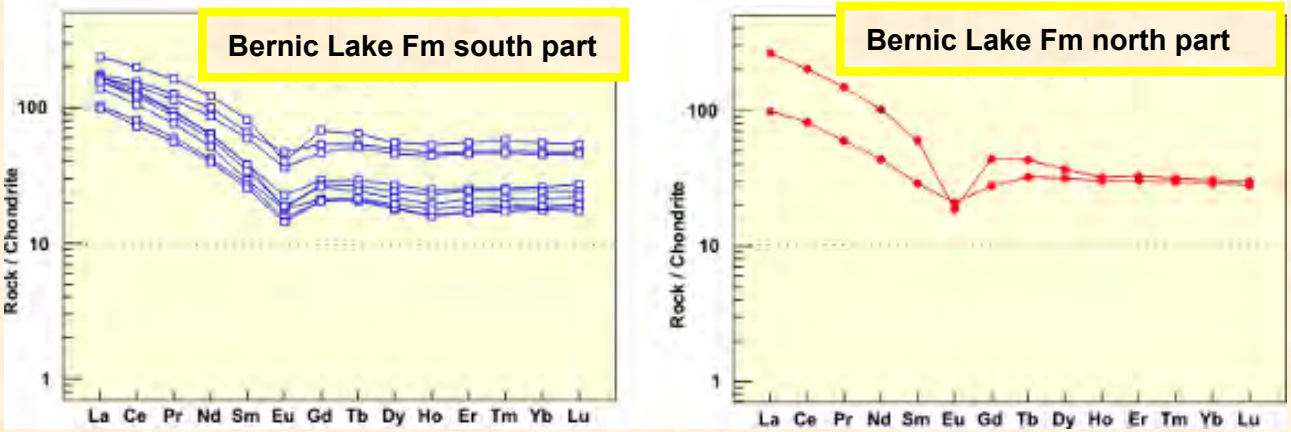
Bernic Lake Formation in eastern BRB mafic to intermediate volcanic rocks





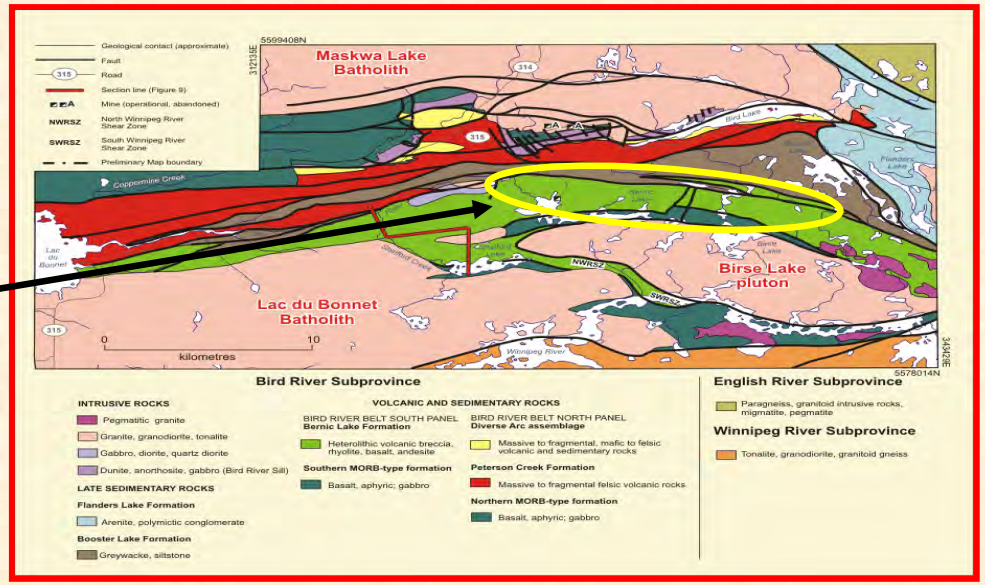
← North Panel

Felsic volcanic rocks

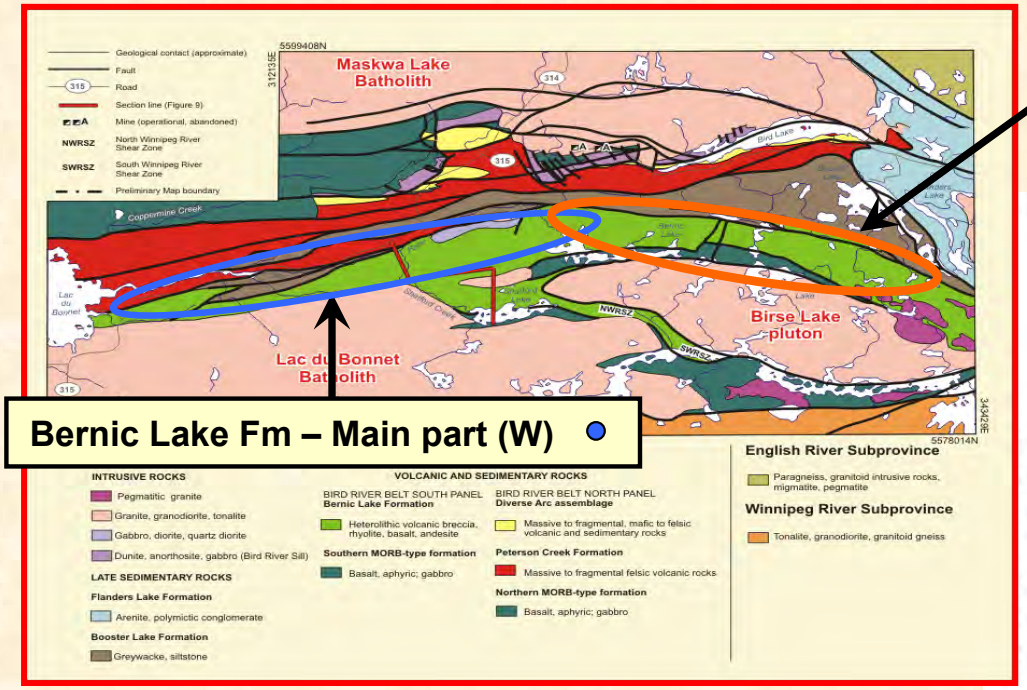


← South Panel

Bernic Lake Formation in eastern BRB felsic volcanic rocks

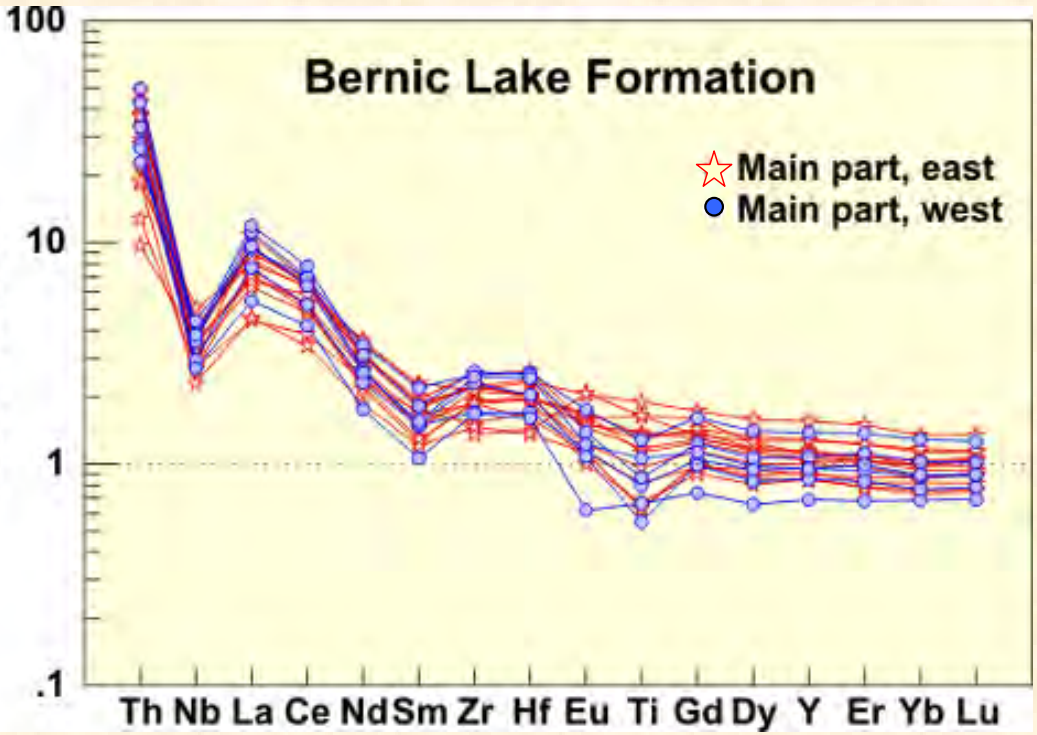


Bird River Belt South Panel



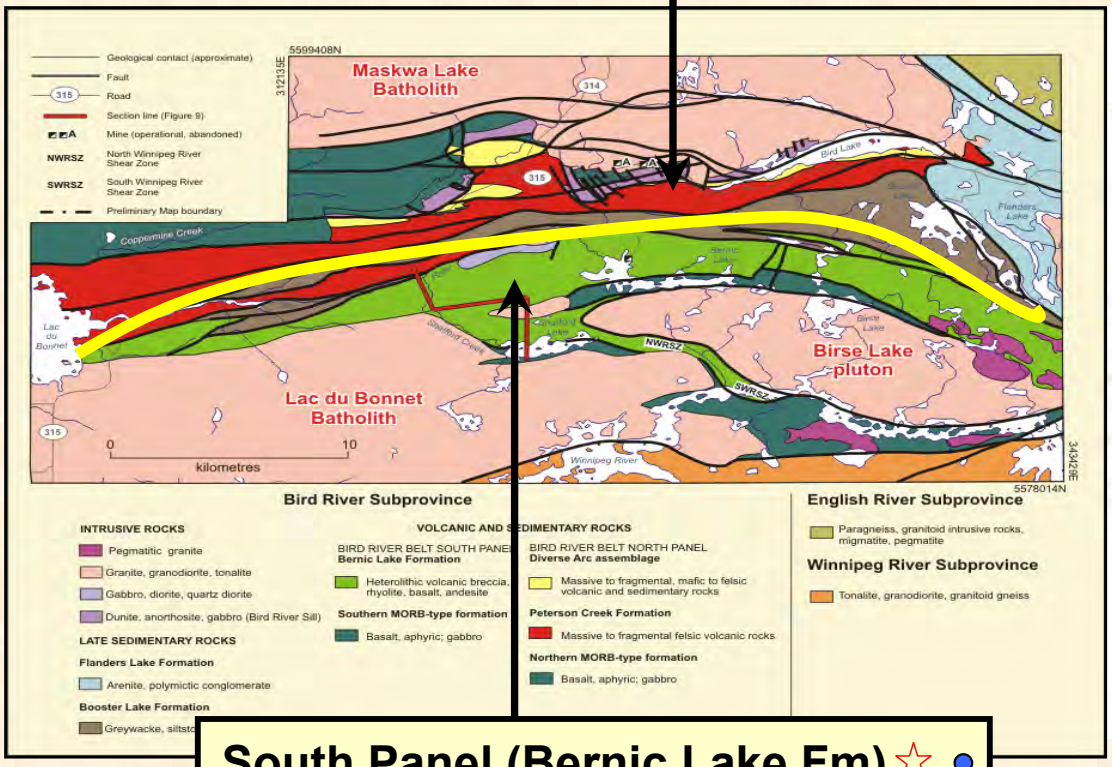
Bernic Lake Fm – Main part (W) ●

Bernic Lake Fm – Main part (E) ☆



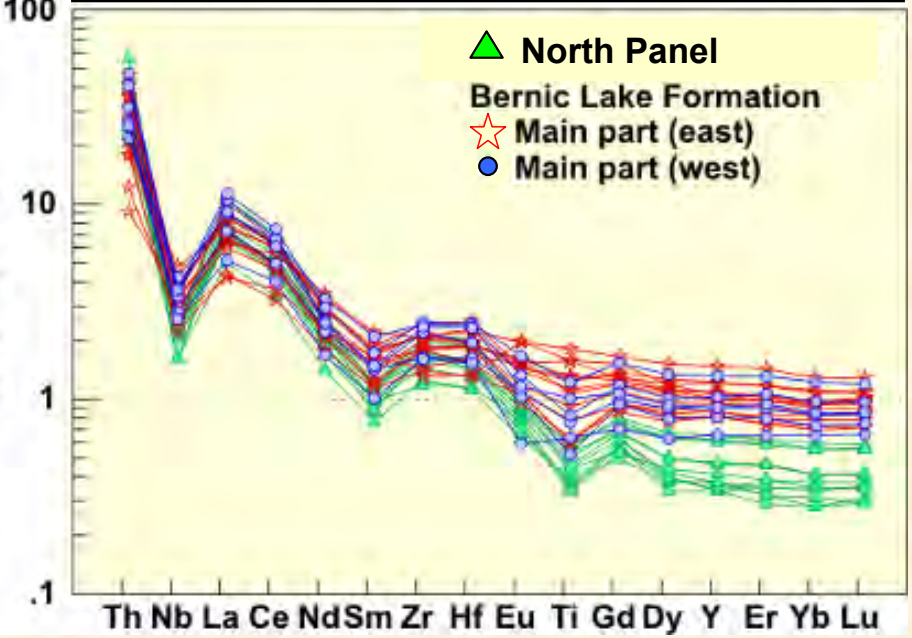
Bird River Belt North vs South Panels

North Panel ▲

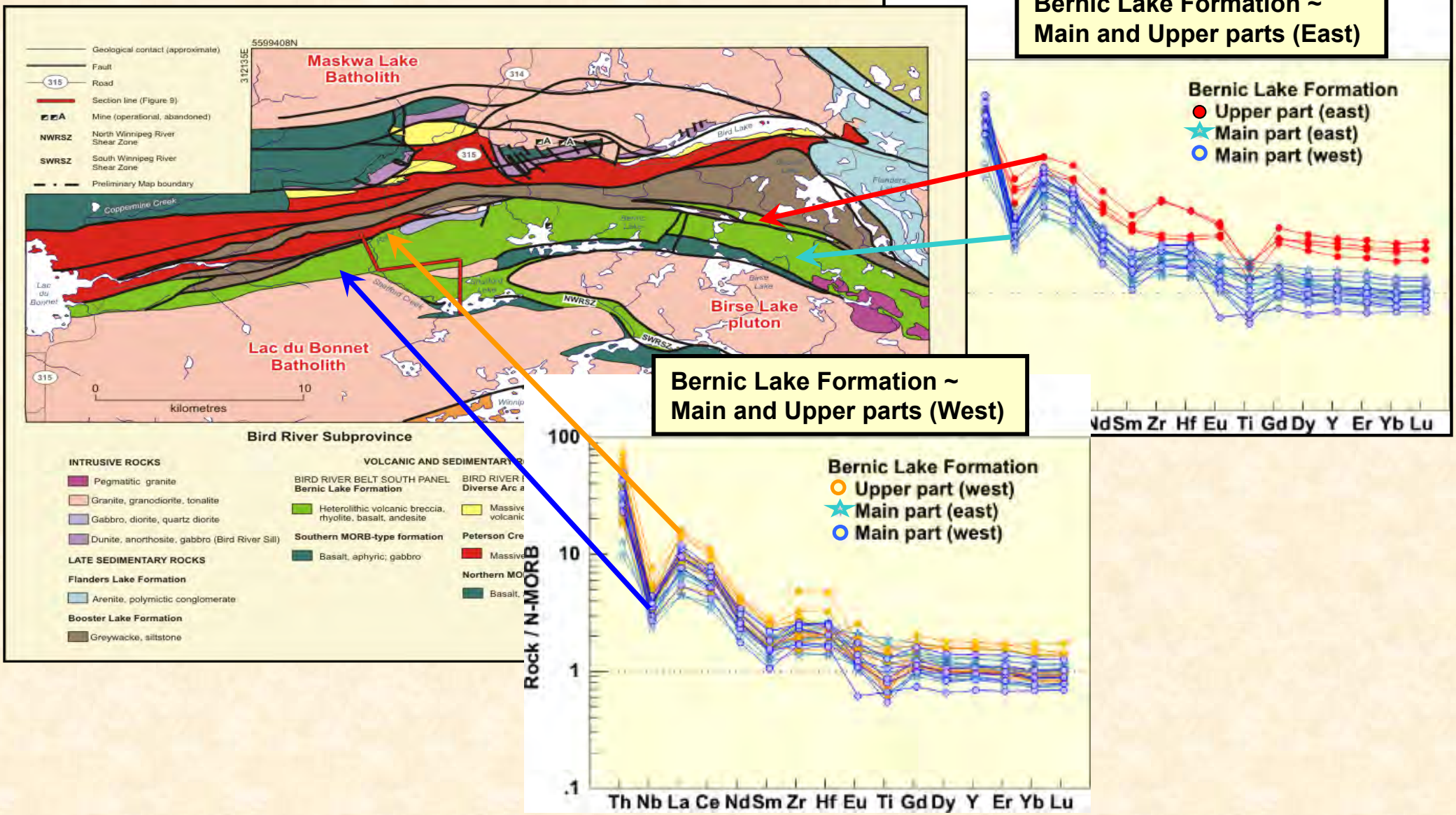


South Panel (Bernic Lake Fm) ☆ ●

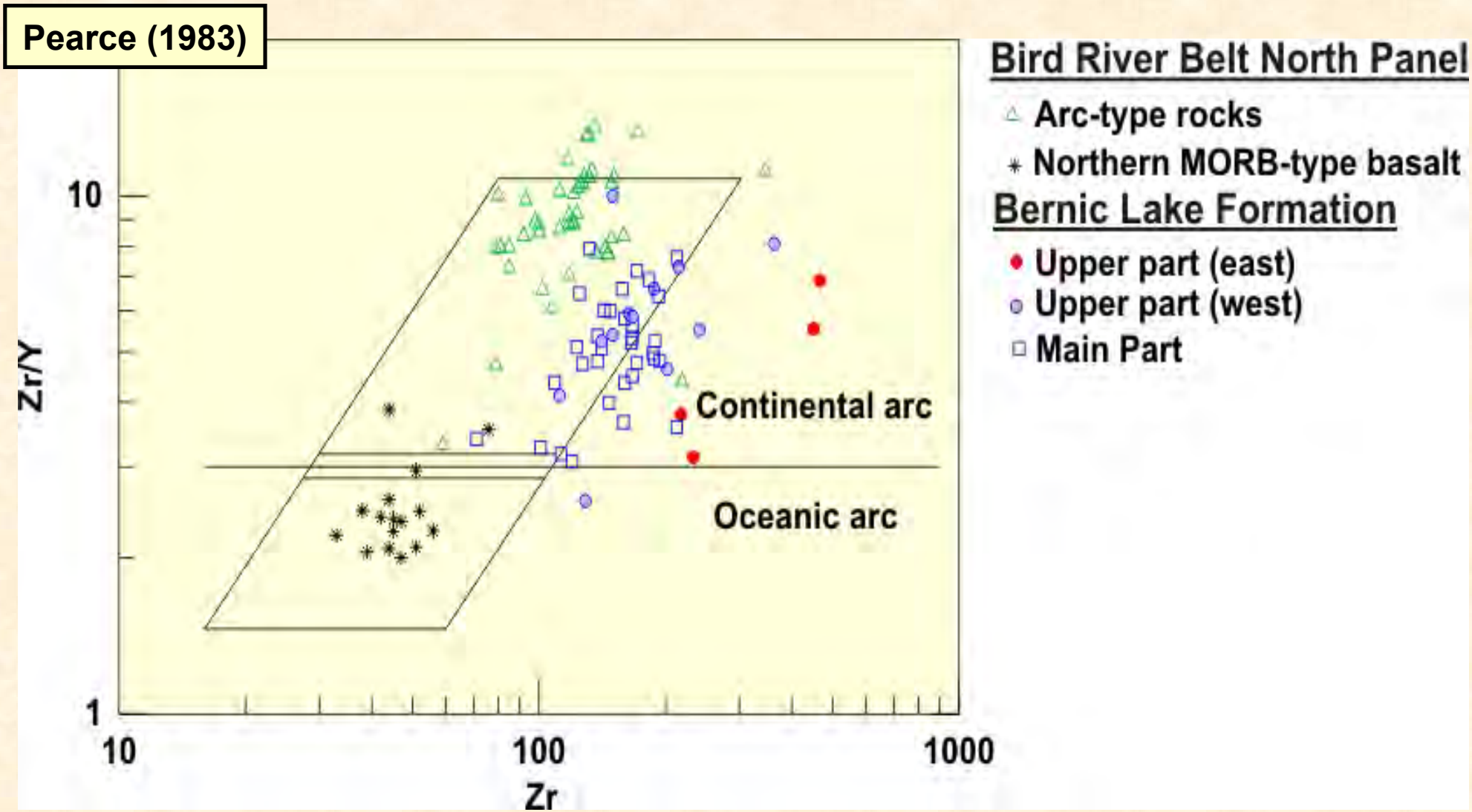
North & South Panels



Bernic Lake Formation ~ Main vs Upper part

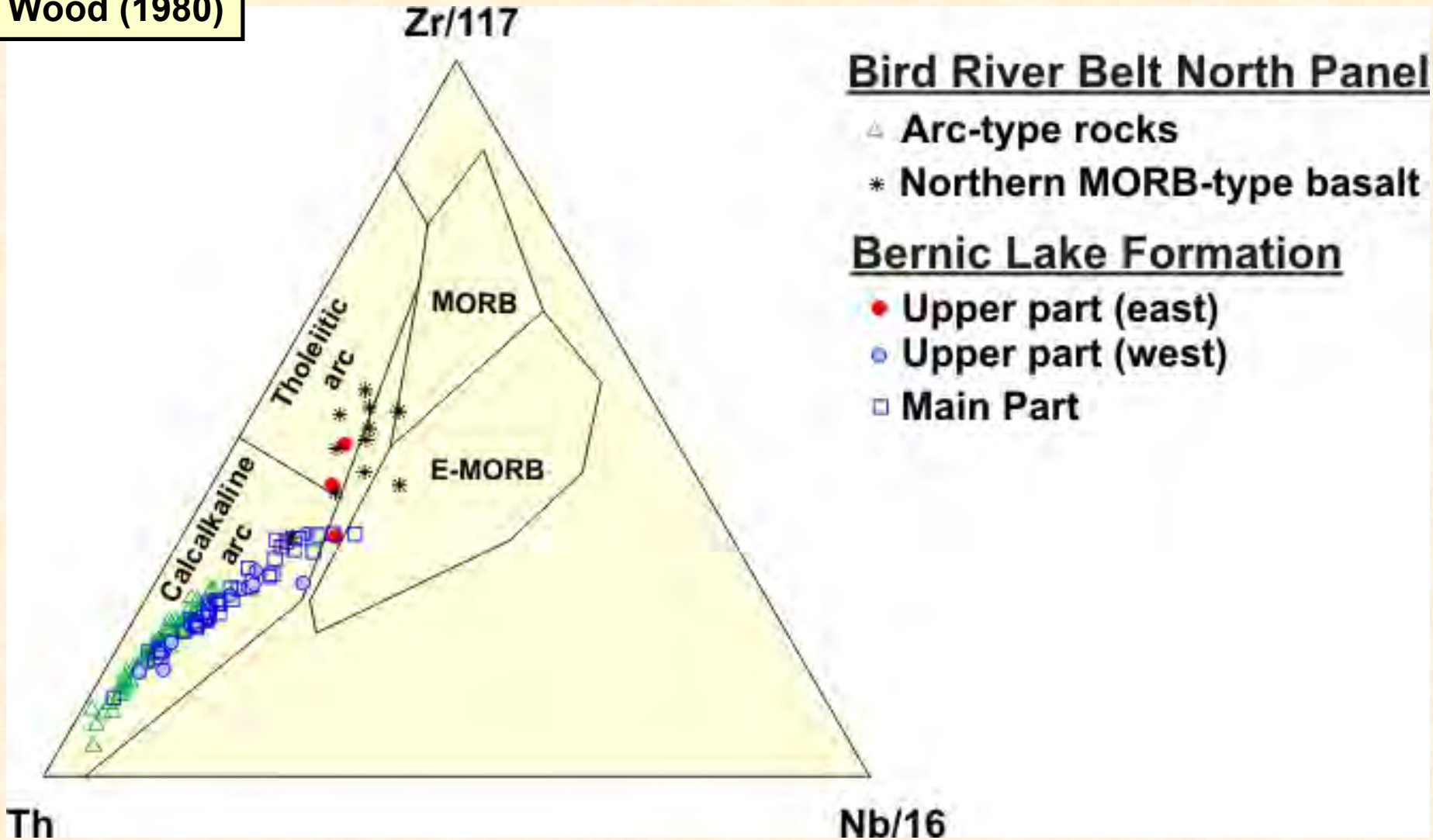


Bird River Belt ~
Tectonic affinity of volcanic rocks



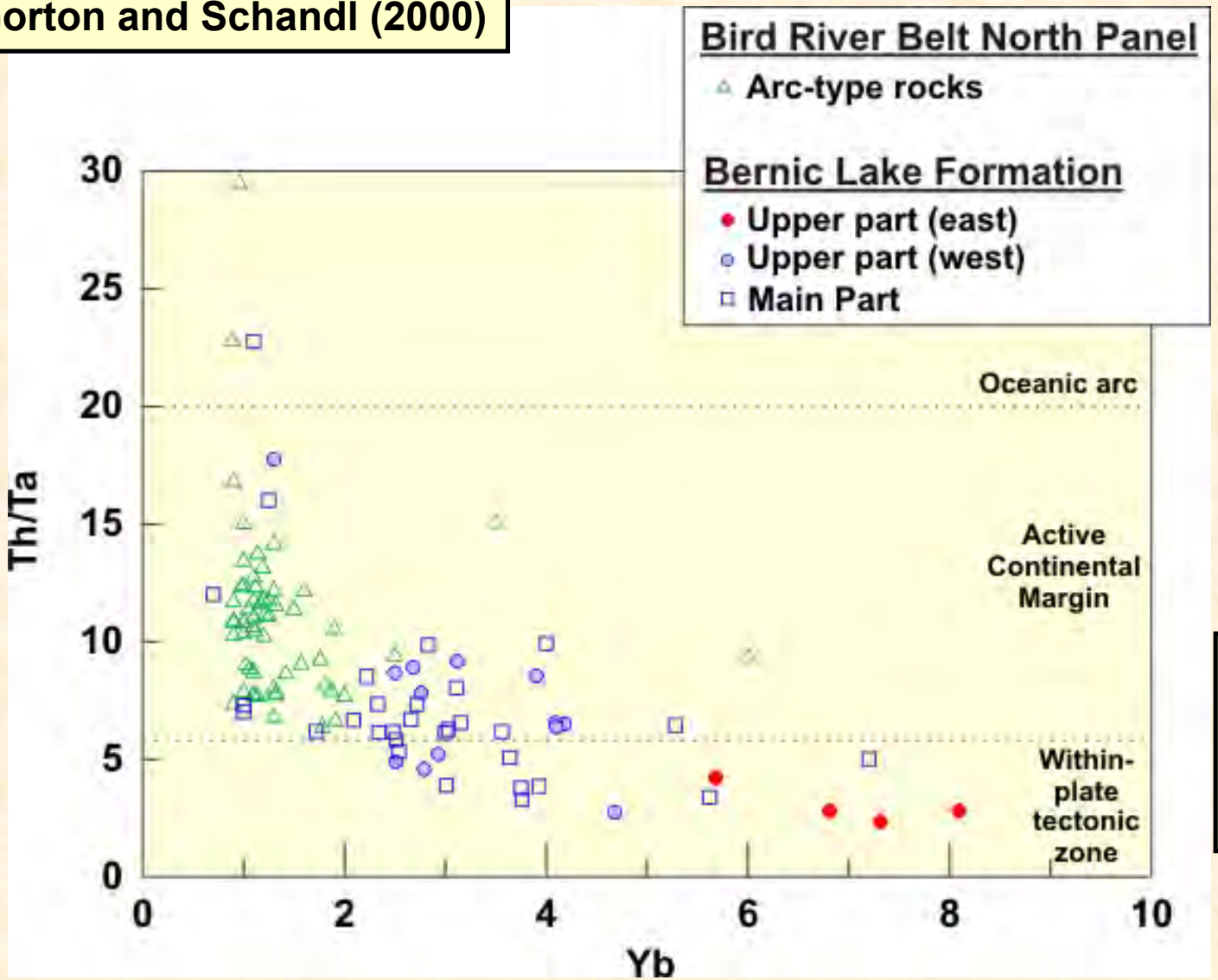
Bird River Belt ~
Tectonic affinity of volcanic rocks

Wood (1980)



Bird River Belt ~
Tectonic affinity of volcanic rocks

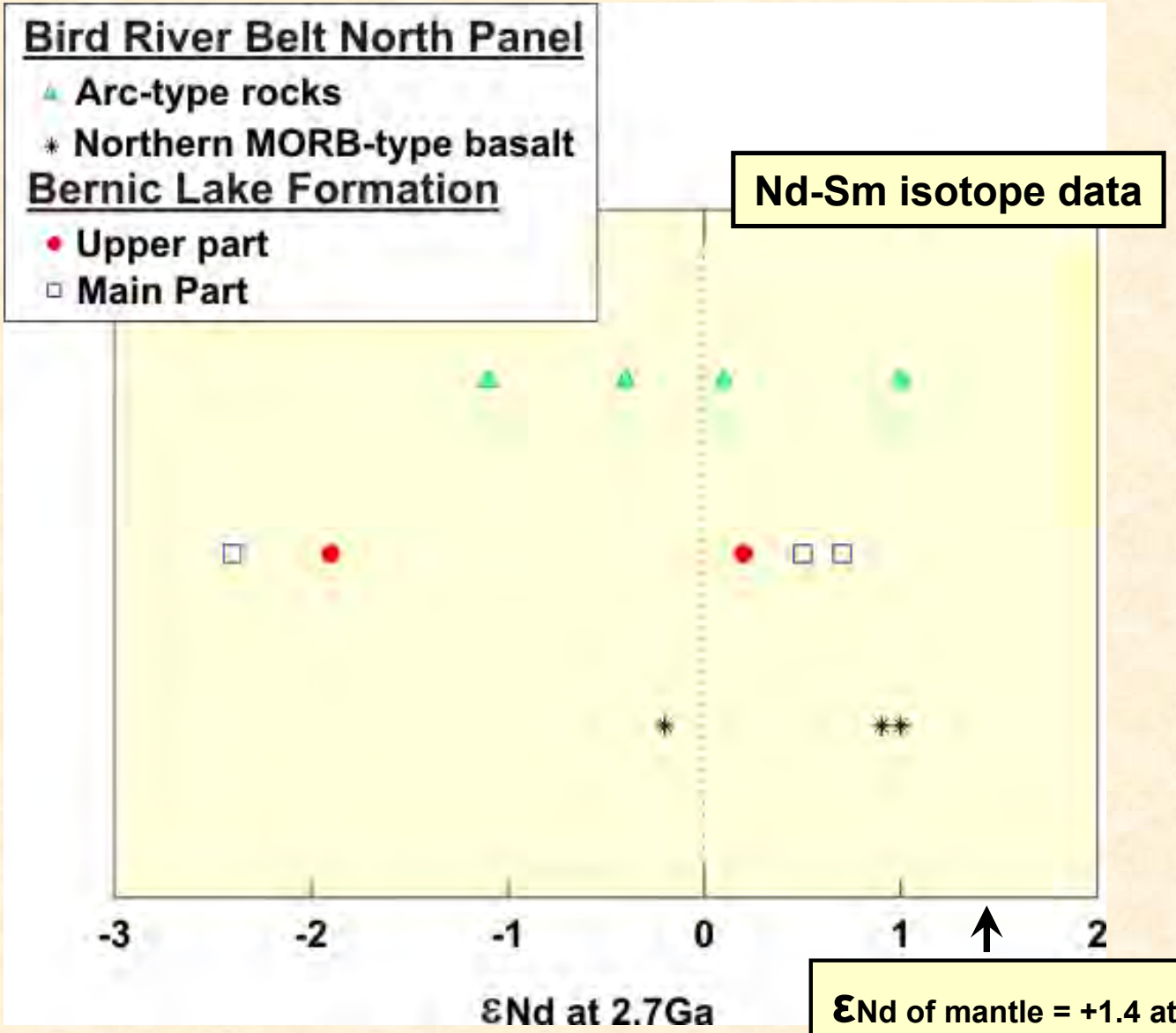
Gorton and Schandl (2000)



SUBDUCTION-RELATED

EXTENSION-RELATED

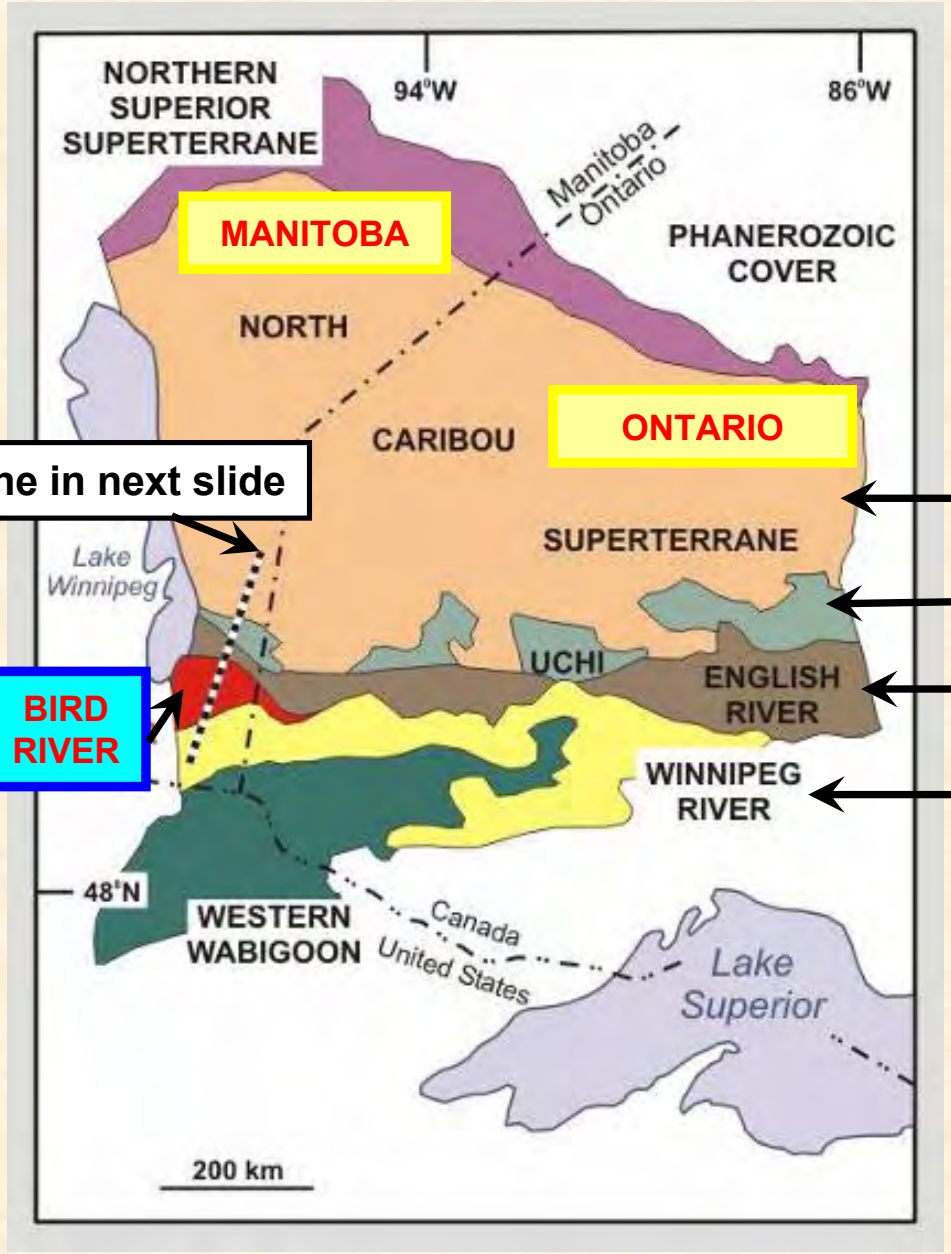
Bird River Belt ~
Nd-Sm isotope data



Bird River Belt ~

Tectonic history

Western Superior Province



Section line in next slide

North Caribou ST

Uchi SP

English River SP

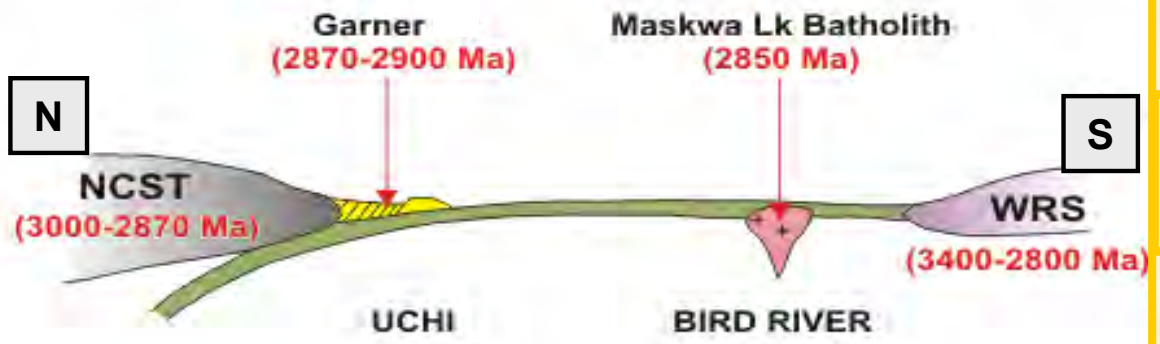
Winnipeg River SP

Tectonic history of southwest Superior Province

North Caribou Superterrane

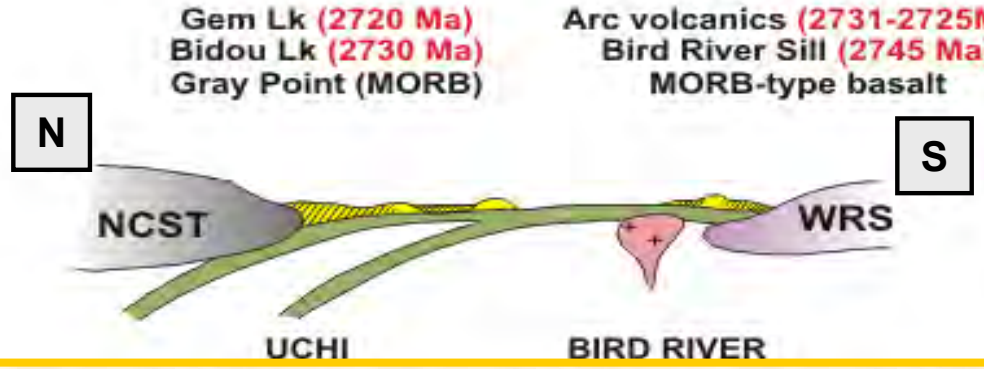
Winnipeg River Subprovince

1) 2940-2850 Ma
Northward subduction of oceanic crust, sporadic arc magmatism



2850 – 2750 Ma ?

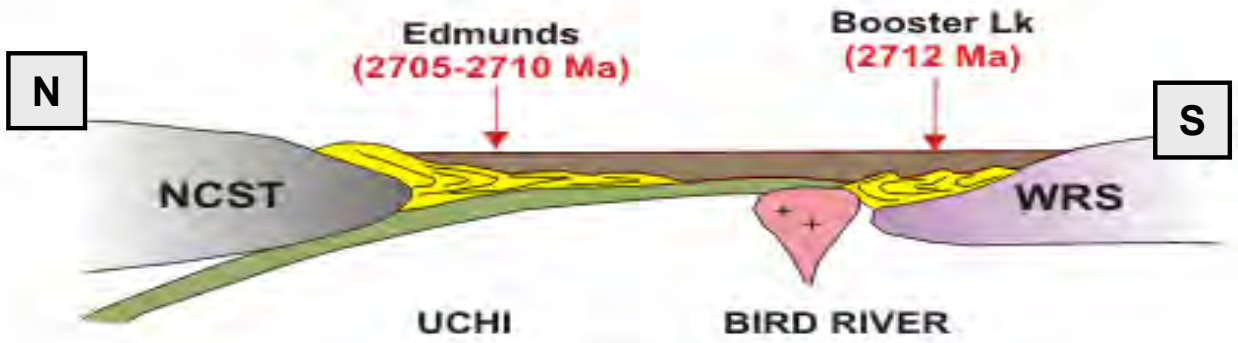
2) 2750-2720 Ma
Renewed subduction-related arc magmatism
Sporadic extension (back-arc basalt)



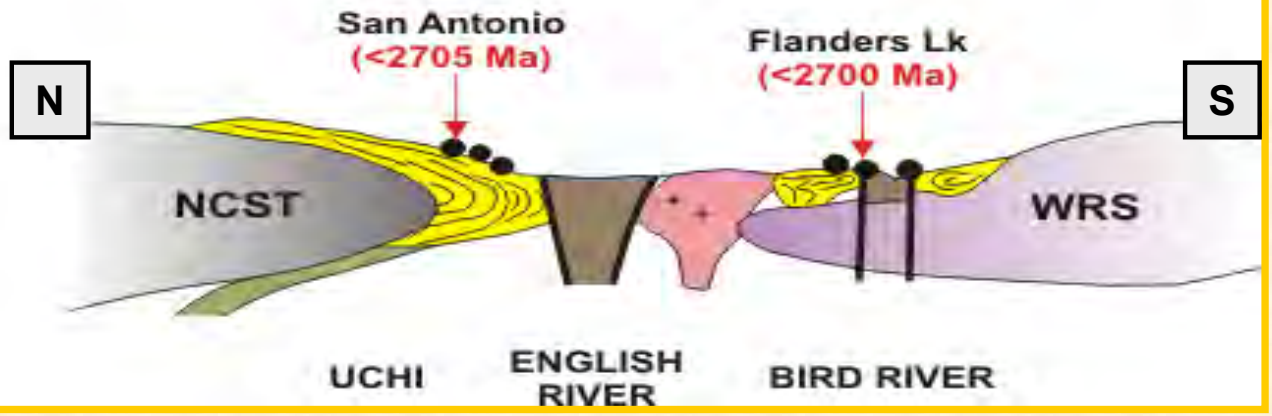
Tectonic history of southwest Superior Province

North Caribou Superterrane

3) 2718-2700 Ma
Convergence NCST with WRS, early D, deformation
Subsidence, turbidite sedimentation

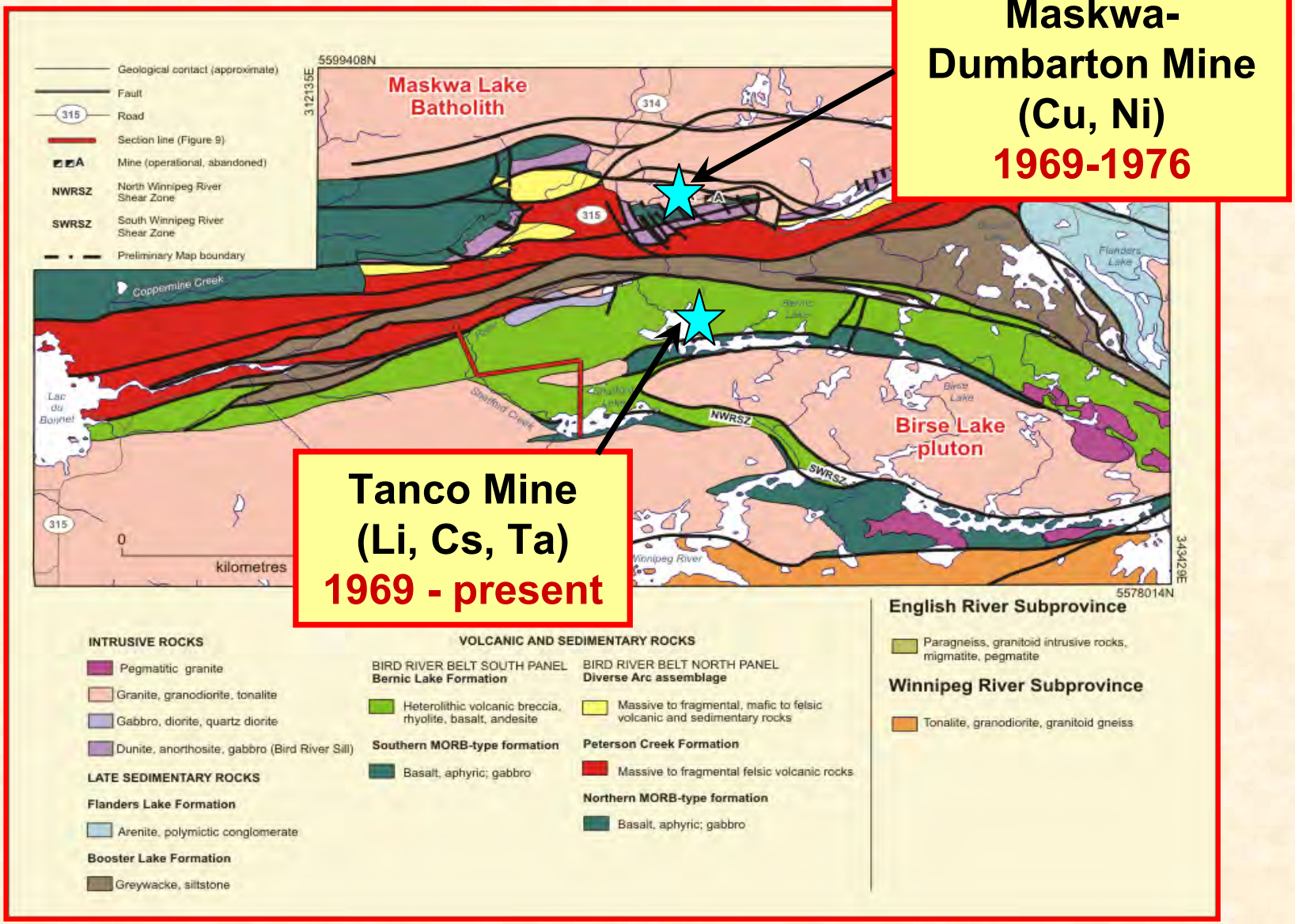


4) 2700-2695 Ma
Accretion of volcanic belts at NCST and WRS margins
Orogenic deformation, uplift
Fluvial sedimentation, late granitoid plutons

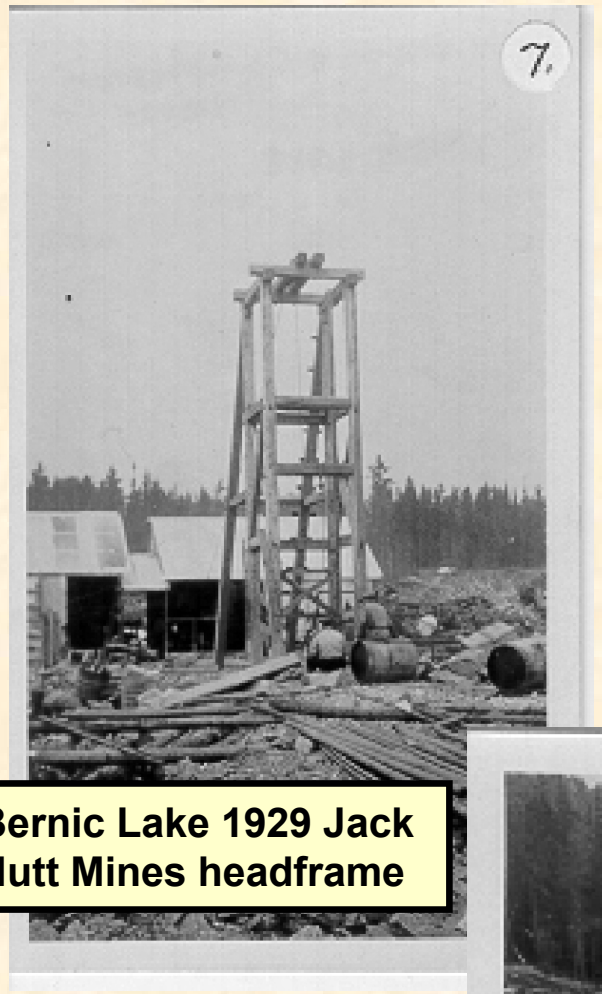


Winnipeg River Subprovince

Bird River Belt economic geology

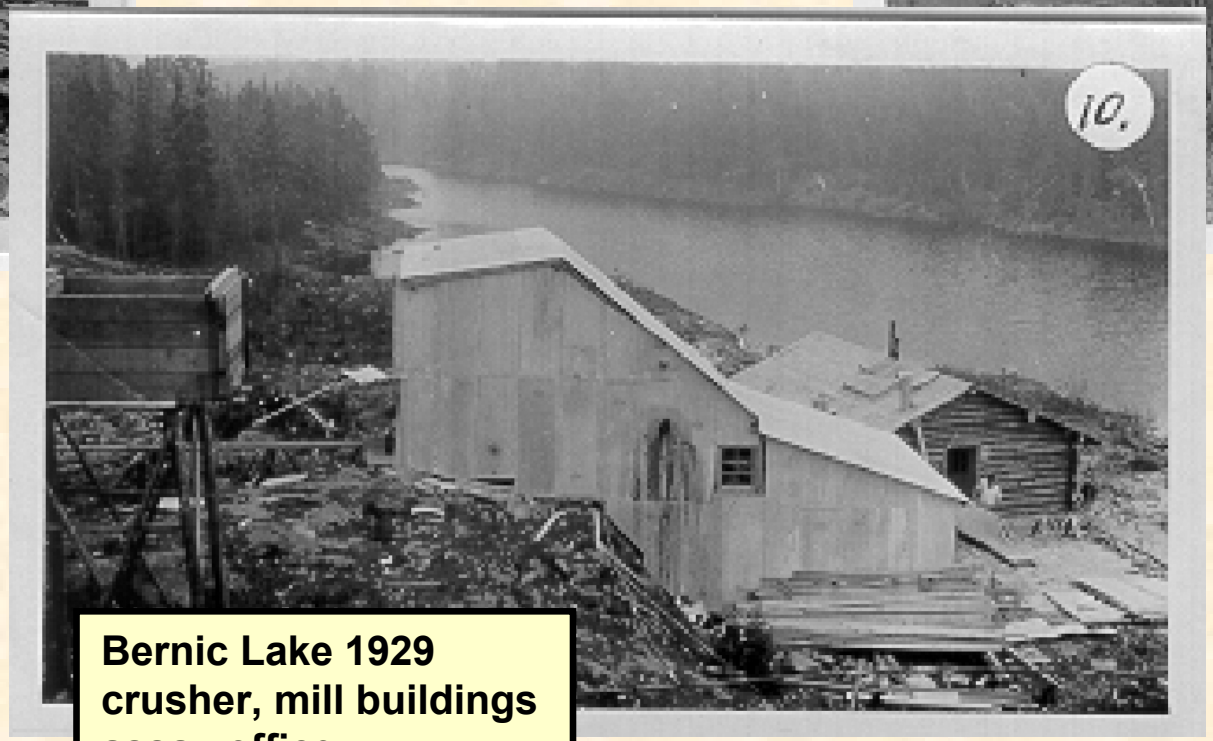


Bernic Lake development (1929, 1957)



Bernic Lake 1929 Jack Nutt Mines headframe

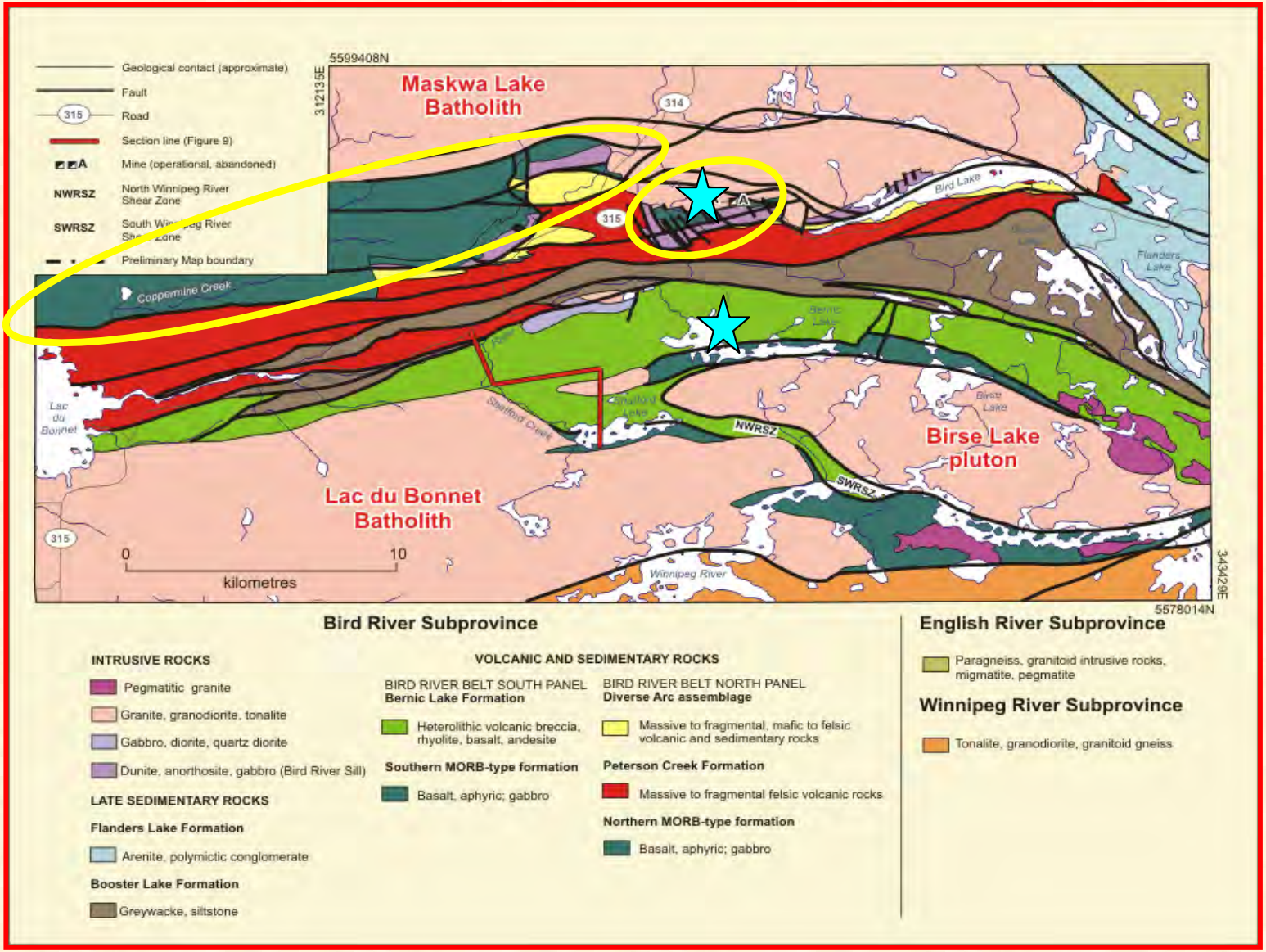
Bernic Lake 1957 Montgarry Shaft headframe



Bernic Lake 1929 crusher, mill buildings assay office

Bernic Lake (recent)

Bird River Belt ~
current exploration for base metals and PGE



Summary

- Neoarchean Bird River Belt consists of arc-type rocks that were deposited on the margins of a flanking continental terrane. Arc-type components include tholeiitic, calc-alkaline and MORB-type basalts.
- Tectonic setting is continental arc – seismic data suggest the BRB rests on continental lithosphere. Volcanic rocks primarily intermediate to felsic (not bimodal type sequence) due to influence of continental lithosphere underplating.
- Progression from subduction to an extensional tectonic setting is documented in the BRB from North to South panels.
- Current active mineral exploration for base-metals and PGE is focused on Bird River Sill and related intrusions, as well as MORB-type basalt formations. New sources for rare-element pegmatites akin to Tanco deposit are also being sought.