

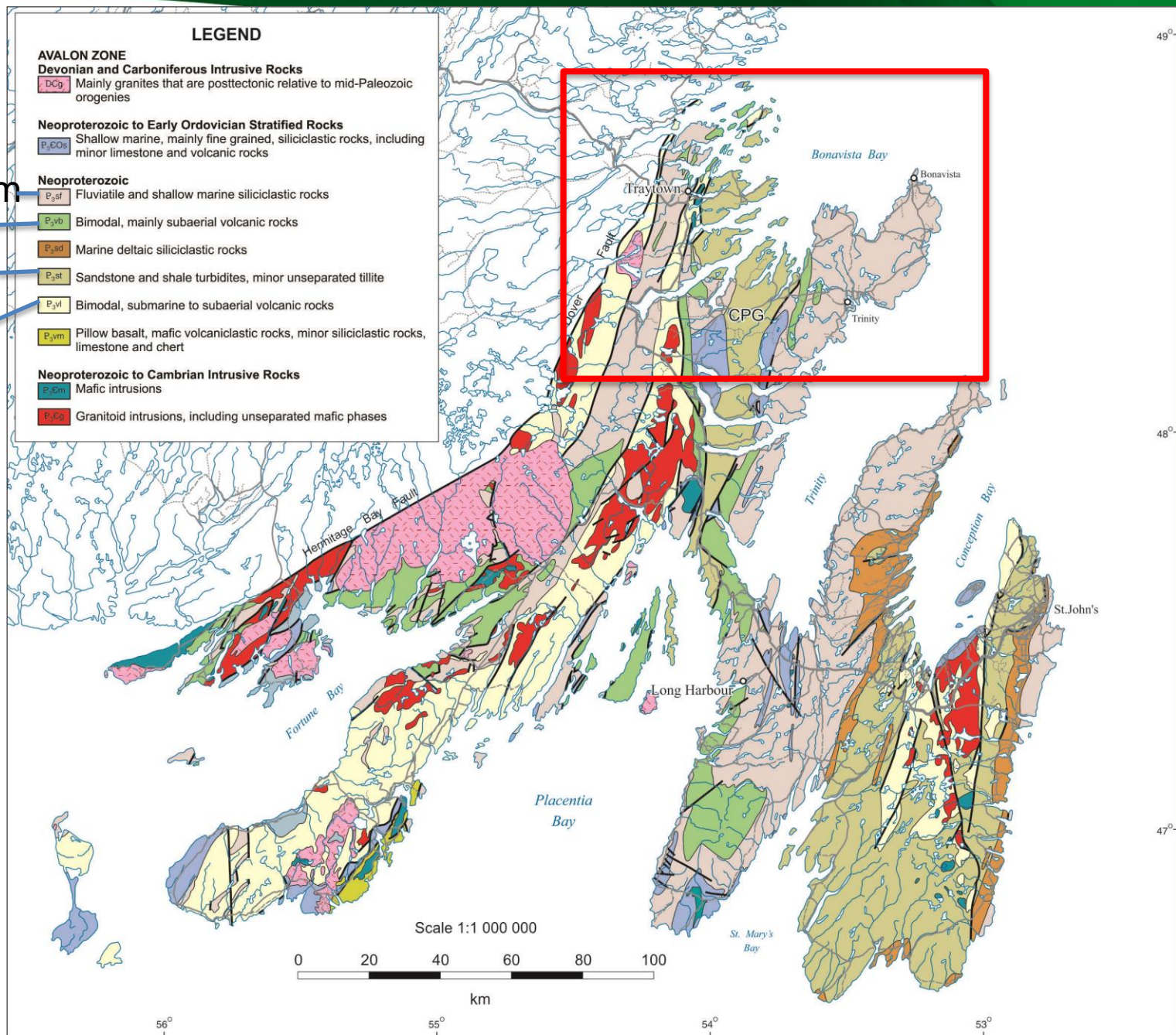
# Comparison of magmatic rocks from Eastport – Burnside area vs Bonavista Peninsula, northwestern Avalon Zone, Newfoundland



# Outline

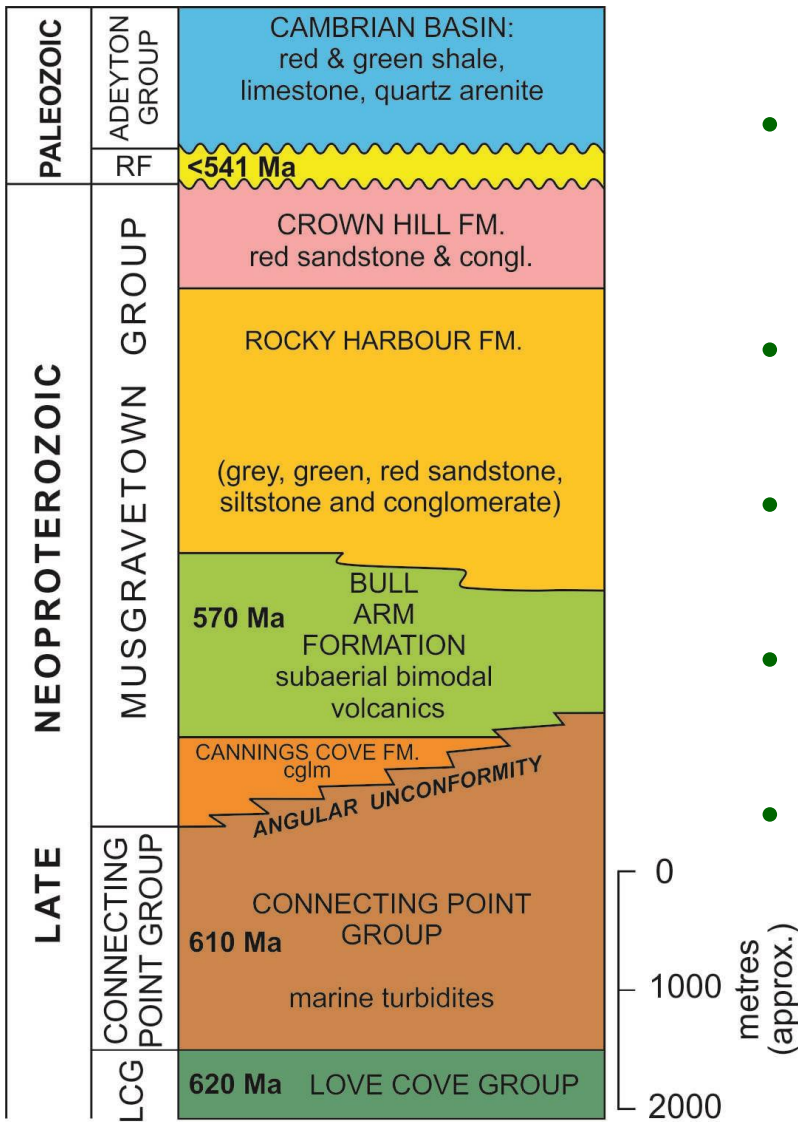
- Introduction (west Avalon map units)
- Previous + recent work – Bonavista ages, geochemistry
- Eastport area – ages, geochemistry
- Comparison of Eastport vs Bonavista geochemistry and geochronology
- Implications for tectonomagmatic evolution and map units

Musgravetown Gp  
 Rocky Harbour Fm  
 Bull Arm Fm  
 Connecting Pt Gp  
 Love Cove Gp



Modified from Colman-Sadd et al., 1990; based on King (1988). 3

# Background



- Stratigraphic interpretation in 2014 (after Mills, 2014; modified after Dec et al., 1992).
- Previous single age date on Bull Arm Fm (MG) = 570 Ma.
- Previous single age date on Love Cove Group = 620 Ma.
- Only Mid-Connecting Point Group = 610 Ma.
- All unpublished data; referred to in literature.

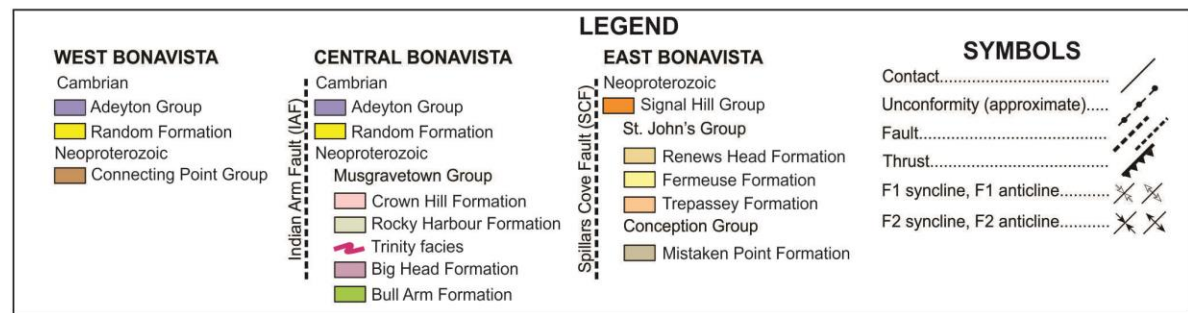
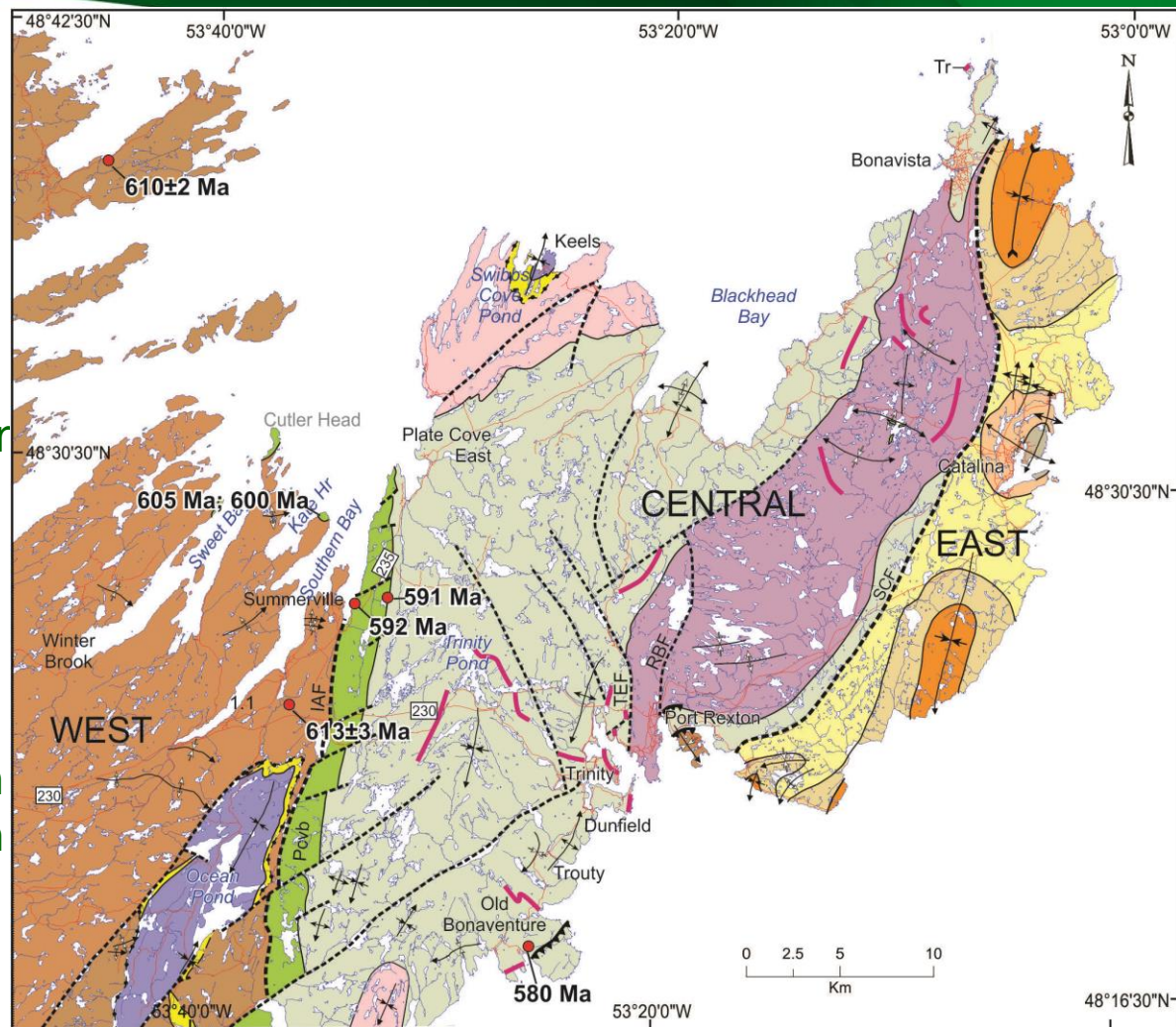
# (relatively) new U-Pb constraints from Bonavista Peninsula

- 610±2 Ma; 613±3 Ma for mid-Connecting Point Gp tuffs.
- 605±2 Ma for crystal lithic tuff in upper Connecting Point Group;
- 600±3 Ma for crystal tuff from the unconformably overlying, basal Musgravetown Group;
- 592±2, 591±2 Ma for ash and lapilli tuff at western and eastern margin, respectively, of the main volcanic belt on Bonavista Peninsula (Plate Cove volcanic belt; PCvb);
- 580±1 Ma for glacial diamictite of the Trinity facies, Musgravetown Group.

## Age Data Refs:

Mills et al., 2016; 2017;

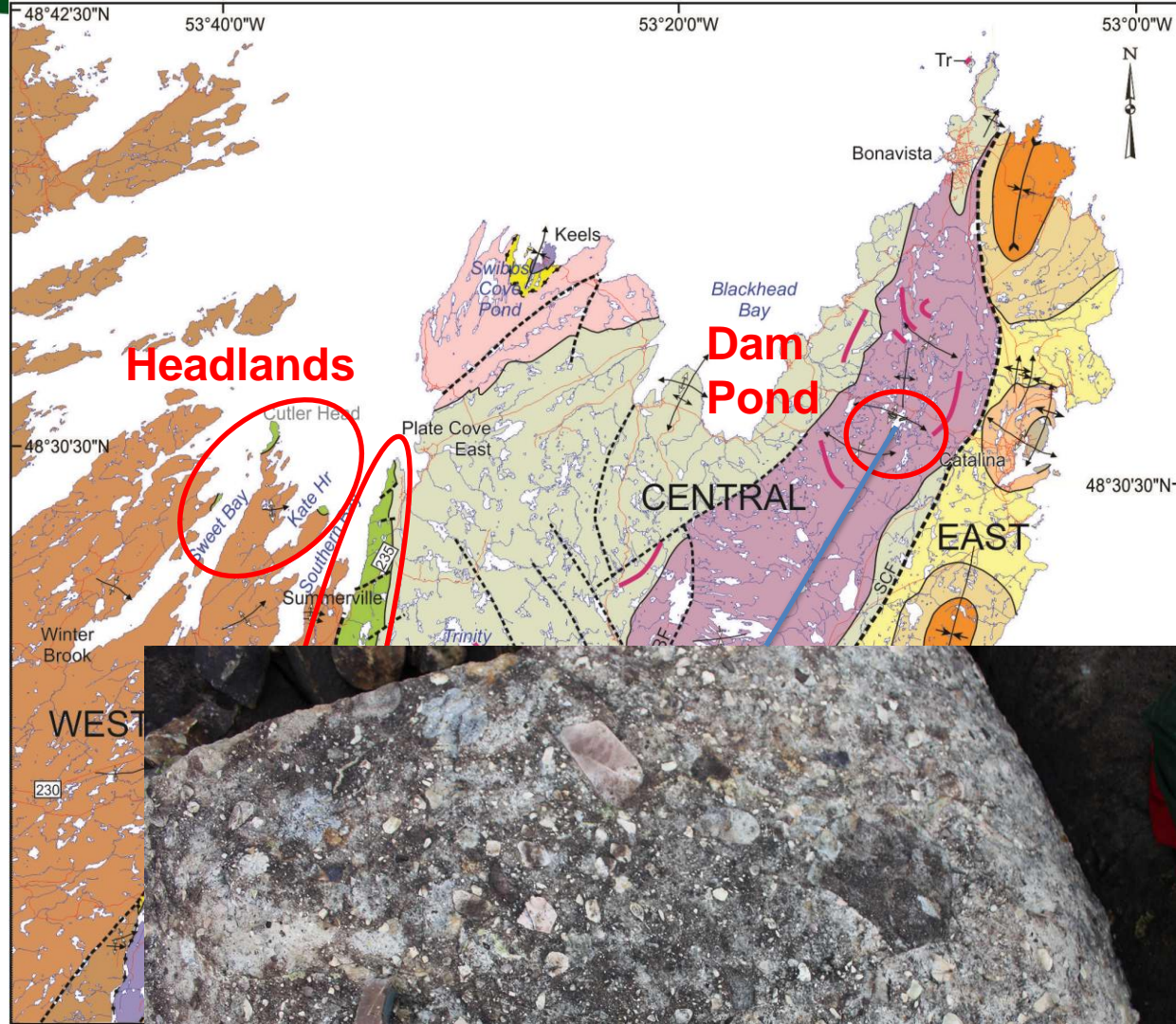
Pu et al., 2016



# Bull Arm Fm on Bonavista Peninsula

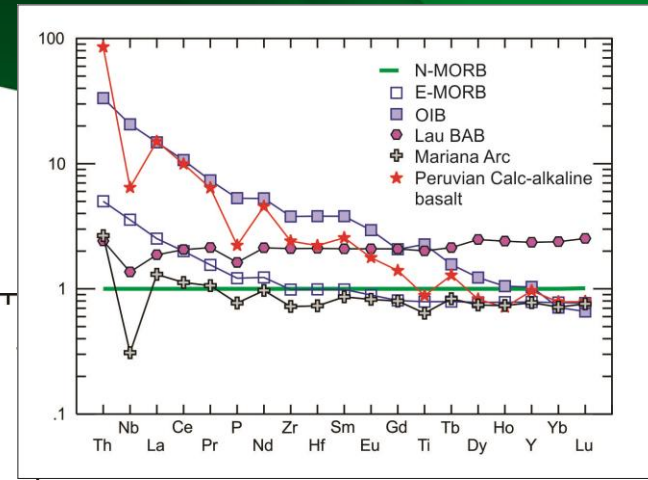
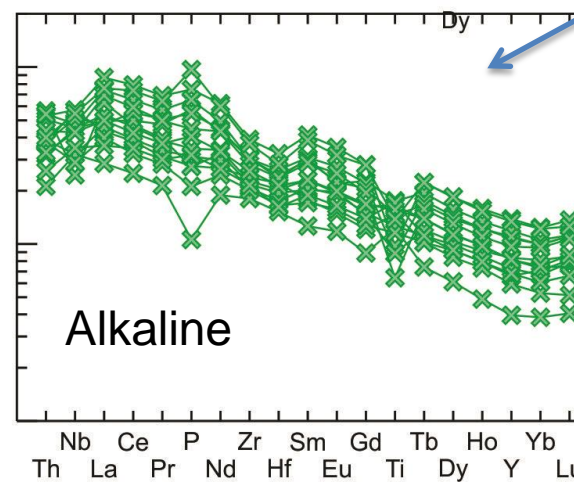
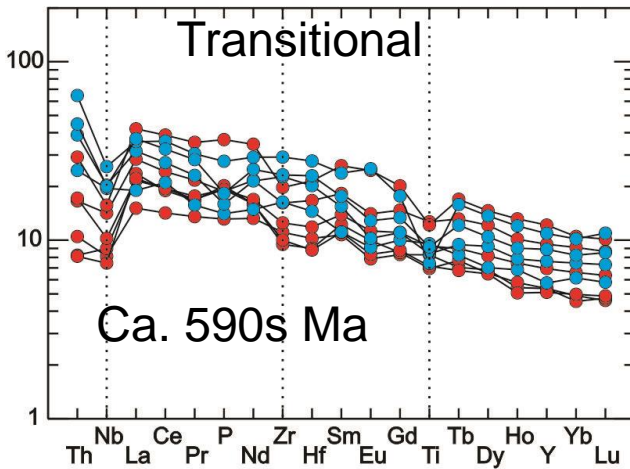
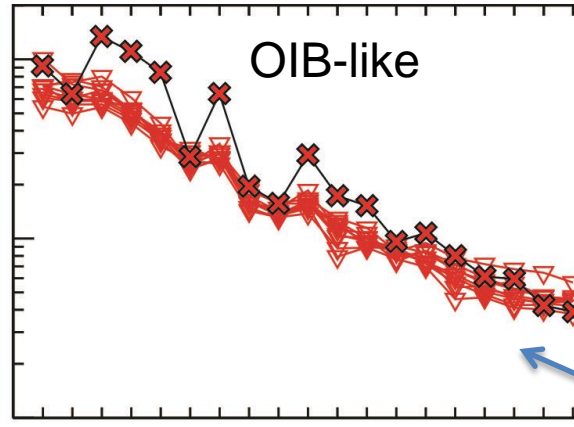
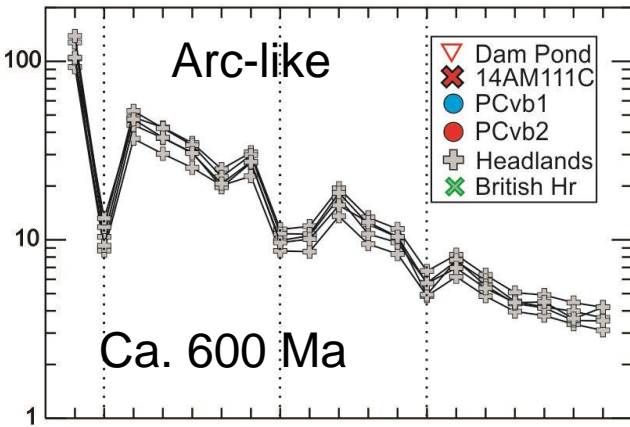
3 Types of Basalt (all previously mapped as BAF):

- Headlands (HB) – occurs above basal MG unconformity (600 Ma)
- Plate Cove volcanic belt – (PCvb) spatial association with 592-591 Ma tuffs
- Dam Pond (DP) – spatial association with glacial diamictite, dated elsewhere at 580 Ma.
- All have been previously assigned to Bull Arm Fm.



Lithogeochem Refs:  
Mills and Sandeman,  
2015; 2017; Mills, 2019

# Geochemistry of Bull Arm Fm on Bonavista Peninsula - mafics



◀ Mafic breccia, Bonaventure Head  
Ca. 580 Ma?

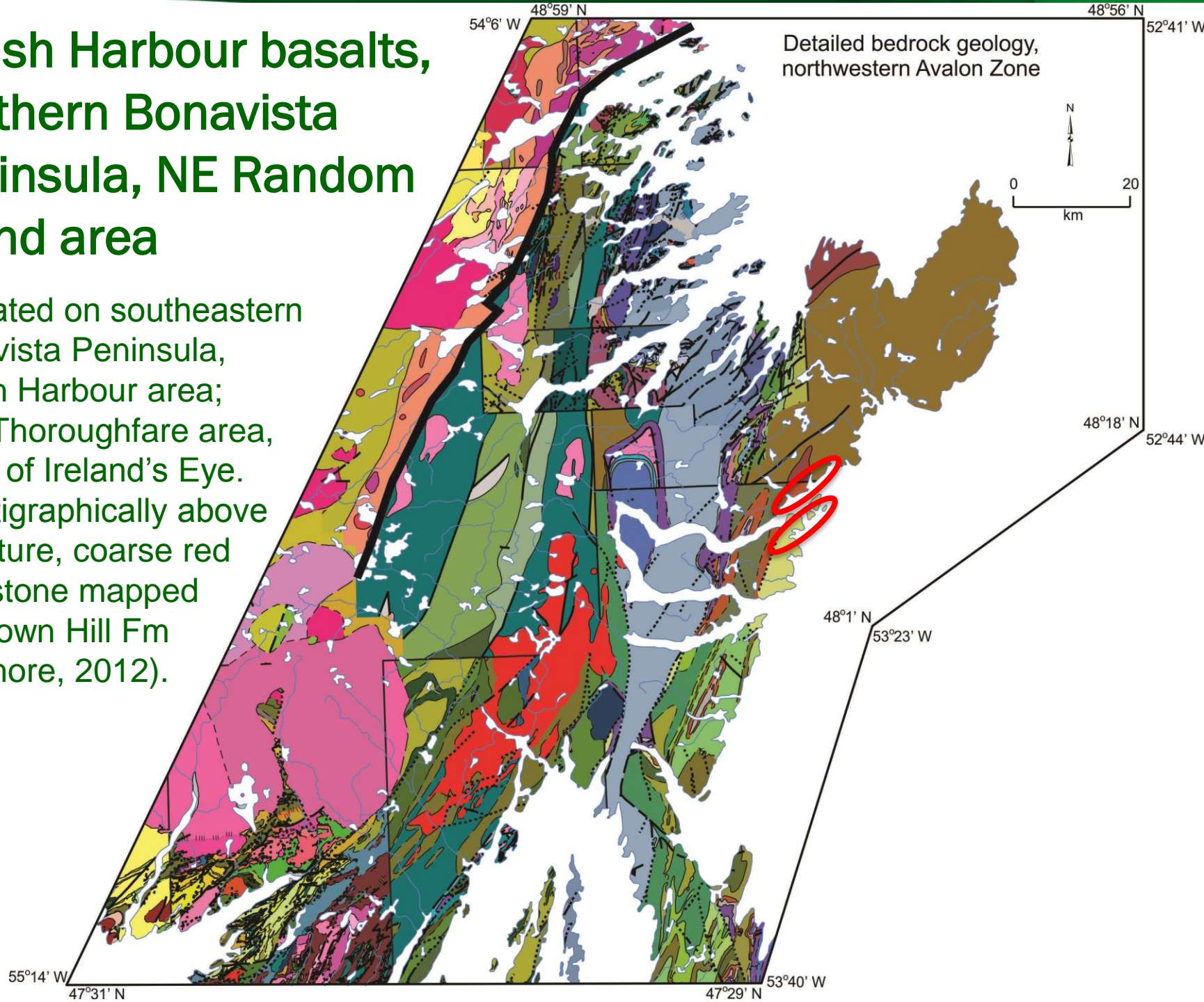
◀ British Harbour basalts (new data)

All XREE plots are normalized to PM (after Sun and McDonough, 1989).

Ref: Mills and Sandeman, 2015

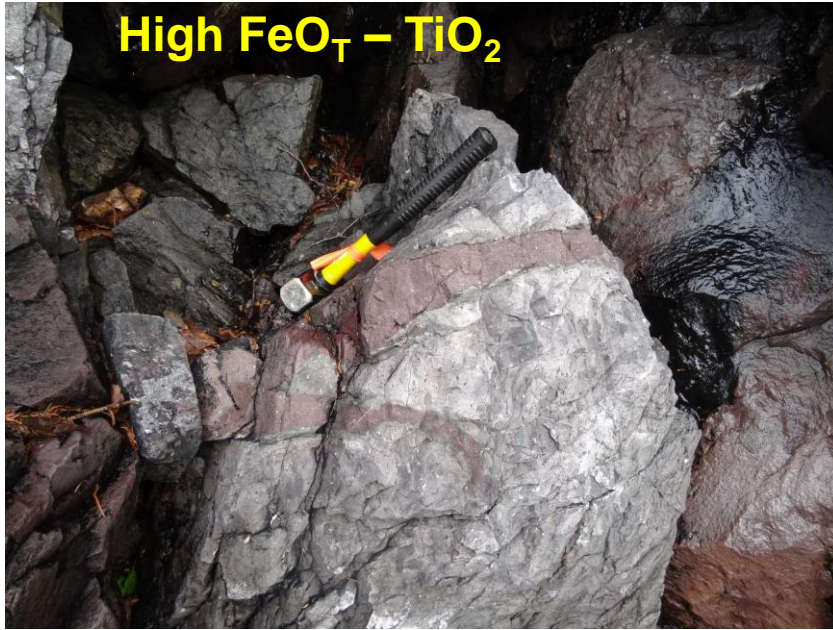
# British Harbour basalts, southern Bonavista Peninsula, NE Random Island area

- Located on southeastern Bonavista Peninsula, British Harbour area; Also Thoroughfare area, south of Ireland's Eye.
- stratigraphically above immature, coarse red sandstone mapped as Crown Hill Fm (Normore, 2012).





# British Harbour basalts



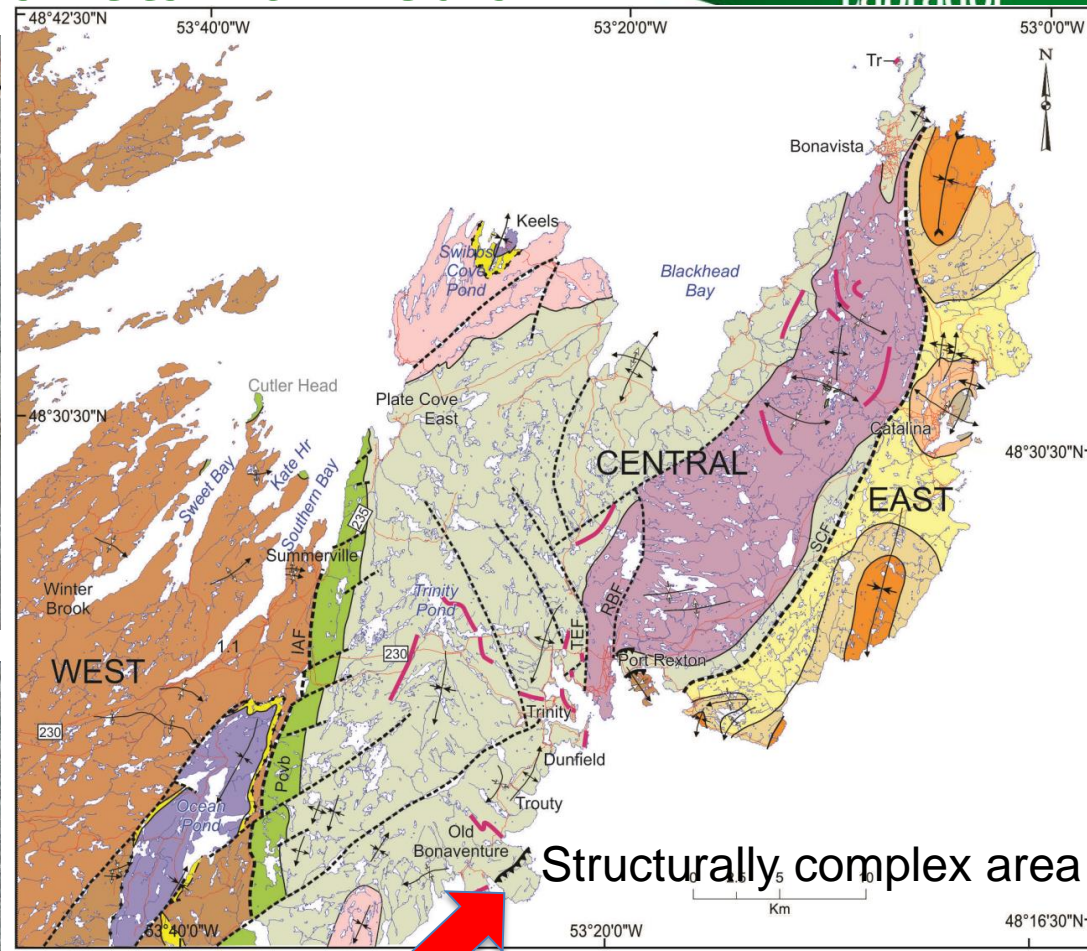
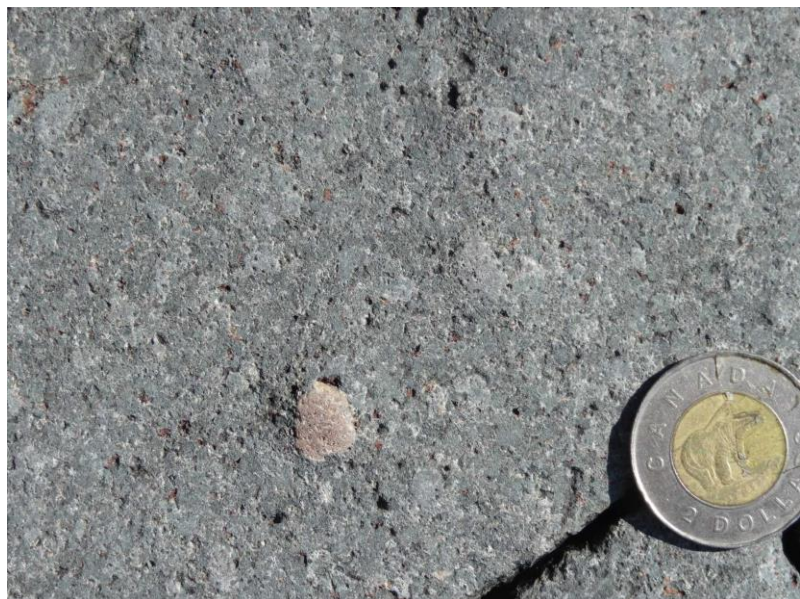


# British Harbour basalts

- Cyclically interbedded basalt breccia and red siltstone to mudstone.
- Basalt clasts locally impinge or deflect underlying laminae.
- Strata-bound soft sediment deformation.
- Could this be a peri-glacial eruption?
- Stratigraphic position relative to Trinity diamictite uncertain
- Occur above redbeds mapped as Crown Hill Fm (Normore, 2012) – BUT not all redbeds are upper Musgravetown Group (see Mills, 2019).



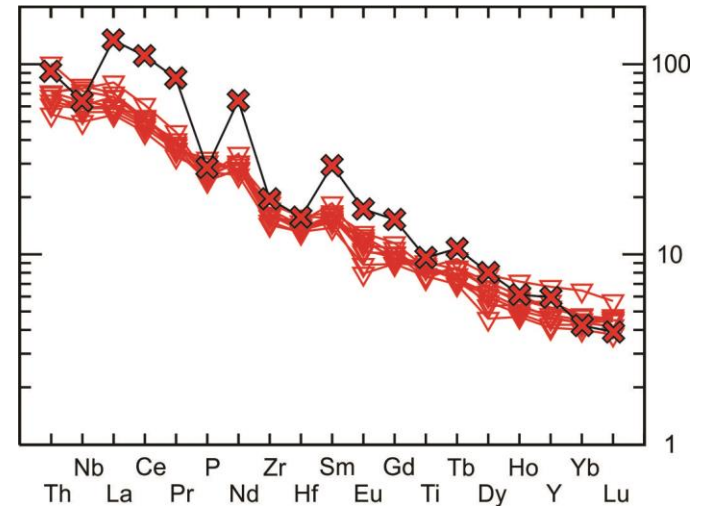
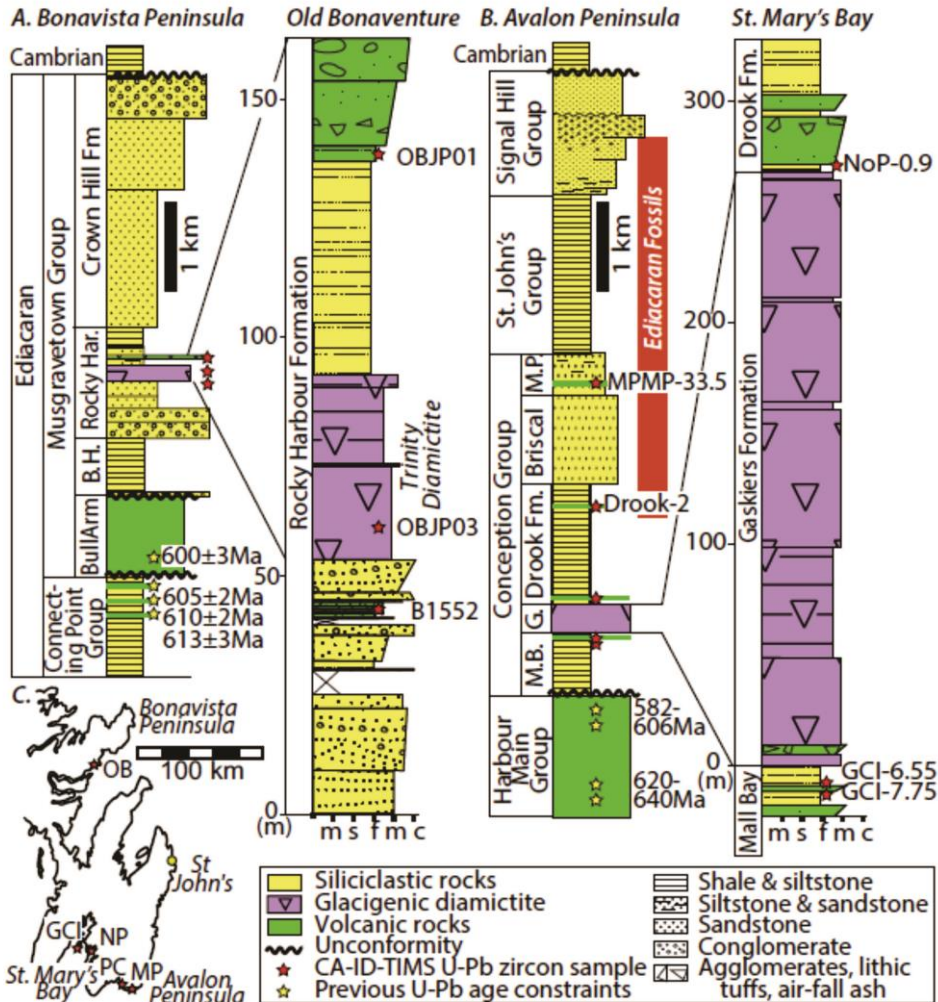
# Basalt breccia, south Bonavista Peninsula



| WEST BONAVISTA  | CENTRAL BONAVISTA  | EAST BONAVISTA  | LEGEND   |
|---|--|---|--|
| <ul style="list-style-type: none"> <li>Cambrian</li> <li>Adeyton Group</li> <li>Random Formation</li> <li>Neoproterozoic</li> <li>Connecting Point Group</li> </ul> | <ul style="list-style-type: none"> <li>Cambrian</li> <li>Adeyton Group</li> <li>Random Formation</li> <li>Neoproterozoic</li> <li>Musgravetown Group</li> <li>Crown Hill Formation</li> <li>Rocky Harbour Formation</li> <li>Trinity facies</li> <li>Big Head Formation</li> <li>Bull Arm Formation</li> </ul> | <ul style="list-style-type: none"> <li>Neoproterozoic</li> <li>Signal Hill Group</li> <li>St. John's Group</li> <li>Renews Head Formation</li> <li>Fermeuse Formation</li> <li>Trepassey Formation</li> <li>Conception Group</li> <li>Mistaken Point Formation</li> </ul> | <p><b>SYMBOLS</b></p> <ul style="list-style-type: none"> <li>Contact.....</li> <li>Unconformity (approximate).....</li> <li>Fault.....</li> <li>Thrust.....</li> <li>F1 syncline, F1 anticline.....</li> <li>F2 syncline, F2 anticline.....</li> </ul> |

# Basalt breccia, south Bonavista Peninsula

OBJP01 dated at  $579.24 \pm 0.17/0.30/0.69$  Ma.  
 B1552 dated at  $579.63 \pm 0.15/0.29/0.68$  Ma.



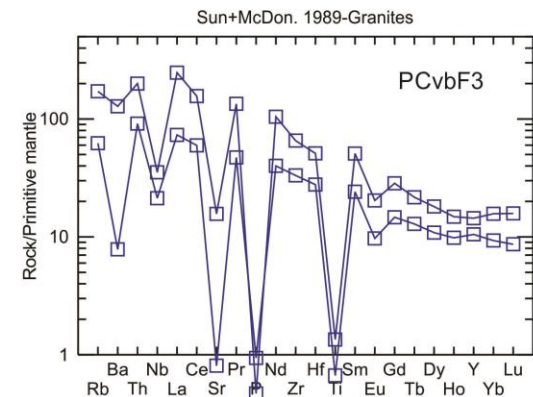
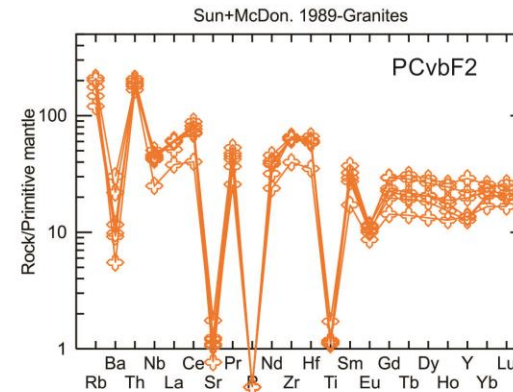
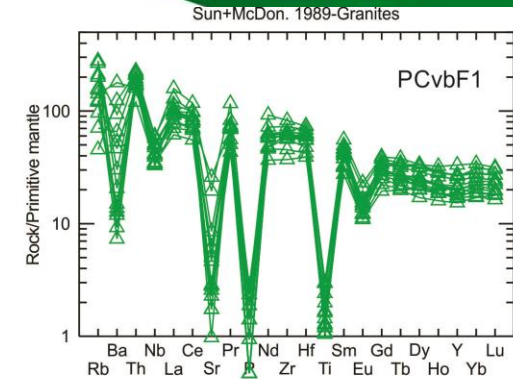
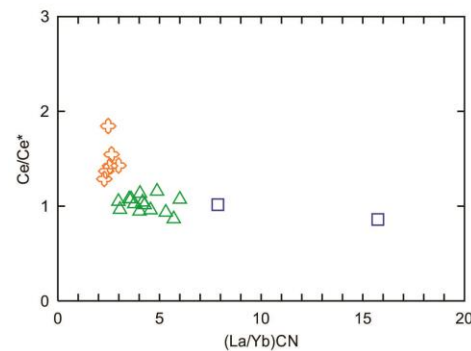
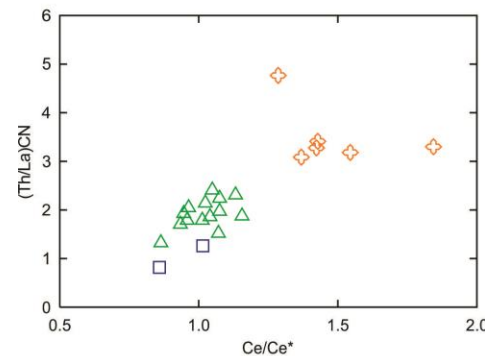
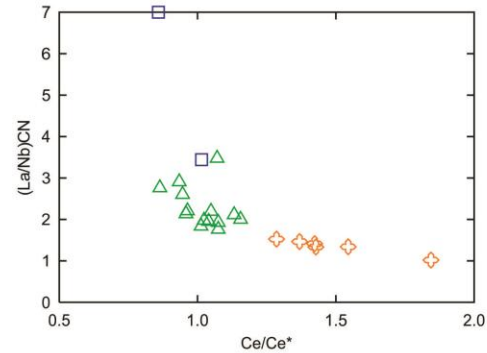
- Basalt breccia ~50 m above Trinity diamicrite; chemically similar to OIB-like basalts at Dam Pond.
- The dated sample is from a pink ash tuff near the top of a 45 m succession of laminated siltstone; about 2 m below the basalt breccia.

◀ Ref:  
 Pu et al., 2016

# Geochemistry of Bull Arm Fm on Bonavista Peninsula – felsics

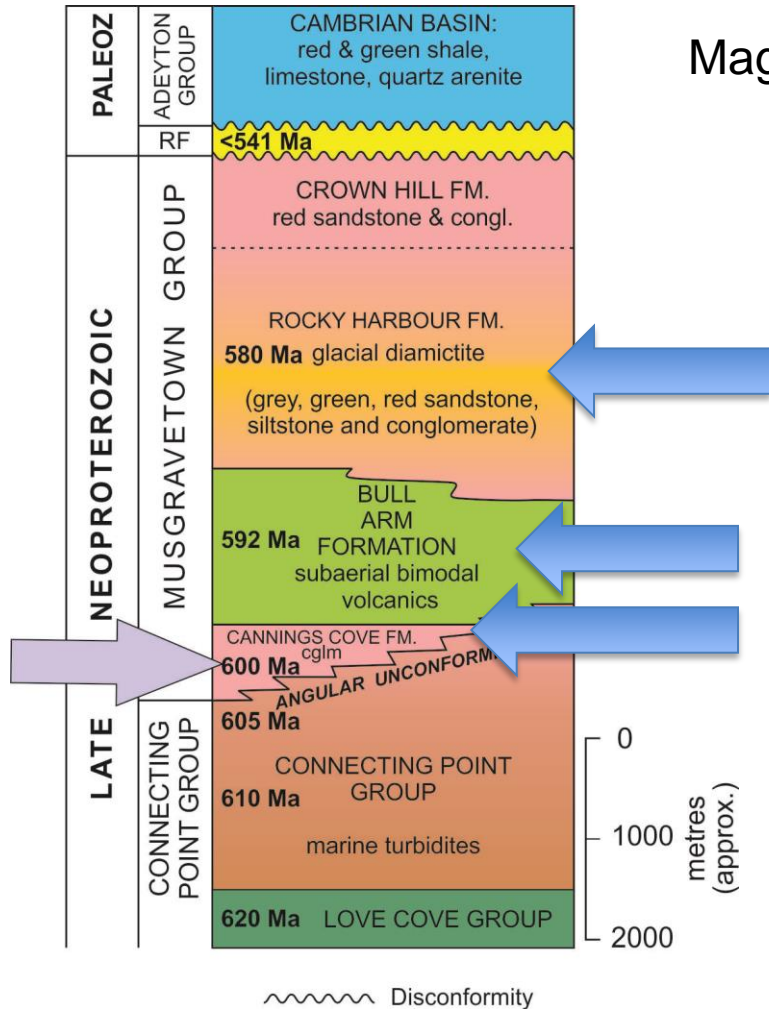
- Occur mainly within PCvb
- 3 distinct petrochemical groups:
  - Main group
  - High Ce group
  - Highly fractionated group

- Complex spatial pattern
- Chronological order unclear; no direct age constraints



# Developing lithostratigraphic interpretation for Bonavista Peninsula

Magmatic shift commences after 600 Ma (Mills, 2019).



- Ca. 580? Ma Dam Pond basalt – OIB-like
- Ca. 580? Ma British Hr basalt – alkaline - WP
- Ca. 590s Ma Plate Cove volcanics – transitional
- Ca. 600 Ma Headland basalt – calc-alkaline

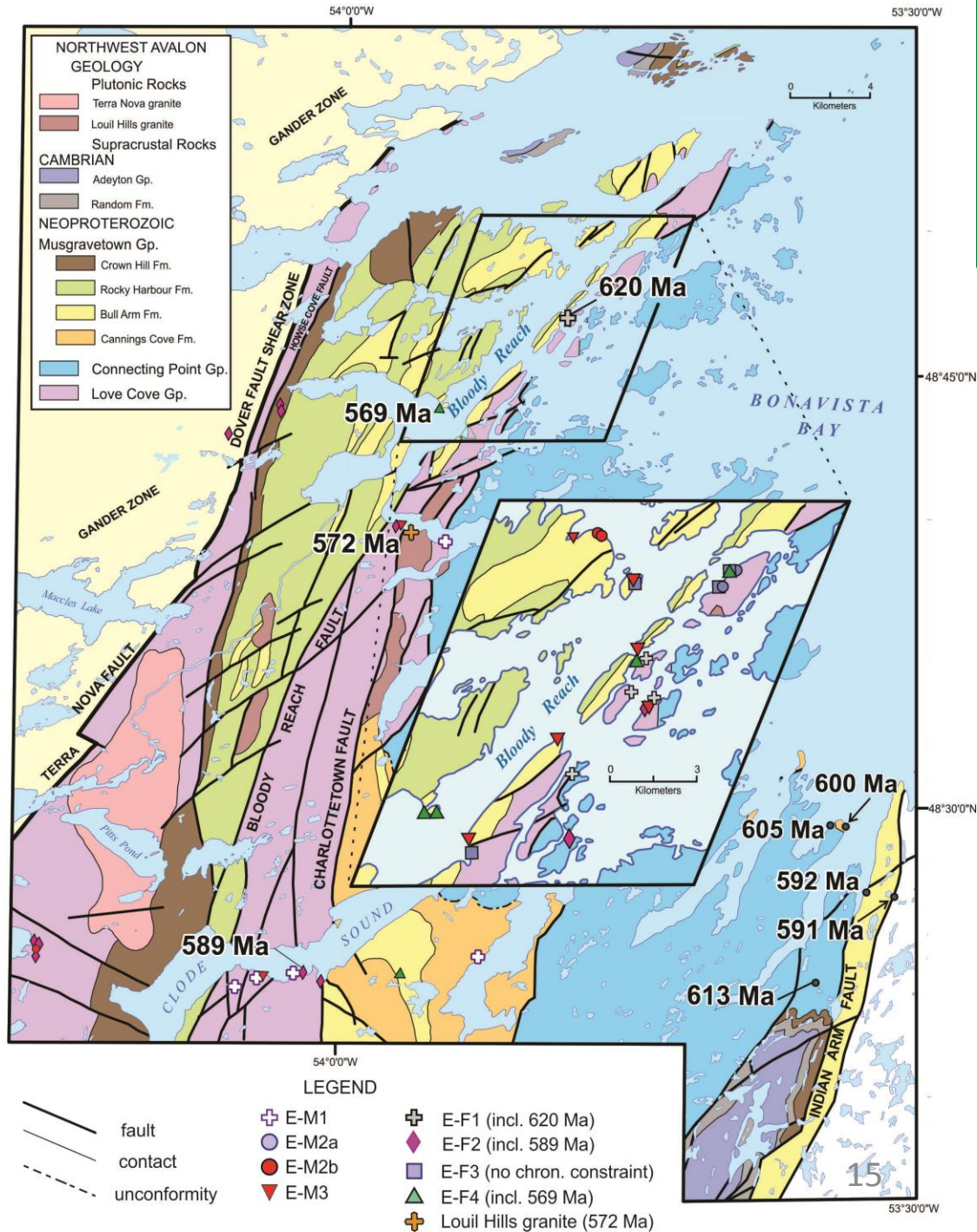
# Eastport area

Age-based, petrogenetic groups:

- E-F1: incl. 620 Ma LCG
- E-F2: incl. 589 Ma “LCG”
- E-F3: no age constraint; Petrochemically similar to 572 Ma Louil Hills granite
- E-F4: incl. 569 Ma (refined from 570 Ma) “BAF” rhyolite

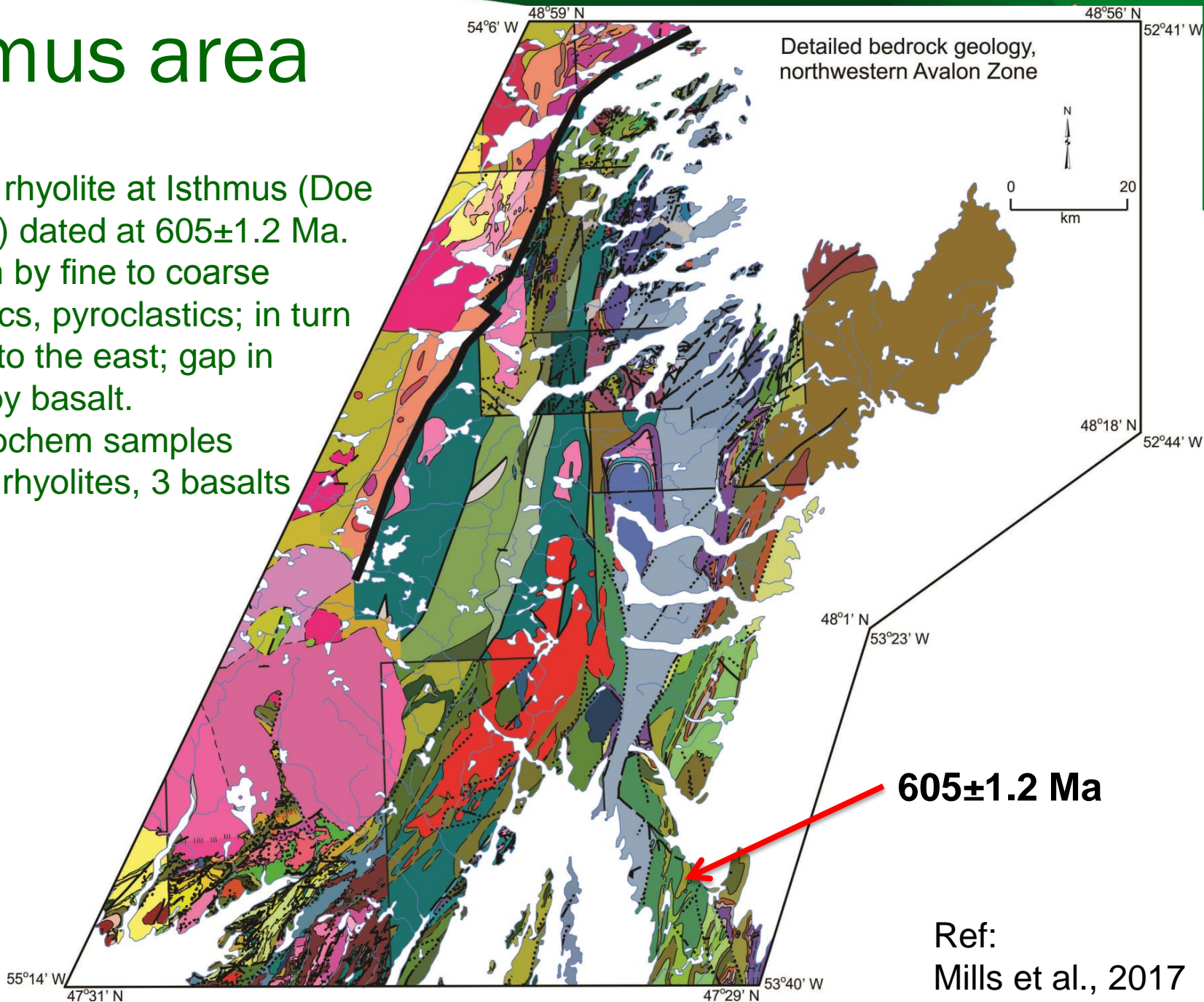
Mafic lithogeochemistry:

- E-M1, E-M2, E-M3: no age constraints



# Isthmus area

- Banded rhyolite at Isthmus (Doe Hills area) dated at  $605 \pm 1.2$  Ma.
- Overlain by fine to coarse siliciclastics, pyroclastics; in turn overlain (to the east; gap in section) by basalt.
- Lithogeochem samples include 4 rhyolites, 3 basalts

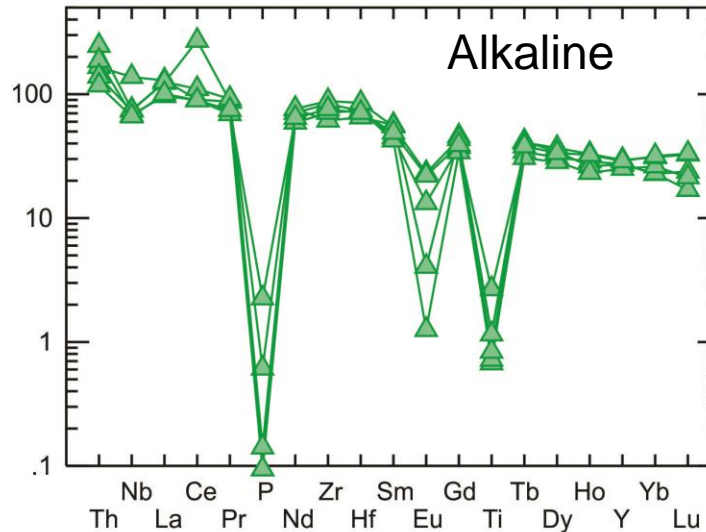
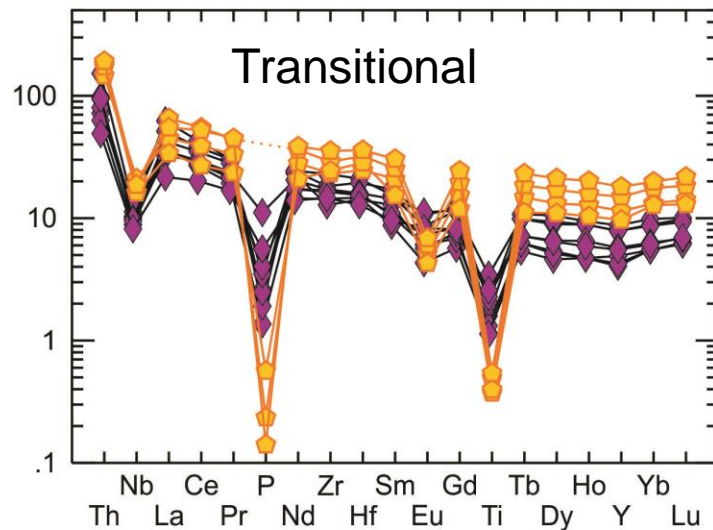
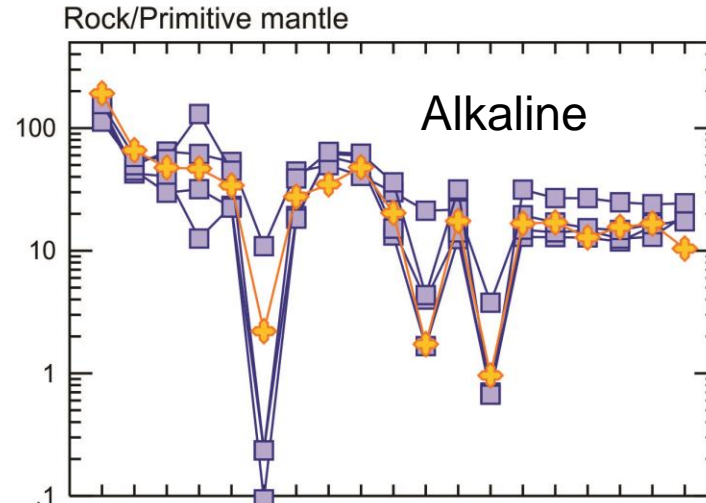
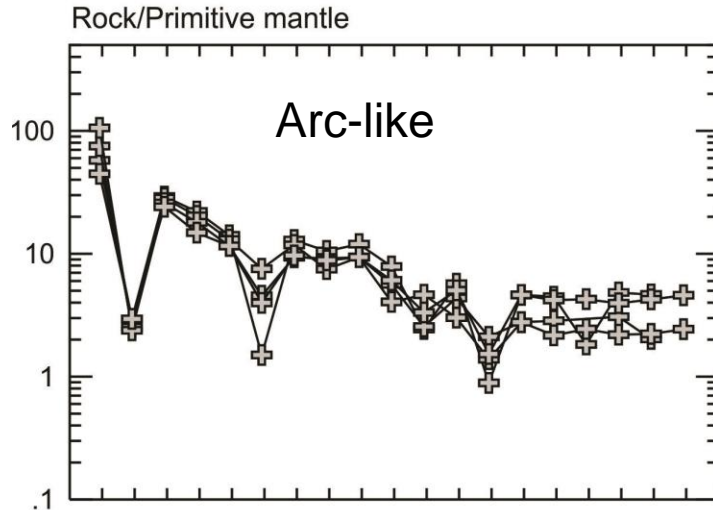




# REE geochemistry of Eastport area felsic to intermediate volcanic rocks

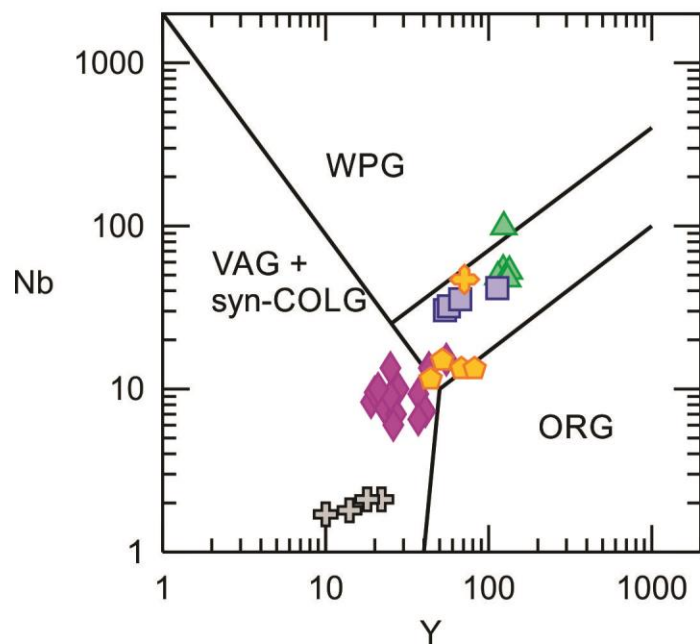
- ⊕ E-F1 (incl. 620 Ma)
- ◆ E-F2 (incl. 589 Ma)
- ◇ Isthmus BAF (incl. 605 Ma)

- E-F3 (no chron. constraint)
- ▲ E-F4 (incl. 569 Ma)
- ◆ Louil Hills granite (572 Ma)

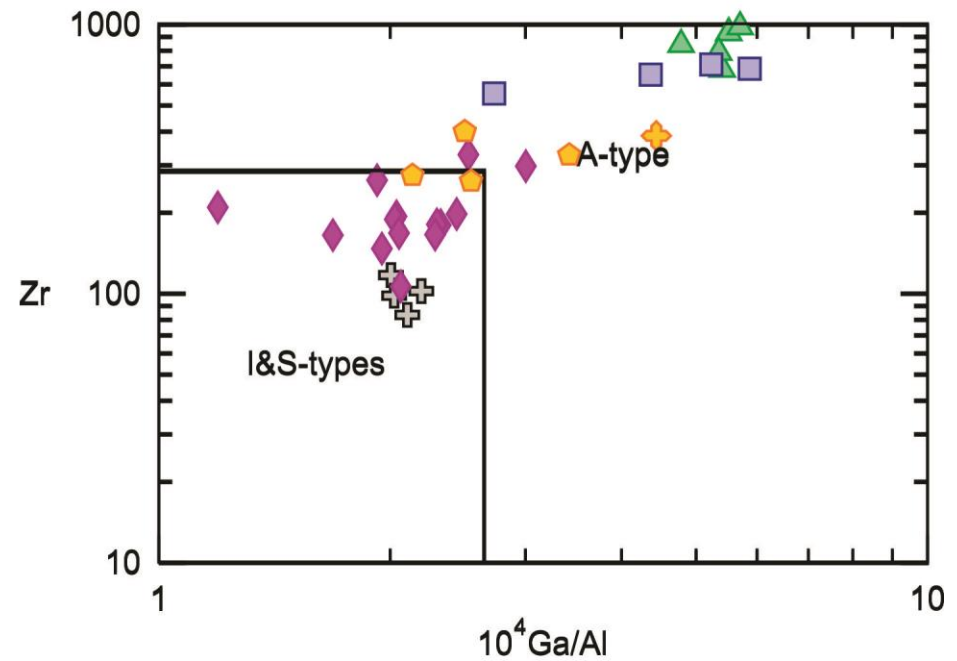


# Felsics – Tectonic Discrimination

- ⊕ E-F1 (incl. 620 Ma)
- ◆ E-F2 (incl. 589 Ma)
- ⬠ Isthmus BAF (incl. 605 Ma)
- E-F3 (no chron. constraint)
- ▲ E-F4 (incl. 569 Ma)
- ⬠ Louil Hills granite (572 Ma)

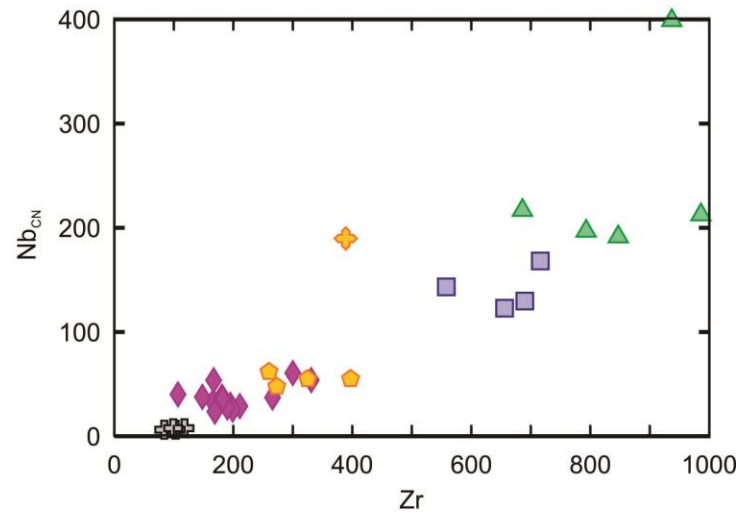
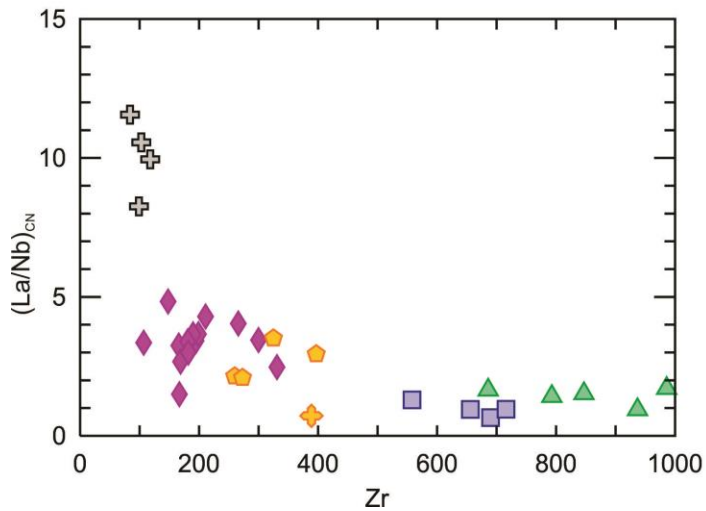
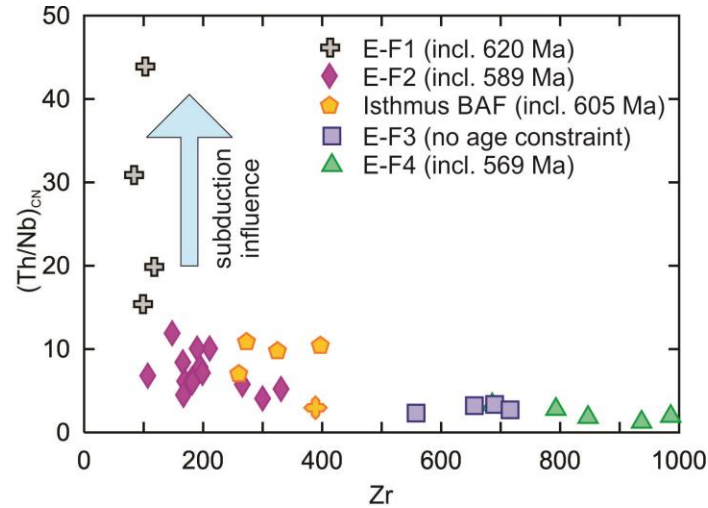
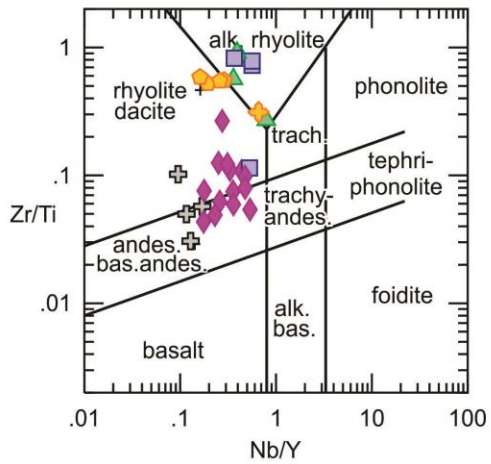


(Pearce, 1984)

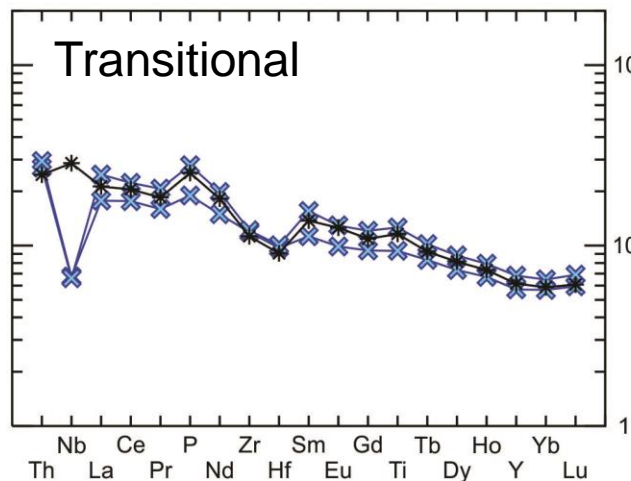
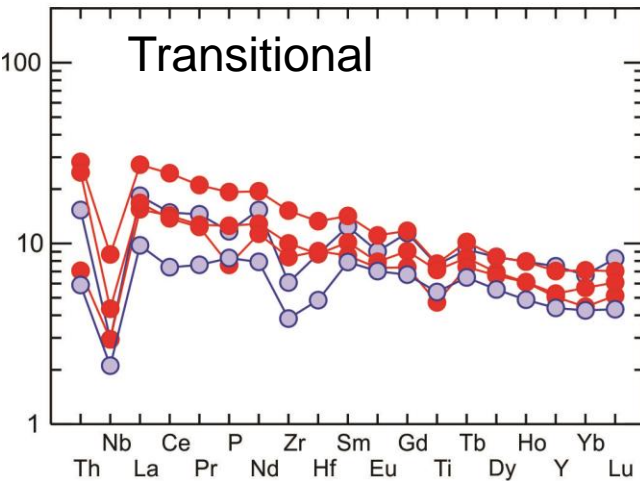
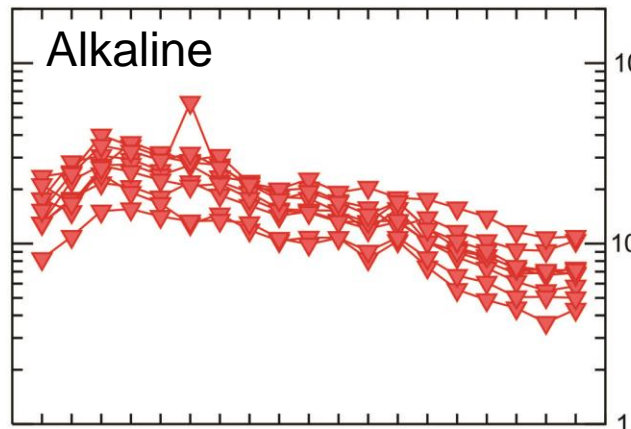
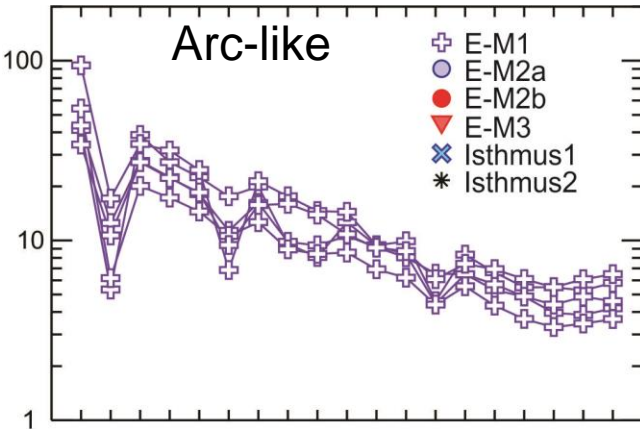


(Whalen et al., 1987)

# Eastport Felsics



# Geochemistry of Eastport mafics



E-M1 – Arc-like (n=5)

- Dykes cut 589 Ma tuff,
- 1 Flow within Cannings Cove Fm, MG

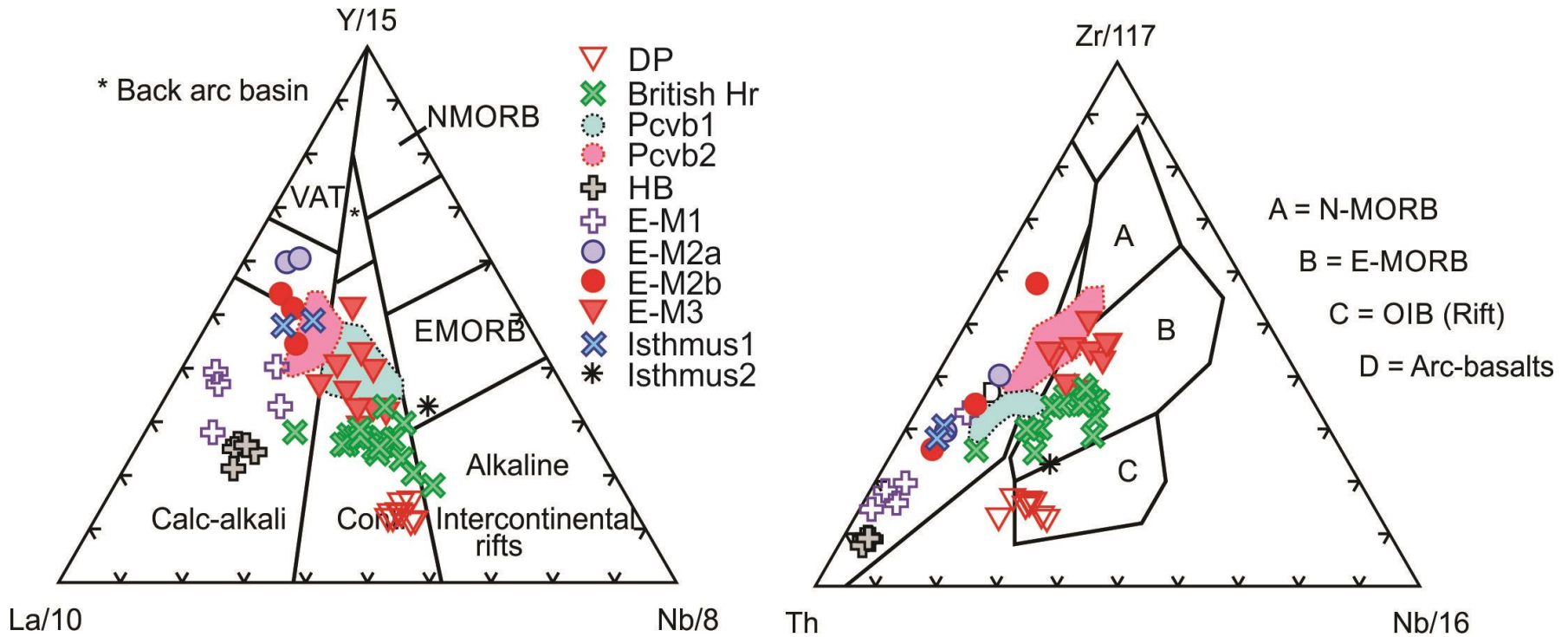
E-M2 – Transitional

- pyroclastics, dyke, 1 flow
- Below 569 Ma felsic flow

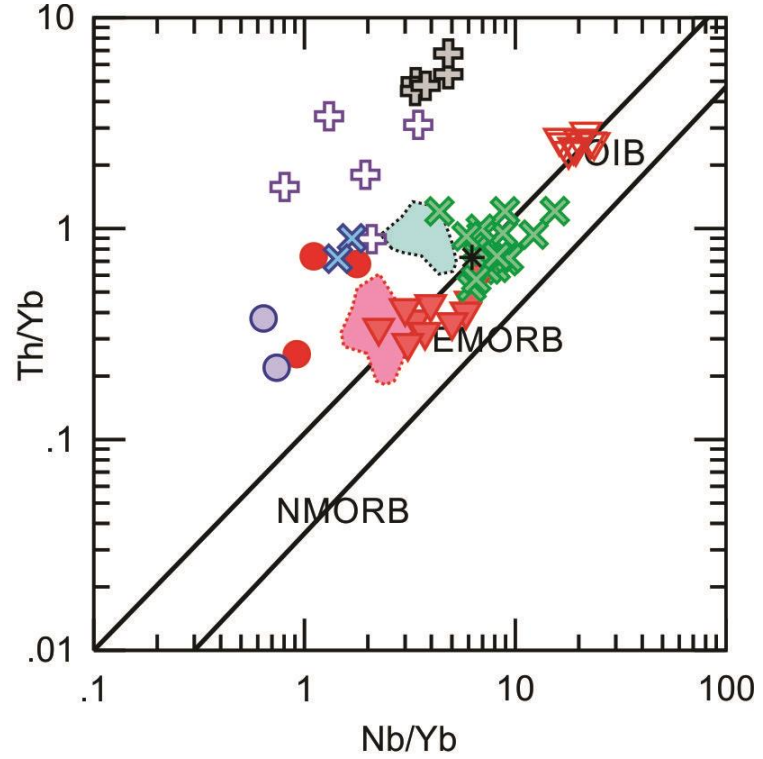
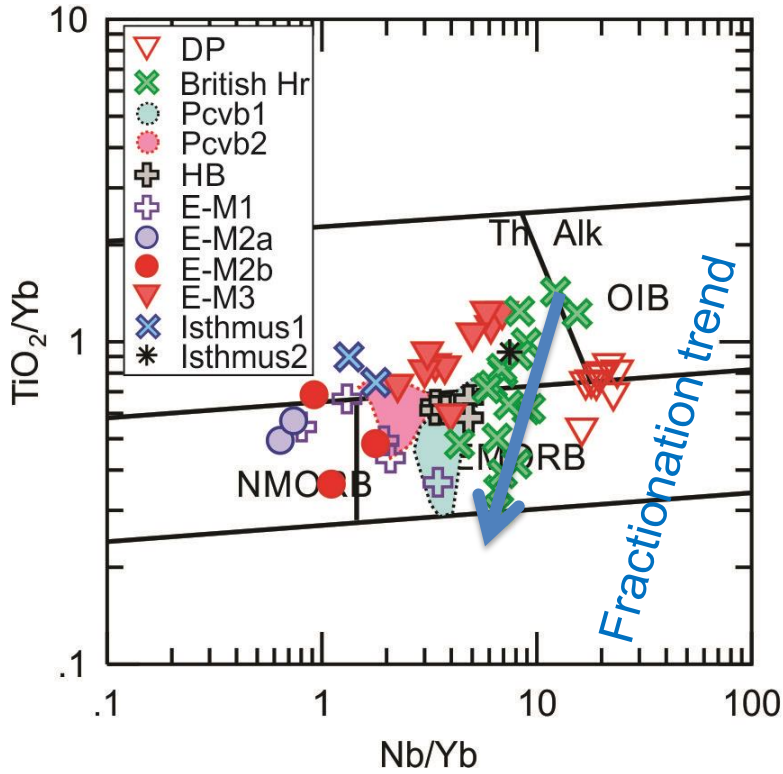
E-M3 – Alkaline basalt  
(OIB: extensional)

- below 569 Ma felsic flow

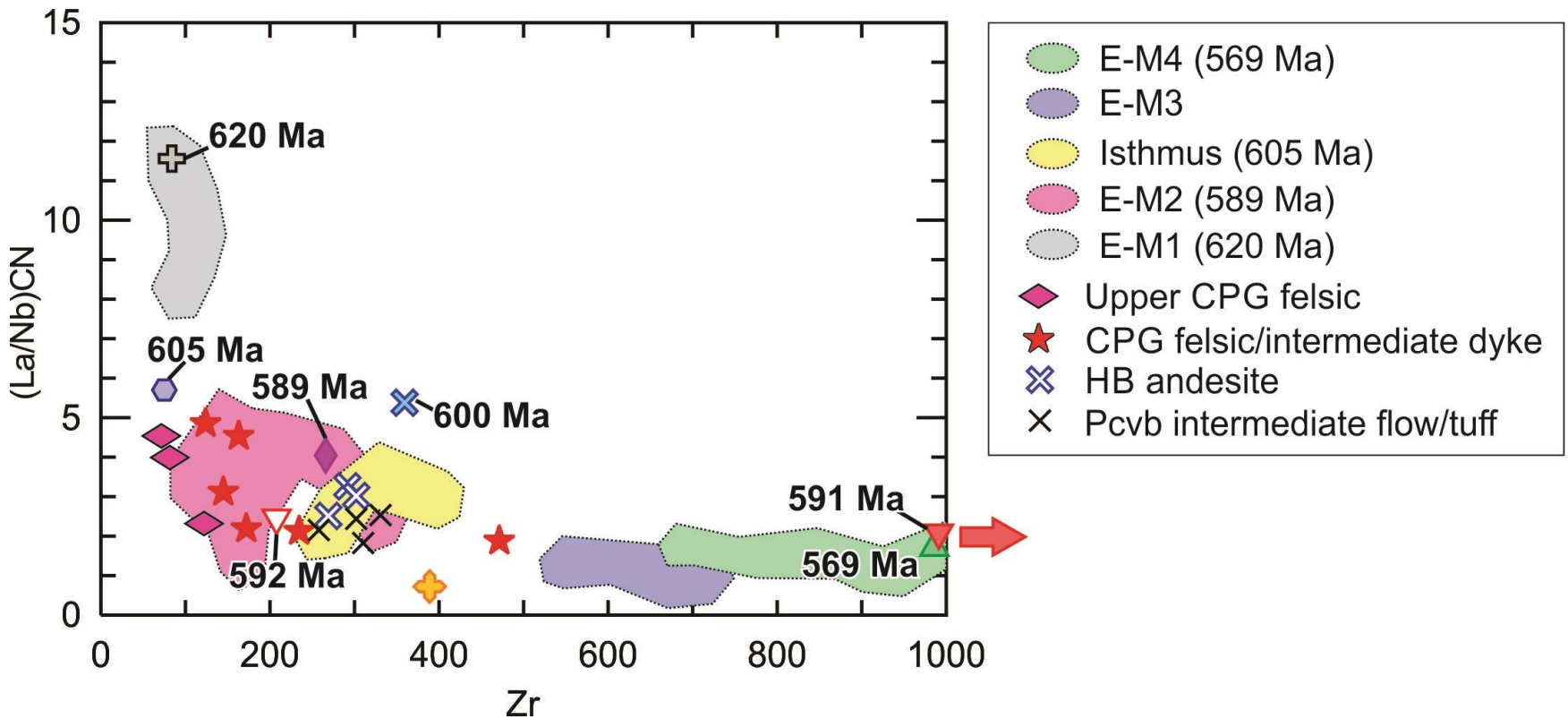
# All mafics – tectonic discrimination



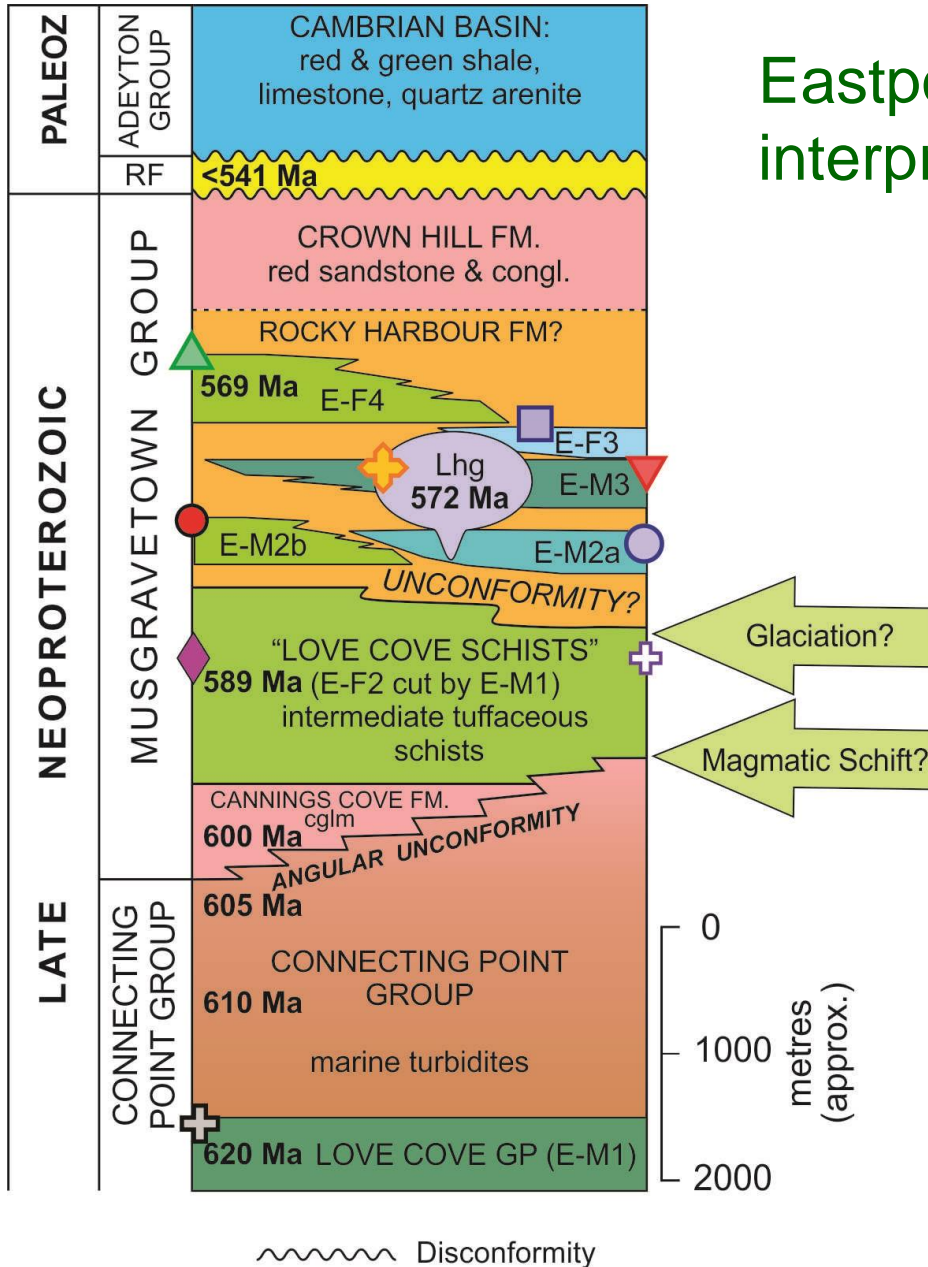
# All mafics – Pearce, 2008 plots



# All Felsics



## Eastport-Burnside interpreted stratigraphy



- Calc-alkaline rocks are the oldest.
- Love Cove schists are transitional (flatter XREE patterns; smaller negative Nb anomalies).
- Possible unconformity above Love Cove schist? (Younce, 1970; O'Brien, 1987).
- E-M2a and 2b apparently above Love Cove schists and below alkaline (extensional) rocks (E-M3, E-F3 and E-F4).
- Magmatic shift (decrease in subduction component) by 589 Ma.
- Whole-sale extension by 572 Ma, but may have commenced earlier (no age constraint on E-M3 – but similar to British Hr basalts – possibly ca 580 Ma?).

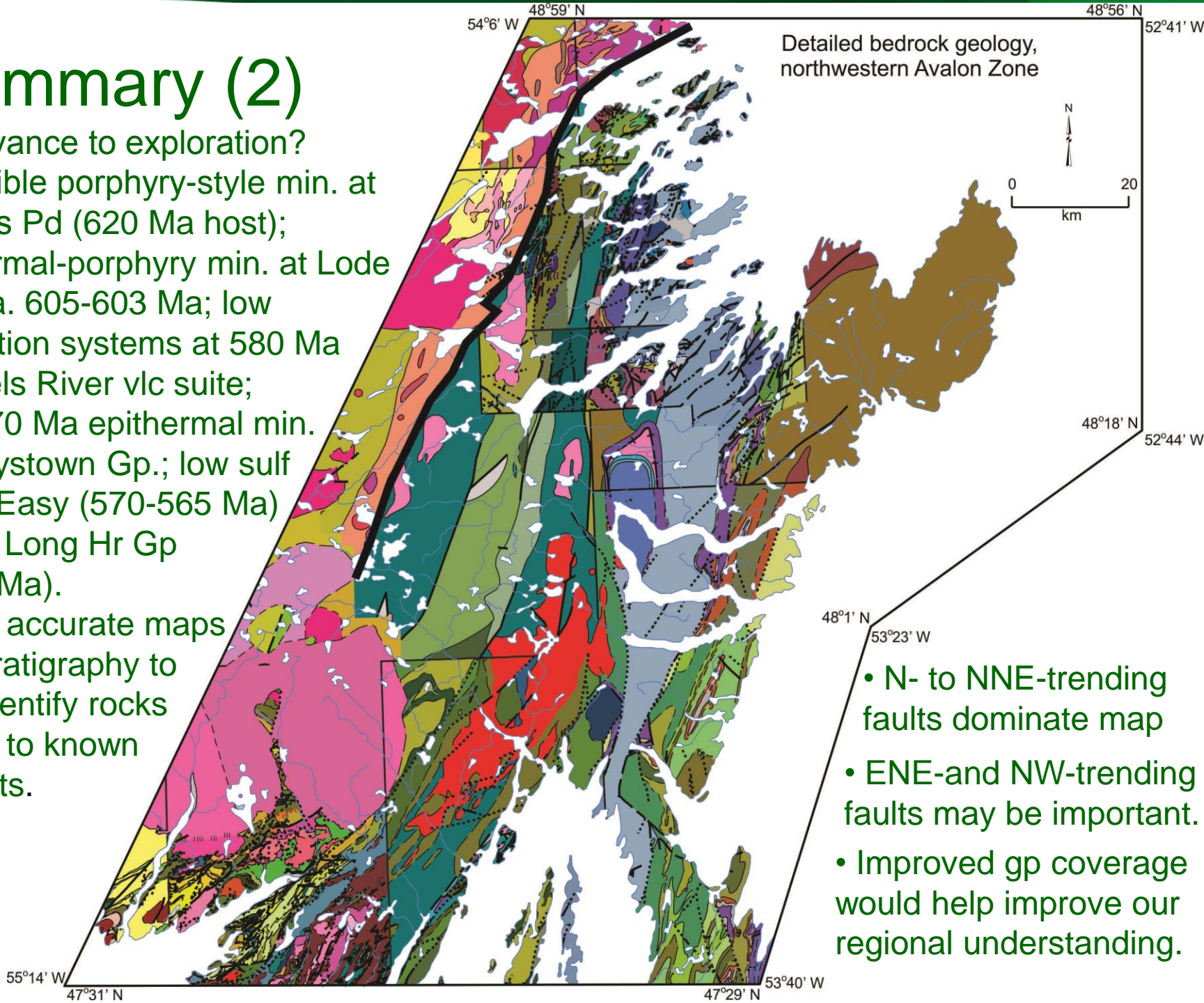


# Summary (1)

- Transition from arc-influenced to extensional volcanics at Bonavista Peninsula occurs post 600 Ma and pre-592 Ma; same transition evident at Eastport – Burnside area, loosely bracketed between 620 Ma and 572 Ma.
- Transitional volcanics at Bonavista = Plate Cove belt; at Eastport – Burnside = EF-2 (includes 589 Ma schist) and E-M2; 605 Ma rhyolite and overlying basalts at Isthmus.
- Extensional volcanism at Eastport post-dates ca. 589 Ma E-F2 group and includes E-M3 (similar to British Harbour basalts).
- Extensional magmatism at Bonavista includes British Harbour (Within Plate) basalts and Dam Pond (OIB-like) basalts. The latter are spatially associated with Trinity diamictite; the former overlie red sandstone and conglomerate mapped as Crown Hill Formation at SE Bonavista (Normore, 2012). Ca. 580 Ma??
- NW Avalon is structurally (and stratigraphically) complex; the role of ENE-trending faults may be more important than traditionally viewed.
- Multidisciplinary (lithostratigraphy, lithogeochemistry, geochronology) approach to bedrock mapping is critical; more detailed geophysics (!).

# Summary (2)

- Relevance to exploration?
- Possible porphyry-style min. at Butler's Pd (620 Ma host); epithermal-porphyry min. at Lode Star ca. 605-603 Ma; low sulfidation systems at 580 Ma Manuels River vlc suite; 575-570 Ma epithermal min. in Marystown Gp.; low sulf at Big Easy (570-565 Ma) And in Long Hr Gp (~565 Ma).
- More accurate maps and stratigraphy to help identify rocks similar to known deposits.



- N- to NNE-trending faults dominate map
- ENE-and NW-trending faults may be important.
- Improved gp coverage would help improve our regional understanding.

# Acknowledgements

- David Haynes, field assistance
- Everett Saunders and Rick Verge, boatmen
- Gerry Hickey, logistical support
- Terry Sears and Kim Morgan, map preparation
- Greg Sparkes, discussions re: regional U-Pb constraints and hosts to known mineralization

