Lithostratigraphy, petrochemistry and U-Pb (zircon) age constraints of volcanic rocks on the Bonavista Peninsula, Newfoundland: implications for the interpretation of the Musgravetown Group

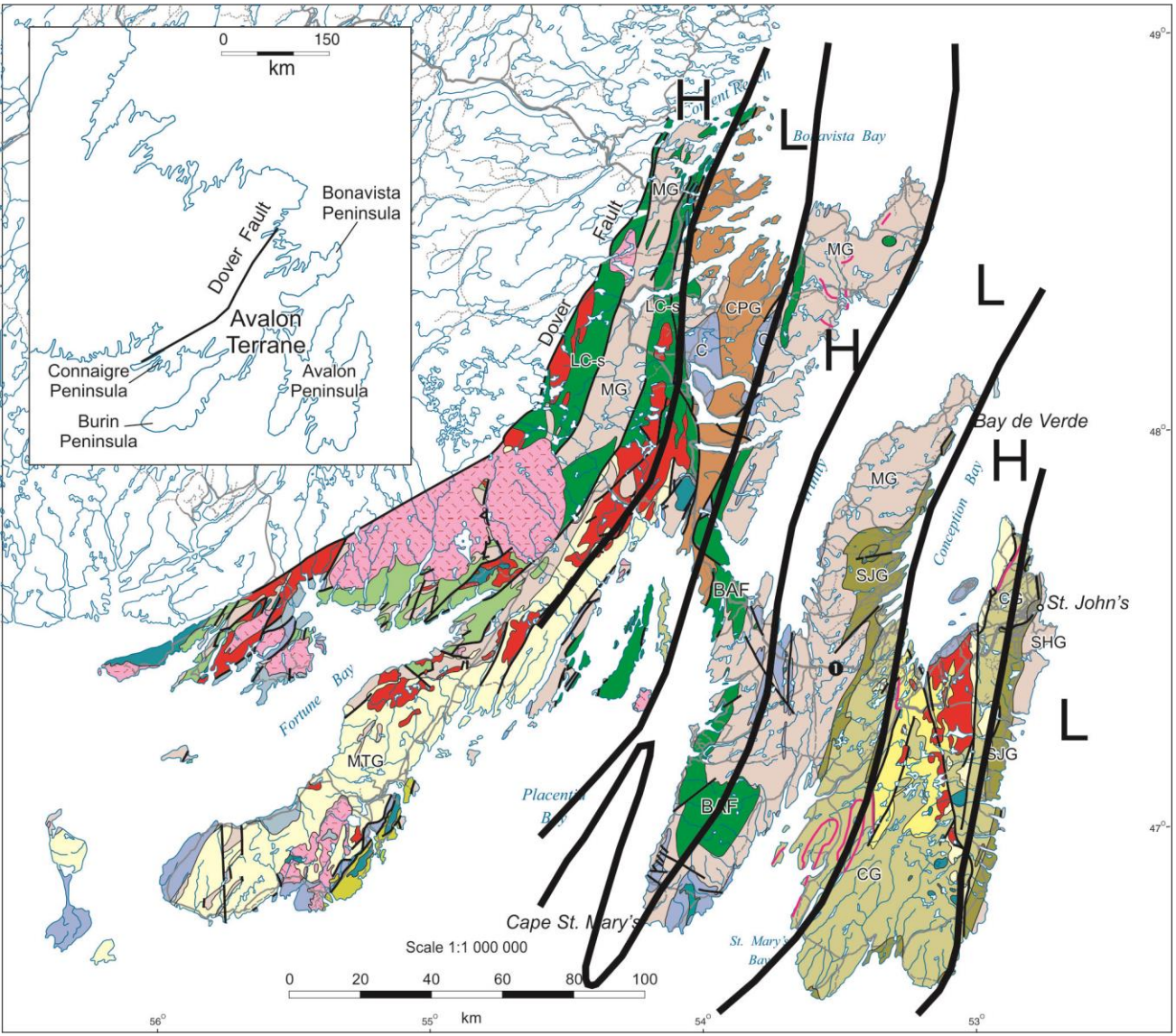
Newfoundland Labrador

Andrea Mills[1], Hamish Sandeman[1] and Greg Dunning[2]
[1],Geological Survey of NL; [2]Memorial University of NL

Outline

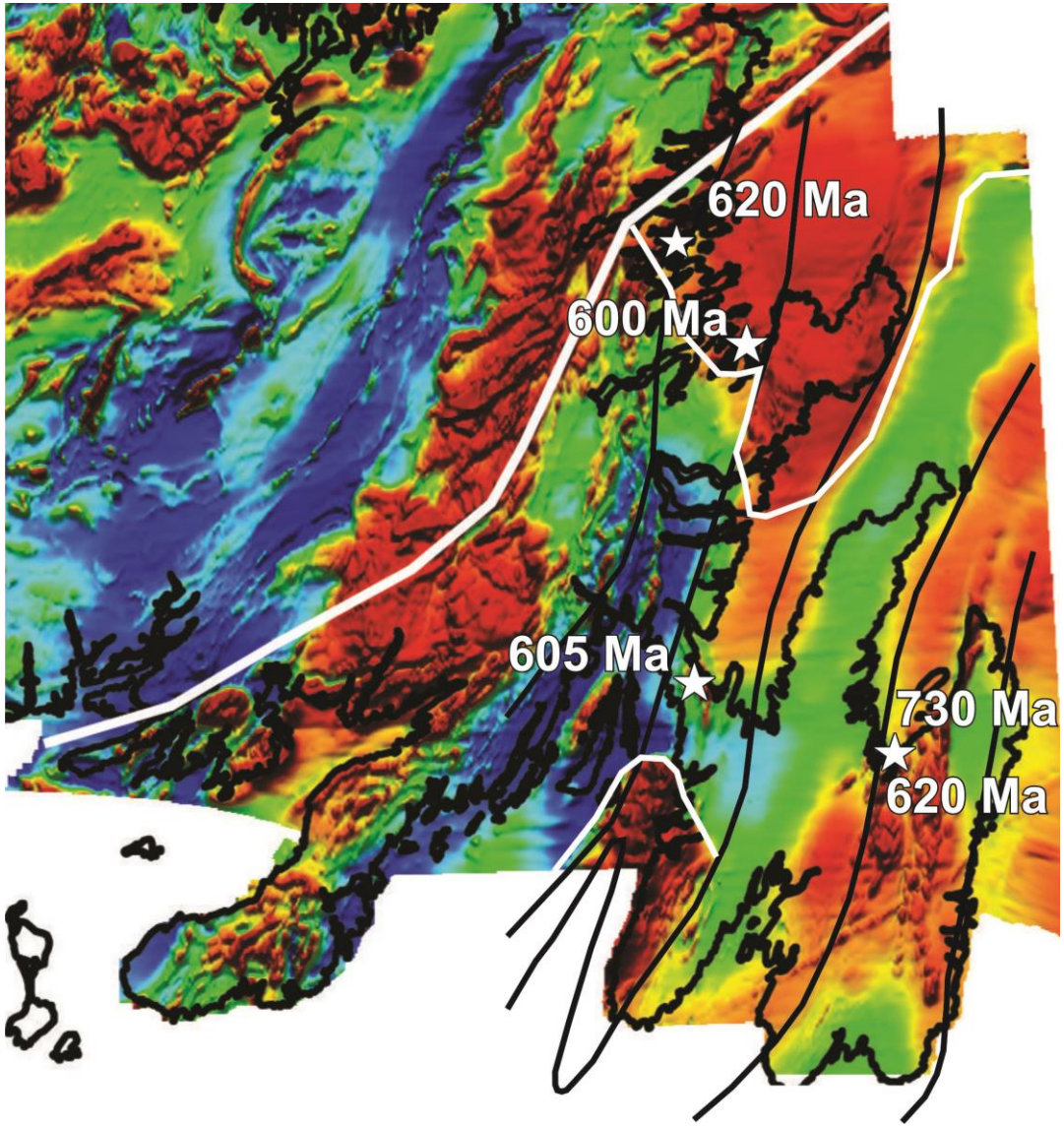
- Overview of Avalonian rocks in Nfld
- Bonavista Peninsula volcanic stratigraphy
- U-Pb (zircon) age constraints
- Geochemistry of igneous rocks
- Implications

Overview: Avalon Terrane in Nfld

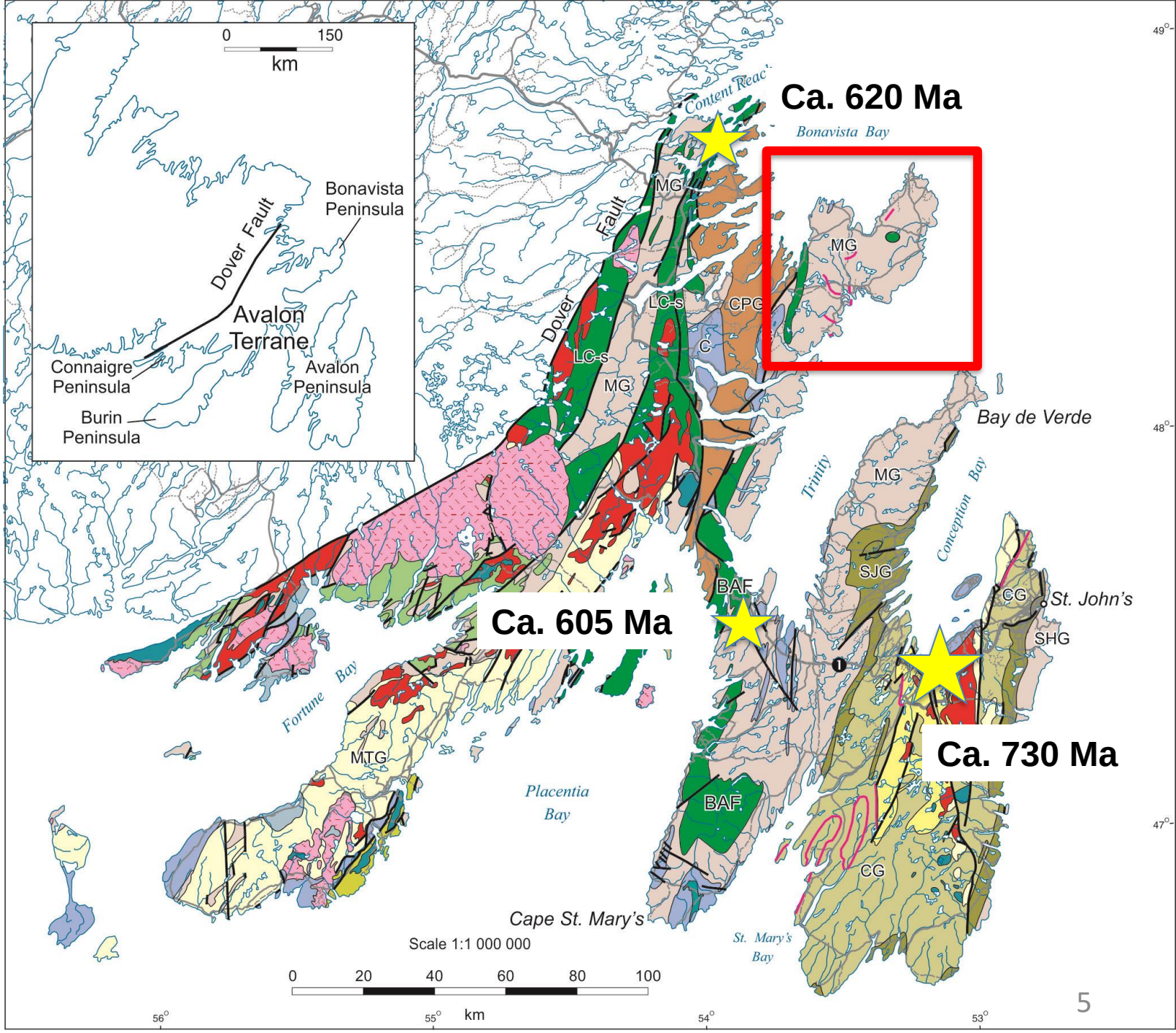


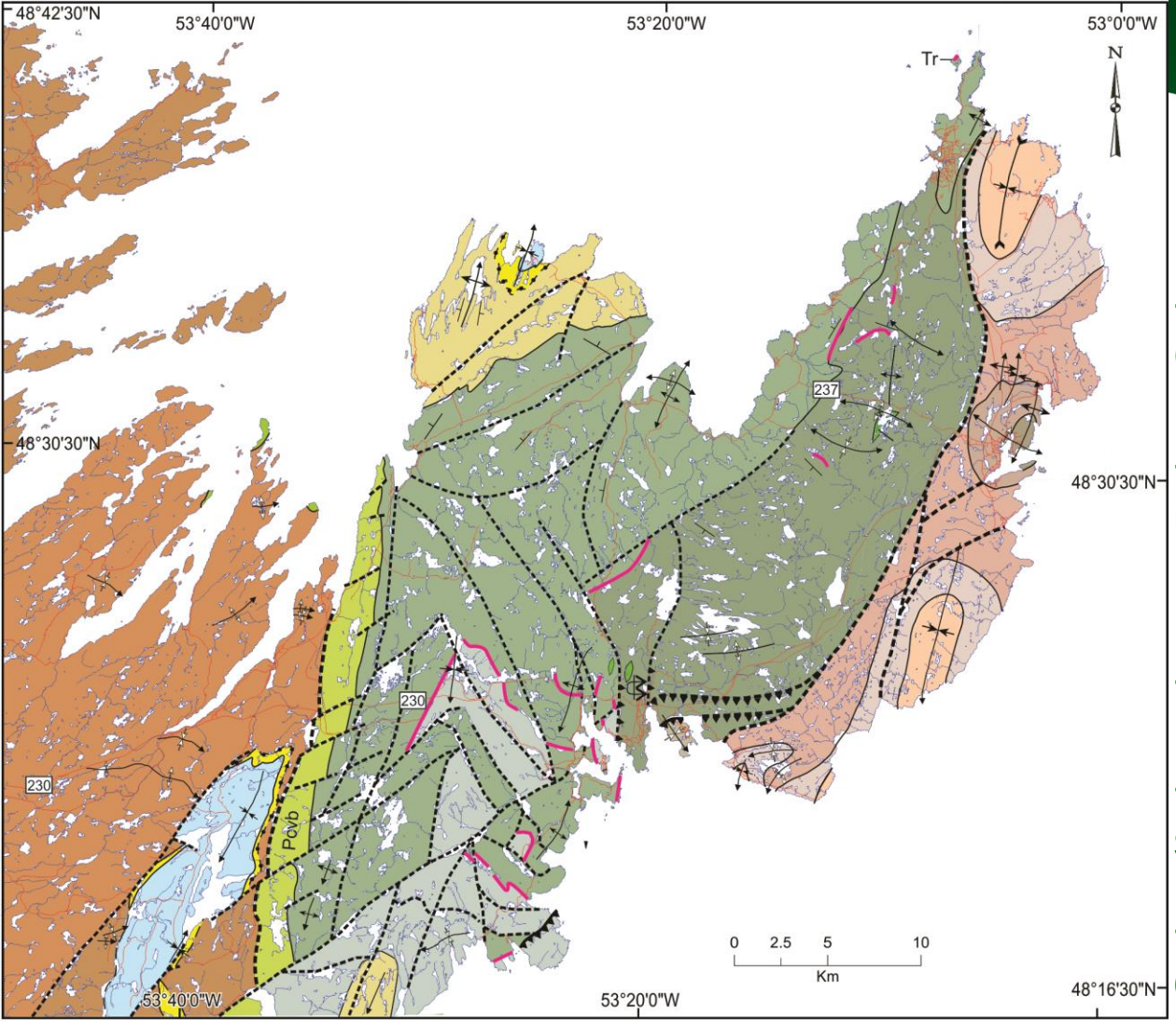
- Summary of Myrow (1995) still relevant, additional U-Pb age data available, but all other knowledge gaps still apply (sequence and lithostratigraphy, chemostratigraphy, magnetostratigraphy).
- New age constraints summarized by van Staal et al. 2020
- Formerly viewed as minimally deformed, alternating mag-High, mag-Low = alternating arc – basin rocks, with CG = CPG ocean basin rocks

Modified from Colman-Sadd et al., 1990; aeromag belts from Knight and O'Brien, 1988



- New geophysics offshore, but all was reprocessed in early 1990s.
- Shows complexities – eastern mag-high is separated from western mag-high by a mag-low
- Western mag-high is separated by a mag-low that runs through the Isthmus
- Magnitude is different for east vs. west mag-high
- Are east and west parts similar?


Ca. 620 Ma
Ca. 605 Ma
Ca. 730 Ma
0 150
km
Bonavista Peninsula
Dover Fault
Avalon Terrane
Connaigre Peninsula
Avalon Peninsula
Burin Peninsula
Bonavista Bay
Bay de Verde
Trinity
Conception Bay
Fortune Bay
Placentia Bay
St. Mary's Bay
Cape St. Mary's
St. John's
MG
LC-s
CPG
C
SJG
BAF
CG
SHG
MTG
Scale 1:1 000 000
0 20 40 60 80 100
km
49°
48°
47°
56°
55°
54°
53°



LEGEND

WEST BONAVISTA
Cambrian
Adeyton Group
Random Formation
Neoproterozoic
Musgravetown Group
Canning Cove Formation
Connecting Point Group

CENTRAL BONAVISTA
Indian Arm Fault (IAF)
Cambrian
Adeyton Group
Random Formation
Neoproterozoic
Musgravetown Group
Crown Hill Formation
Rocky Harbour Formation
Trinity facies
Big Head Formation/DP/FP
Bull Arm Formation

EAST BONAVISTA
Spillars Cove Fault (SCF)
Neoproterozoic
Signal Hill Group
St. John's Group
Renews Head Formation
Fermeuse Formation
Trepassey Formation
Conception Group
Mistaken Point Formation

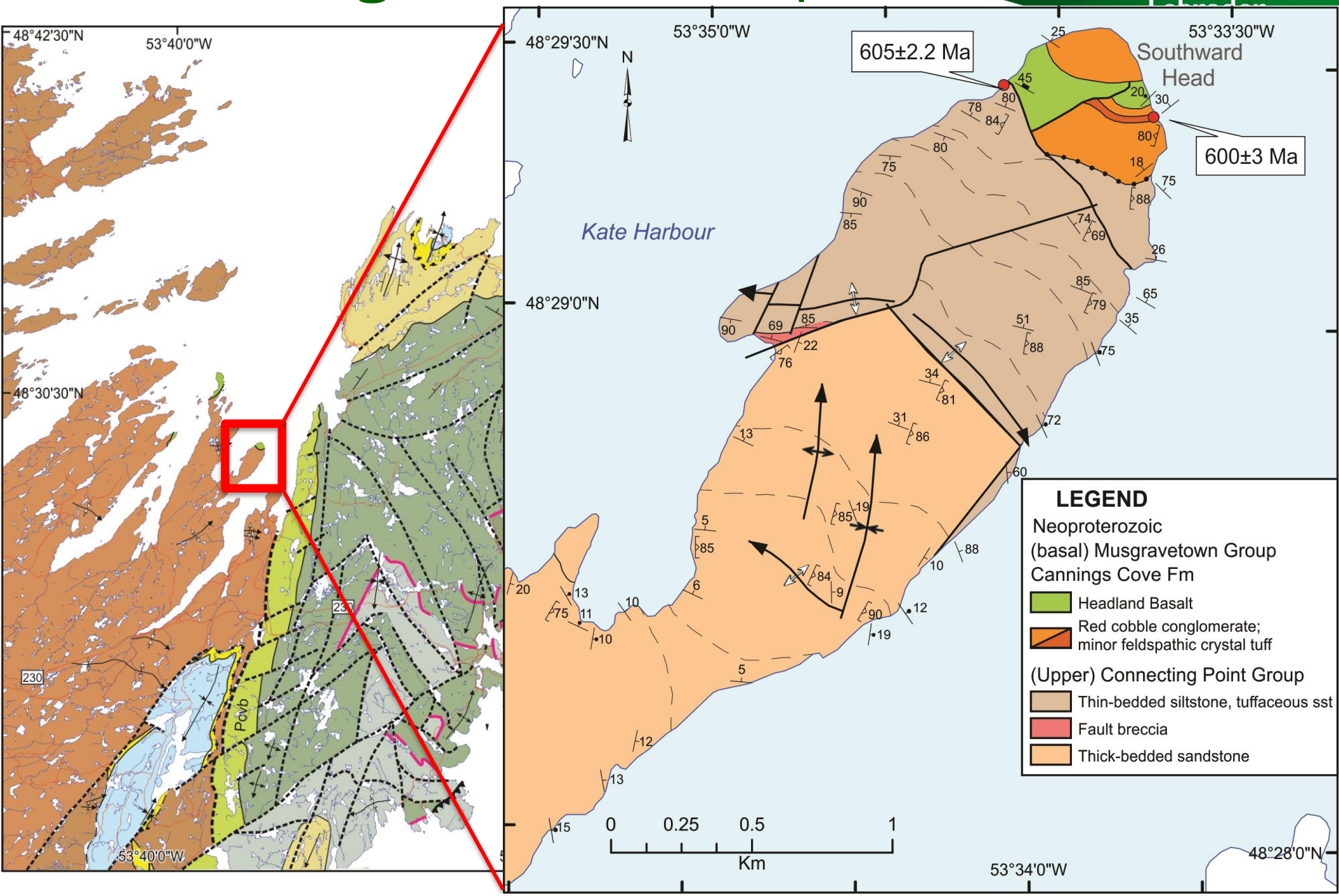
SYMBOLS
Contact
Unconformity (approximate)
Fault
Thrust
F1 syncline, F1 anticline
F2 syncline, F2 anticline
F2 overturned syncline
Bedding

- Turbiditic Connecting Point Group overlain by molasse-like Musgravetown Group
-age-constrained unconformity at Southern Bay Head – basal Cannings Cove Fm
-Plate Cove volcanic belt = Bull Arm Fm
-alkaline basalts: 2 distinct suites

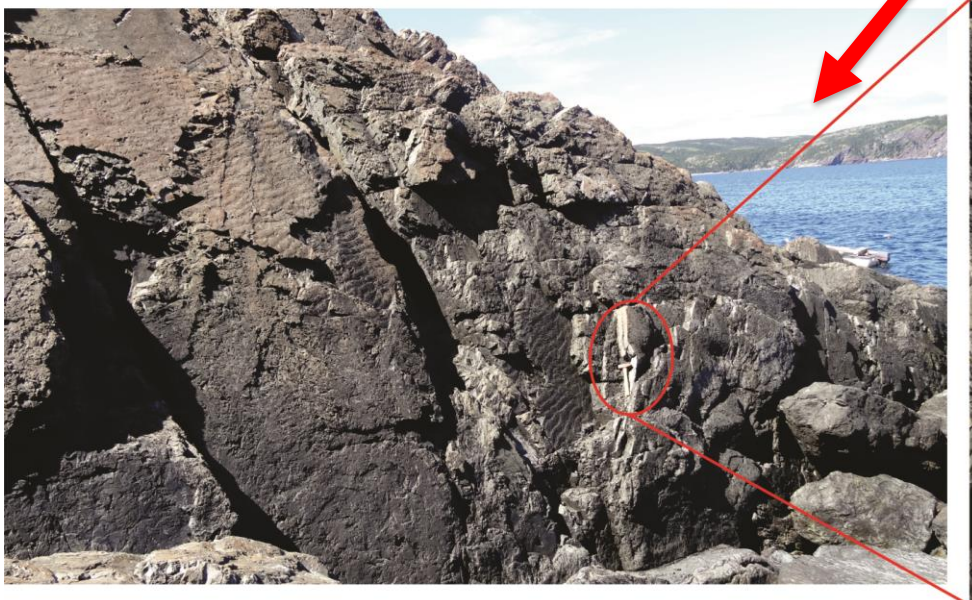
-580 Ma Trinity facies diamictite correlative to Gaskiers Fm on Avalon Pen. (Pu et al. 2016)

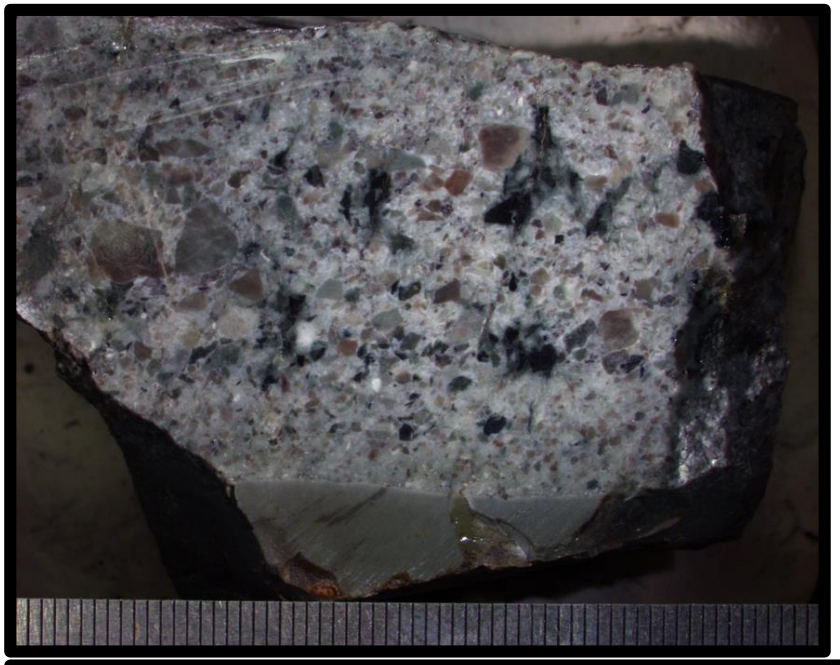
-DP > 580 Ma: British Harbour < 580 Ma

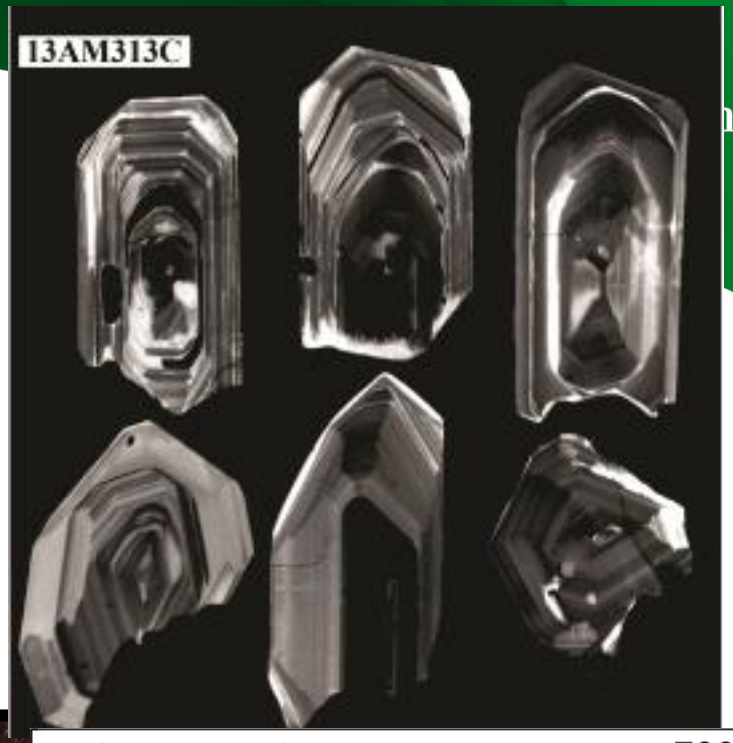
Base of Musgravetown Group

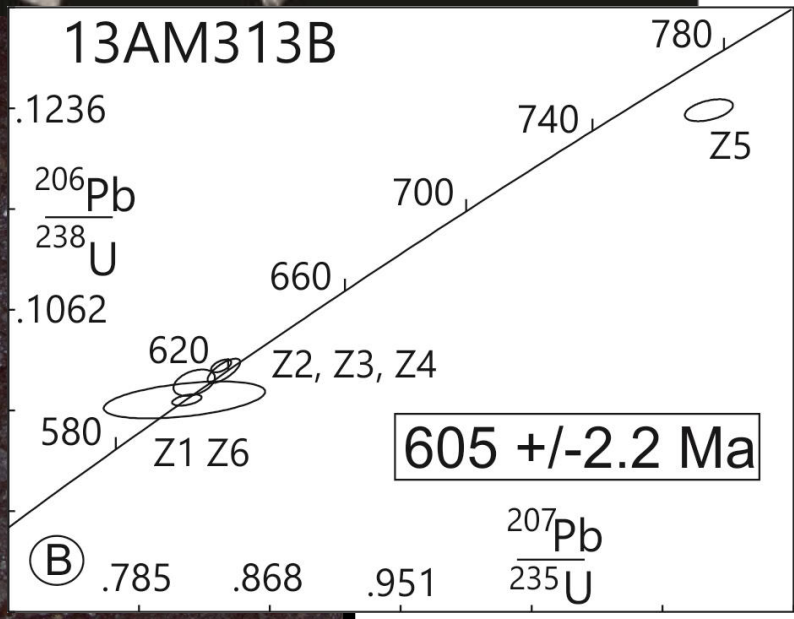


Connecting Point Group

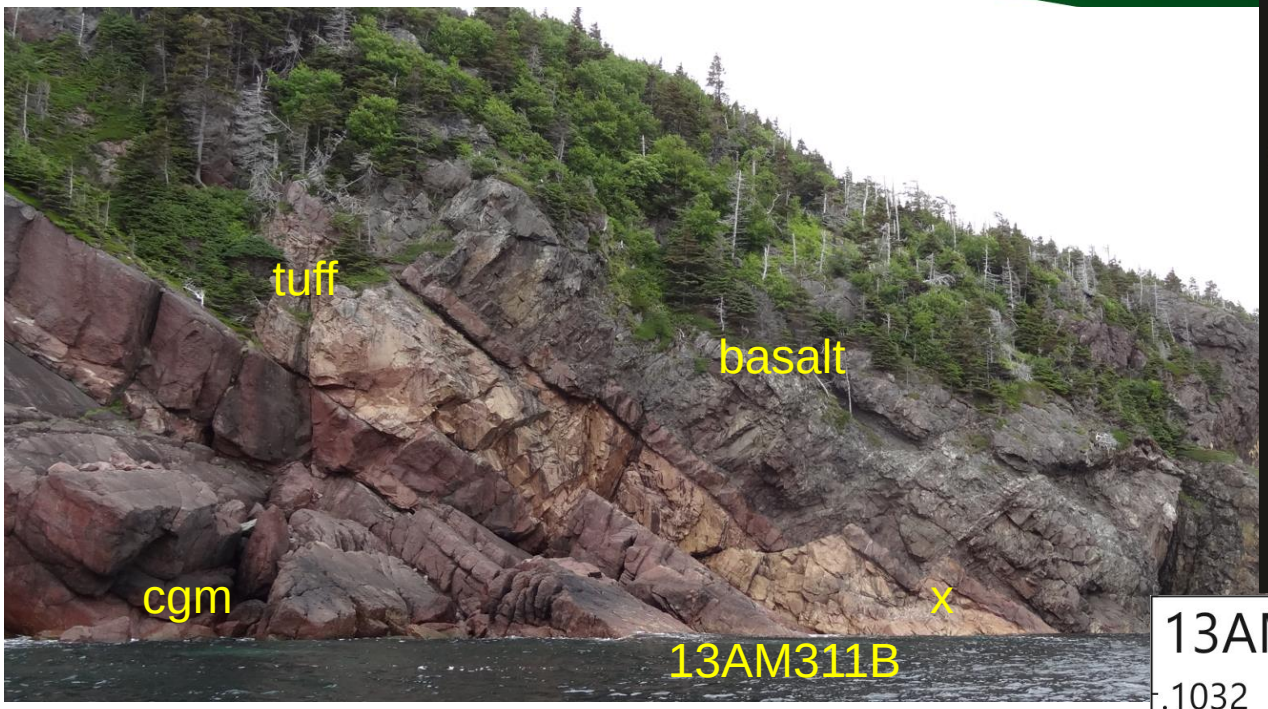




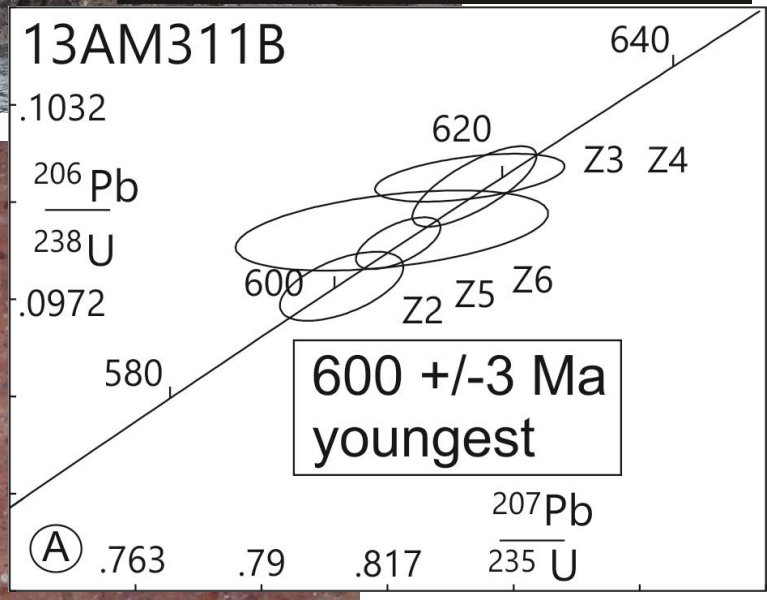

13AM313C

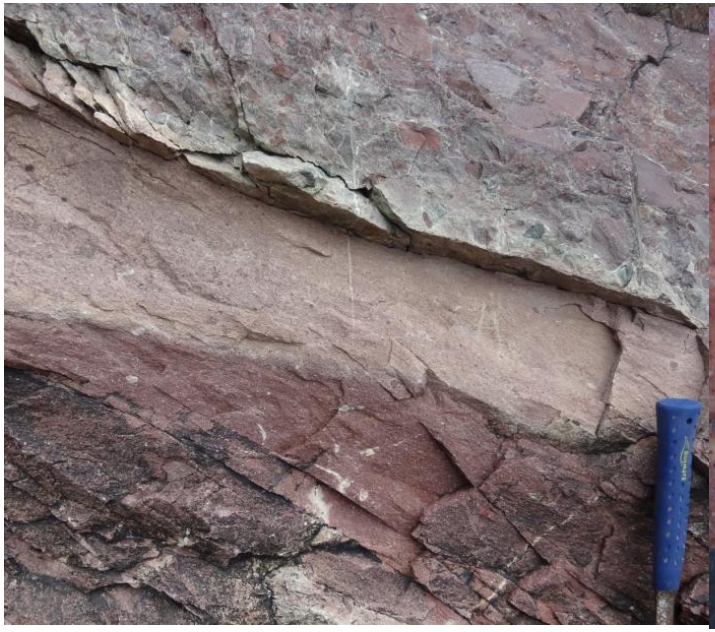

13AM313B
780
740
700
660
620
580
.1236
.1062
206Pb/238U
Z5
Z2, Z3, Z4
Z1 Z6
605 +/-2.2 Ma
B
.785
.868
.951
207Pb/235U
2 mm

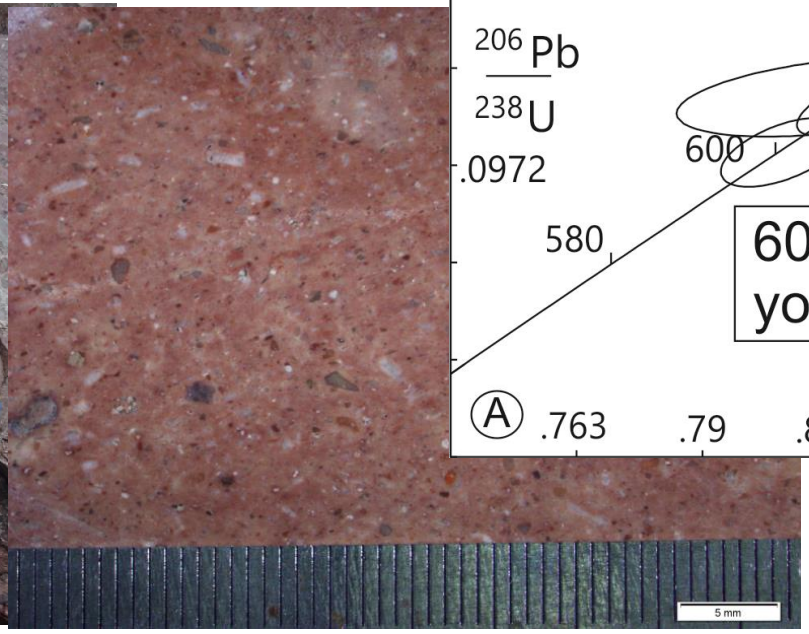
Basal Musgravetown Group


tuff
basalt
cgm
x
13AM311B

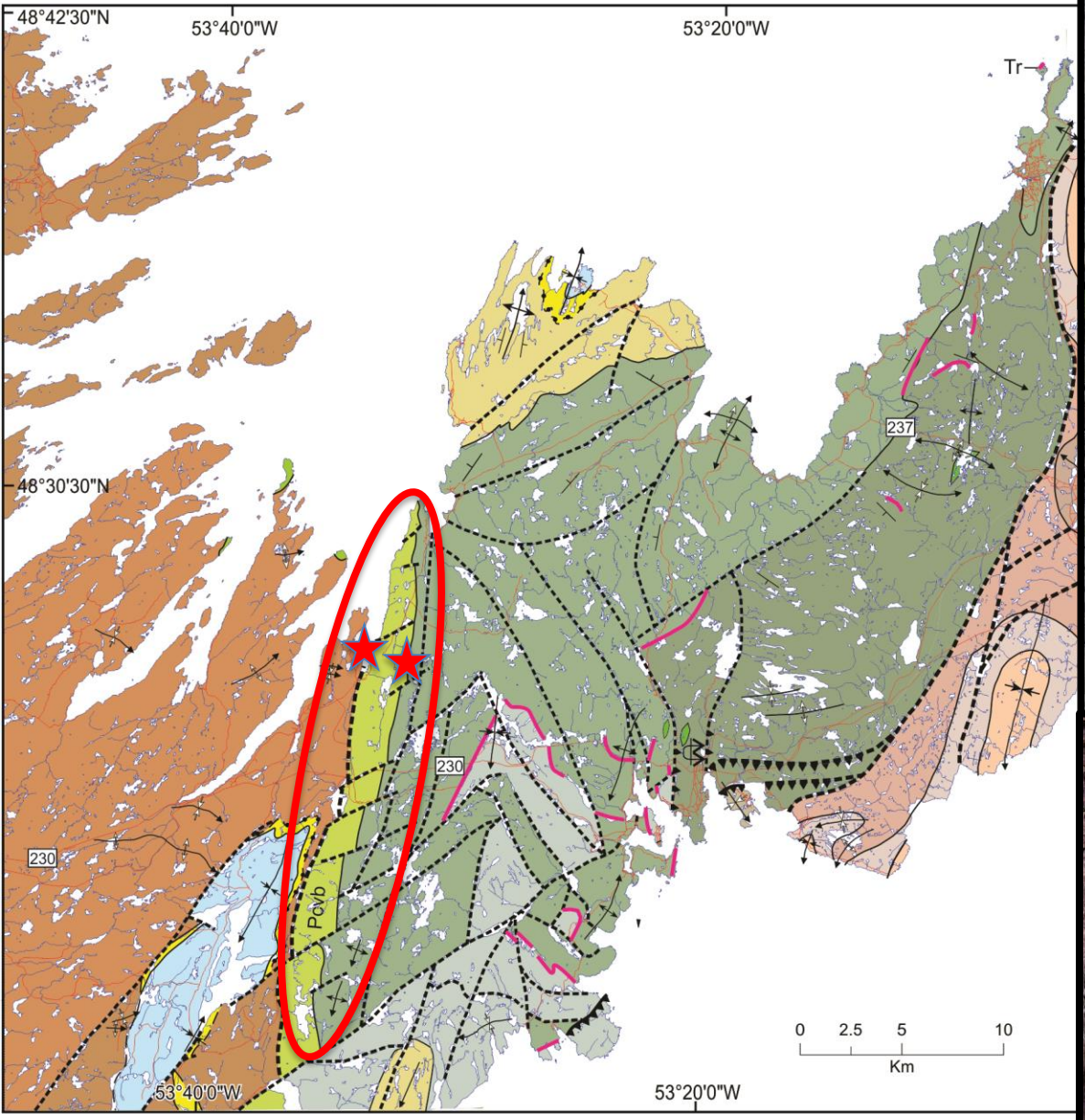

13AM311B

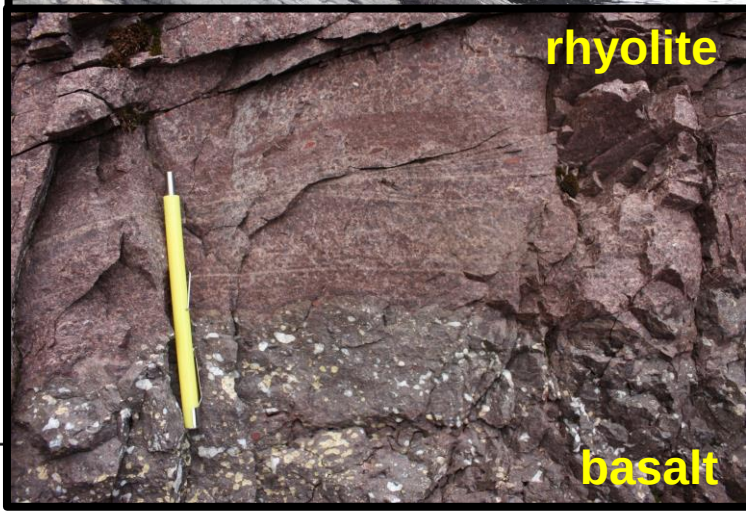

13AM311B
640
.1032
620
Z3 Z4
206 Pb
238 U
600
Z2 Z5 Z6
.0972
580
600 +/-3 Ma
youngest
207 Pb
235 U
A
.763
.79
.817

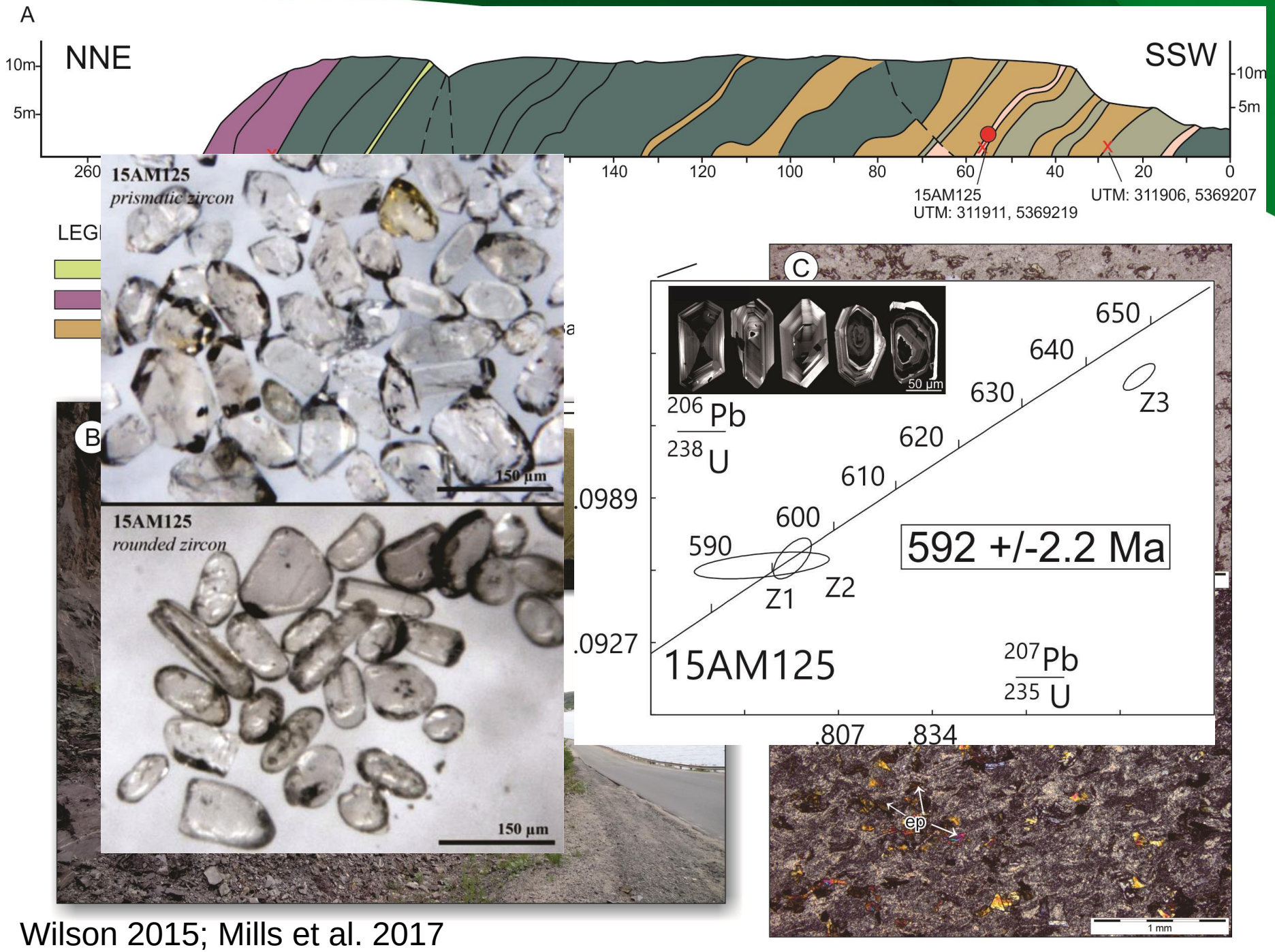



5 mm

Composite PCvb





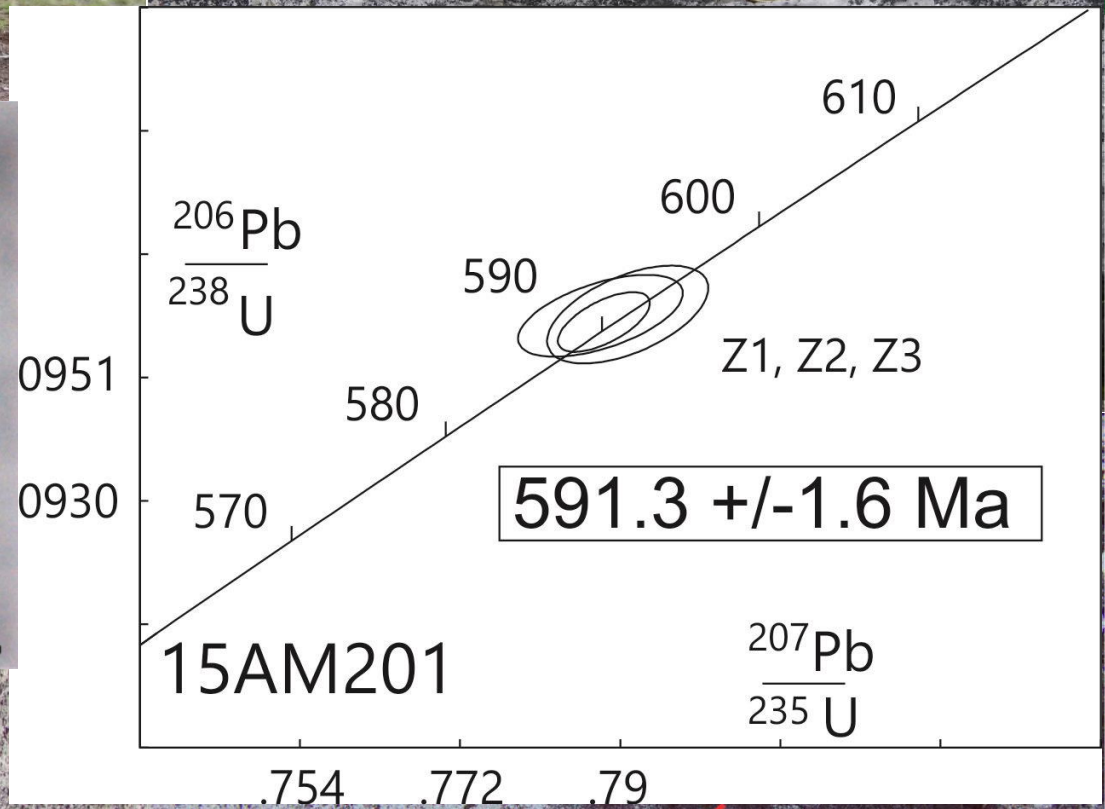


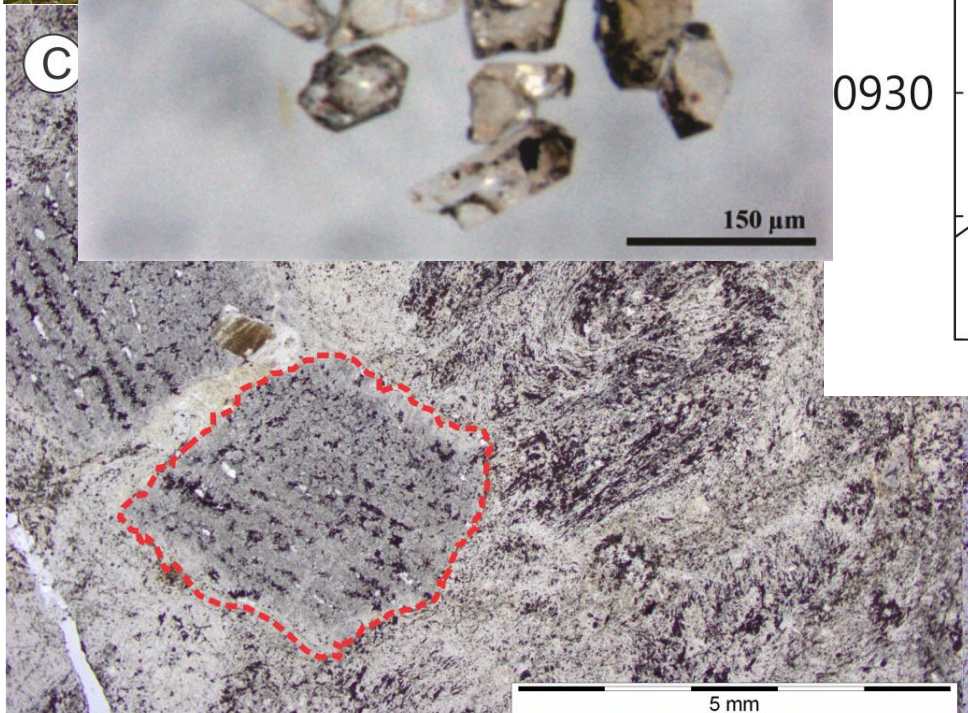
Wilson 2015; Mills et al. 2017

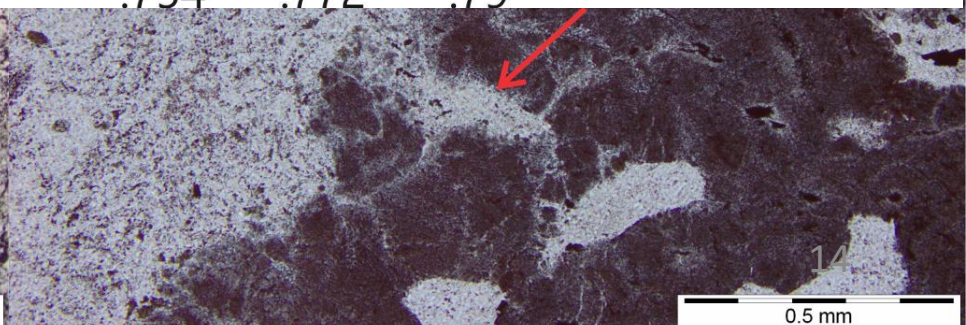

A


B


15AM201
150 µm


610
600
590
580
570
206Pb/238U
0951
0930
Z1, Z2, Z3
591.3 +/-1.6 Ma
15AM201
207Pb/235U
.754
.772
.79


C
5 mm


0.5 mm

Current Research (2011) Newfoundland and Labrador Department of Natural Resources
Geological Survey, Report 11-1, pages 273-293

Newfoundland Labrador

PRELIMINARY FINDINGS ON THE GEOLOGY OF THE TRINITY MAP AREA (NTS 2C/06), NEWFOUNDLAND

L.S. Normore
Regional Geology Section

THE GEOLOGICAL SOCIETY OF AMERICA®

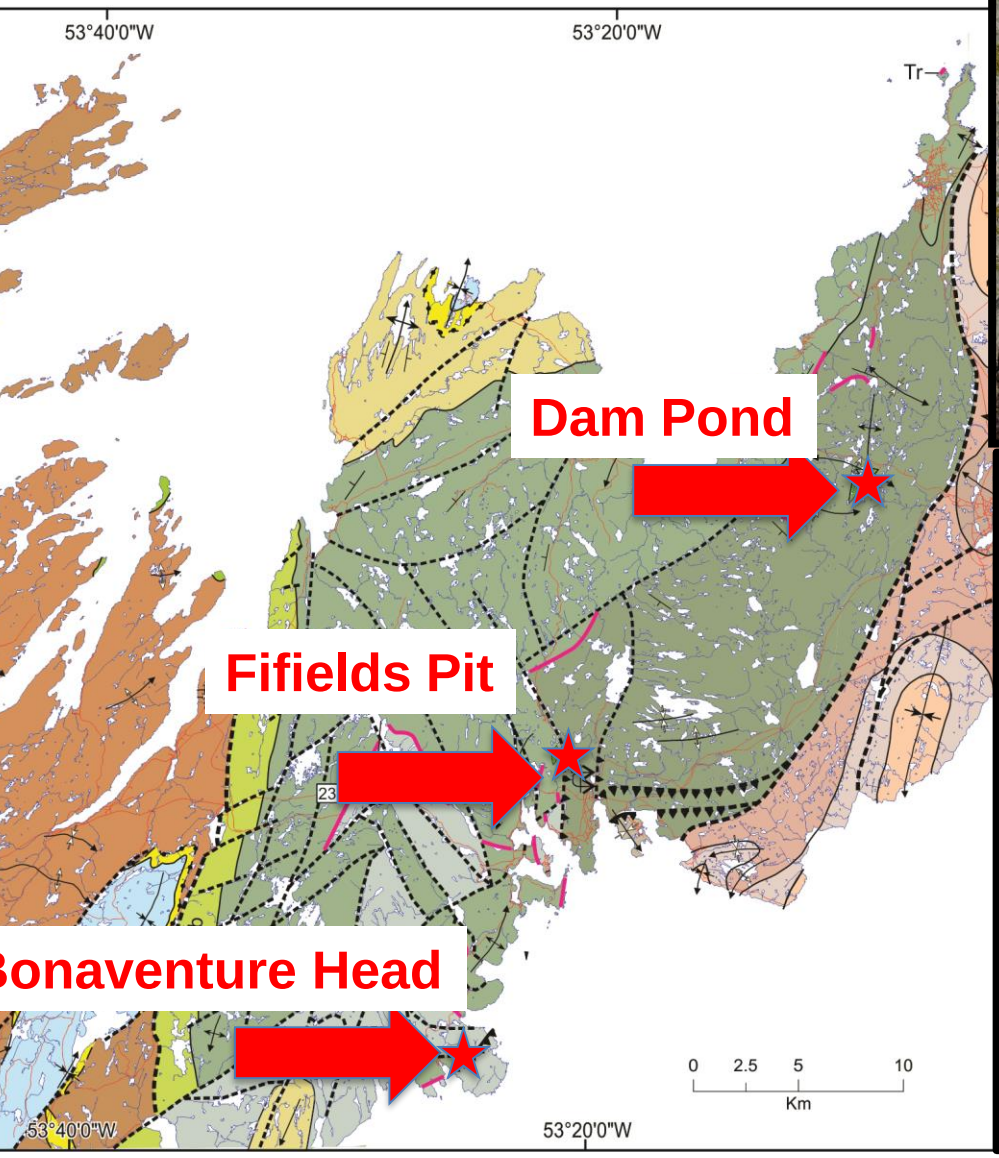
Dodging snowballs: Geochronology of the Gaskiers glaciation and the first appearance of the Ediacaran biota

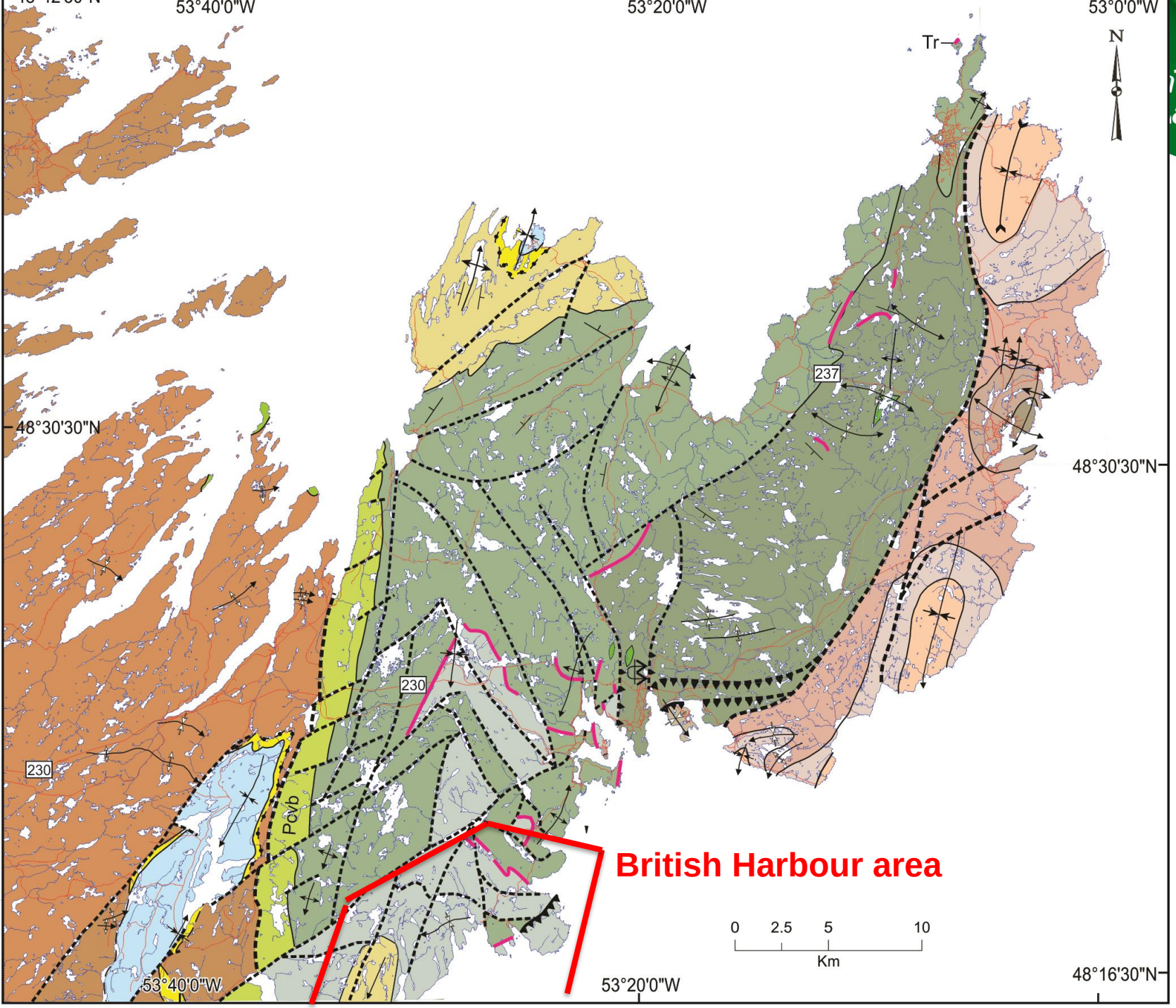
Judy P. Pu[1,2], Samuel A. Bowring[1], Jahandar Ramezani[1], Paul Myrow[3], Timothy D. Raub[4], Ed Landing[5], Andrea Mills[6], Eben Hodgin[2], and Francis A. Macdonald[2]

- ID'ed by Normore (2011)
- Striated clasts, rhythmic-laminations deformed/penetrated by dropstones
- 580 Ma Trinity facies
- correlative to Gaskiers Fm on Avalon Peninsula

Laminated dropstone diamictite

Massive diamictite


53°40'0"W
53°20'0"W
Tr
Dam Pond
Fifields Pit
23
Bonaventure Head
0 2.5 5 10
Km
53°40'0"W
53°20'0"W


53°40'0"W
53°20'0"W
53°0'0"W
Tr
N
48°30'30"N
237
230
230
PCvb
British Harbour area
0 2.5 5 10
Km
53°40'0"W
53°20'0"W
48°16'30"N

SYMBOLS

- British Harbour volcanic rocks
- British Harbour dyke
- British Harbour pyroclastic rocks
- BrHr_pyr_dyke
- Bonaventure Head
- Bedding (tops known, unknown)
- Cleavage
- Anticline (arrows indicate plunge direction)
- Syncline (arrows indicate plunge direction)
- Fault (thrust)
- Fault (undefined)
- Contact
- Bedding form line

48°19'30"N
53°30'0"W
53°24'30"W
48°19'30"N
Old Bonaventure
Bonaventure Head
TRINITY BAY
British Harbour
N
48°14'0"N
53°24'30"W
48°14'0"N
Ireland's Eye Is.
SMITH SOUND
53°35'30"W
Random Island
53°30'0"W
53°35'30"W
0 2.5 5
km

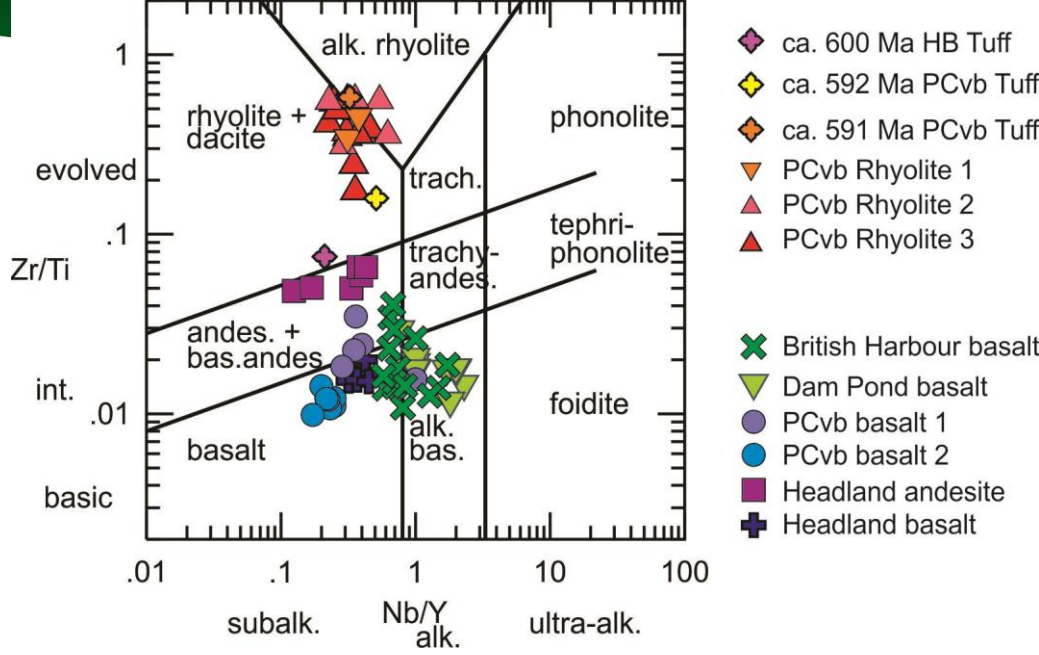
LEGEND

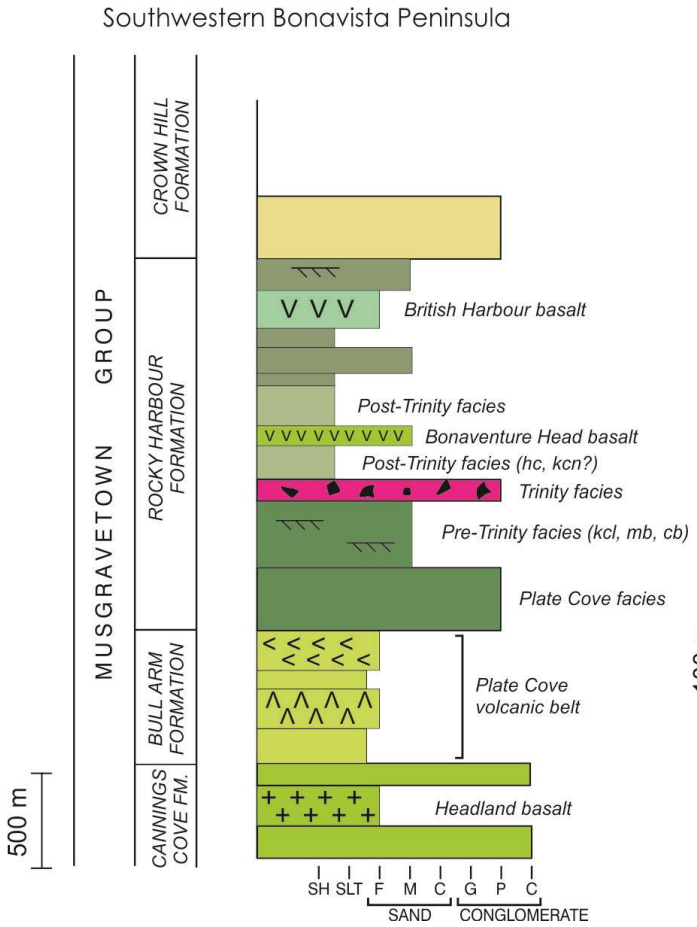
Neoproterozoic
Musgravetown Group

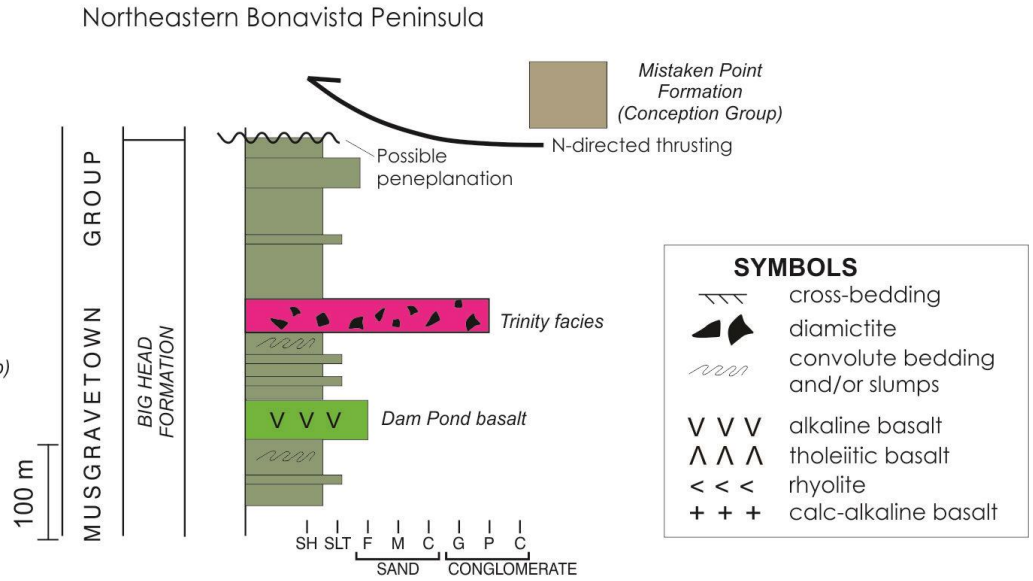
Crown Hill Formation
- Red conglomerate, sandstone, siltstone, minor grey siltstone, sandstone

Rocky Harbour Formation
- British Harbour volcanic unit; mafic pyroclastic rocks & flows
- Red & grey sandstone, minor siltstone
- Grey siltstone, fine-grained sandstone
- Mainly grey siltstone; a) scoriaceous basalt
- Trinity facies - glacial diamictite
- Mainly volcaniclastic conglomerate; minor siltstone, sandstone

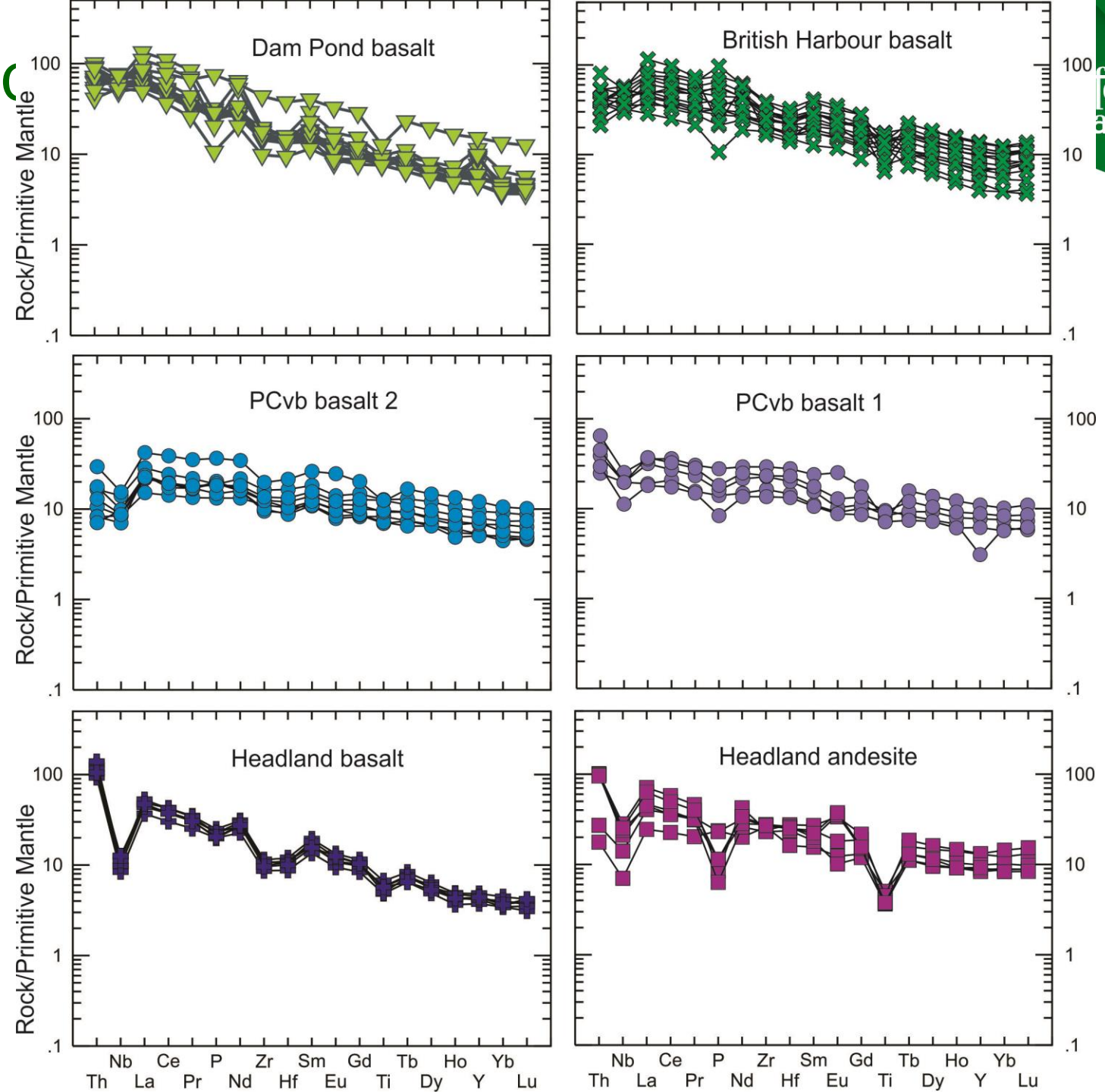
Geochemistry

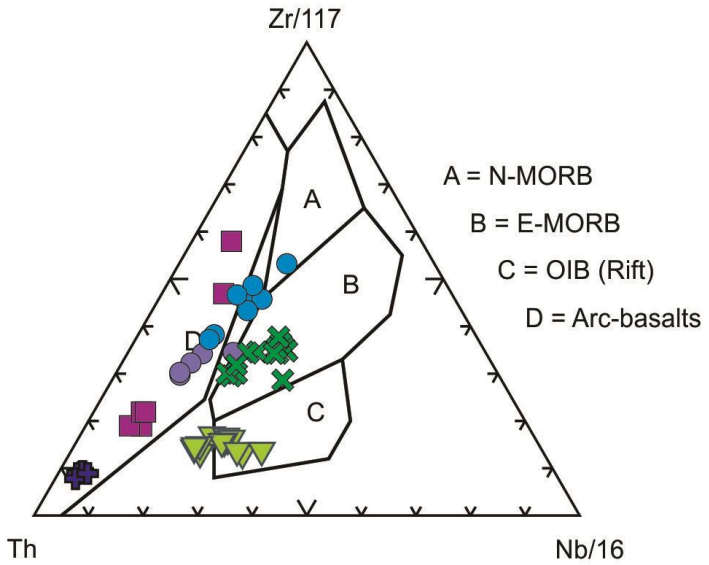


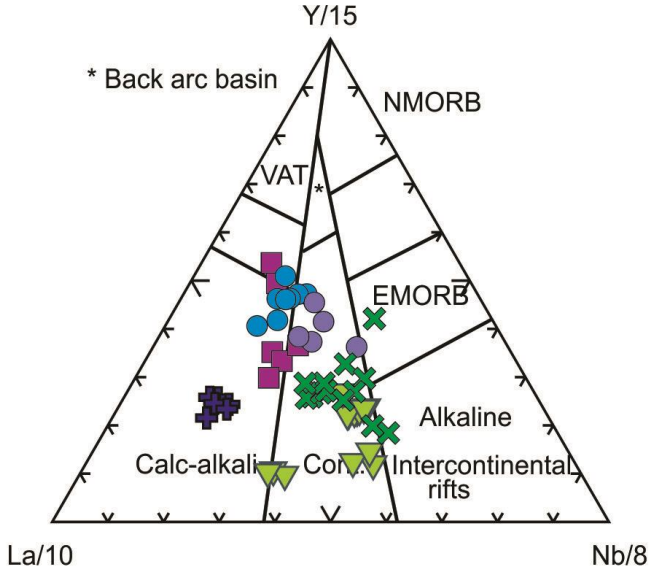


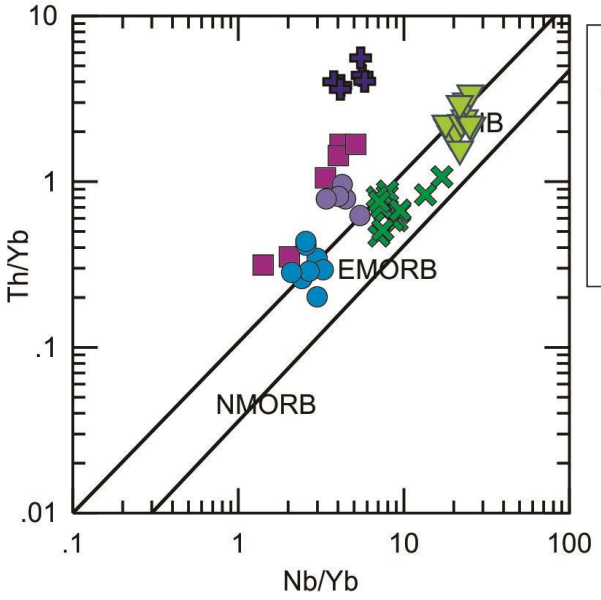


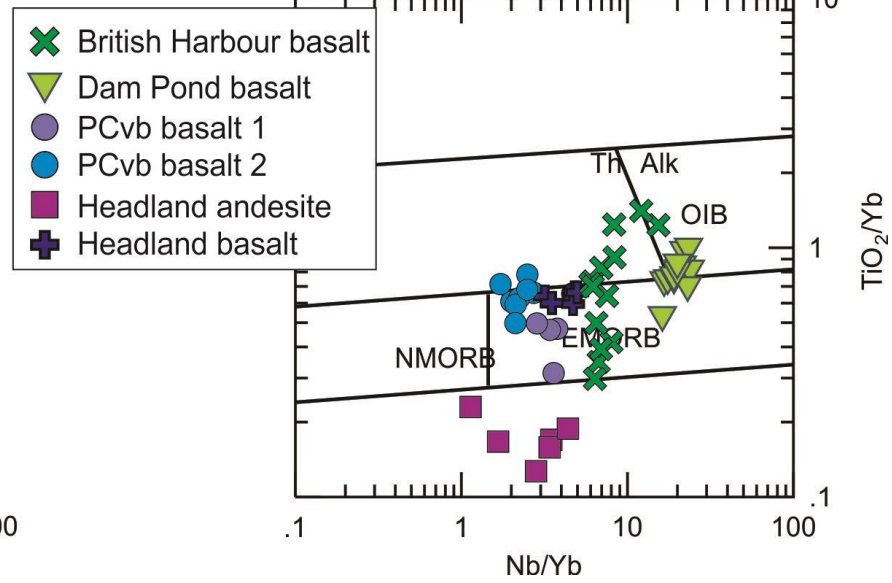
Geo

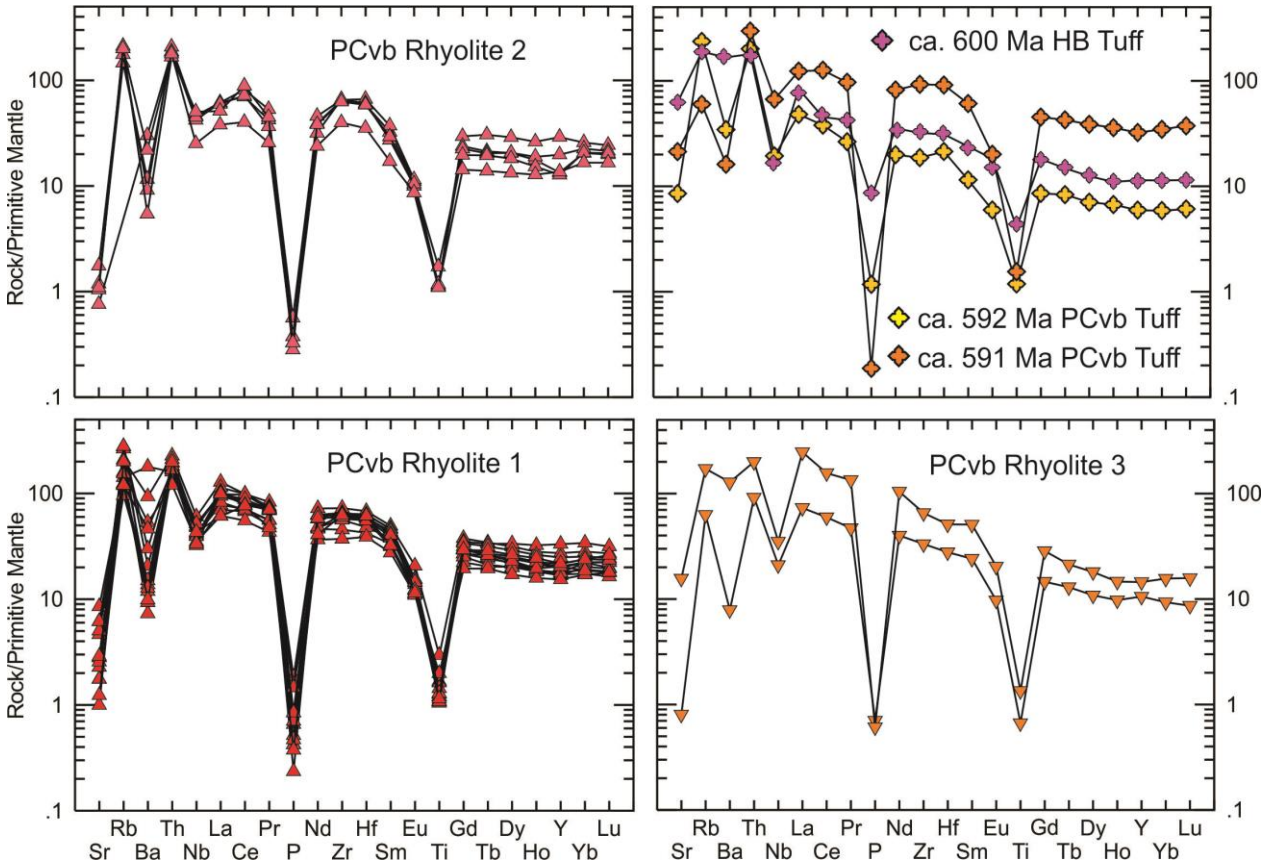

Dam Pond basalt
British Harbour basalt
PCvb basalt 2
PCvb basalt 1
Headland basalt
Headland andesite
Rock/Primitive Mantle
100
10
1
.1
Th Nb La Ce Pr P Nd Zr Hf Sm Eu Gd Ti Tb Dy Ho Y Yb Lu

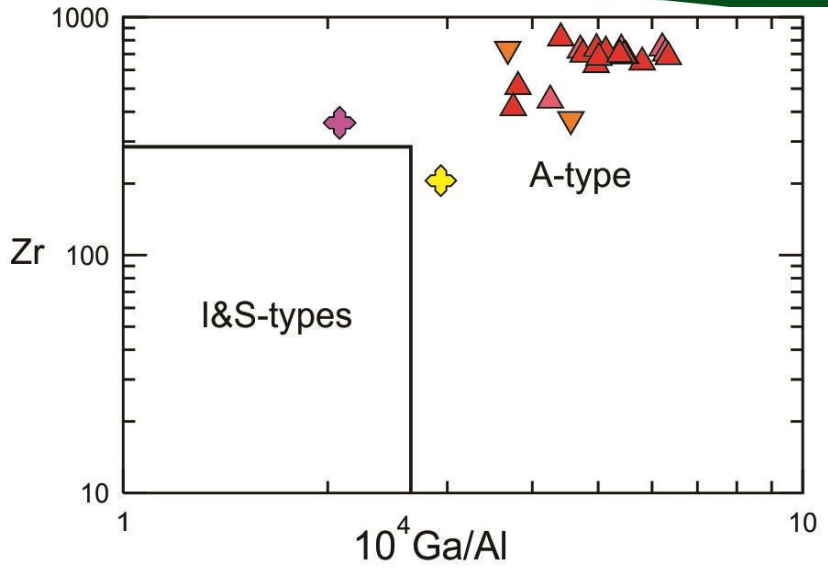

Zr/117
A = N-MORB
B = E-MORB
C = OIB (Rift)
D = Arc-basalts
A
B
C
D
Th
Nb/16

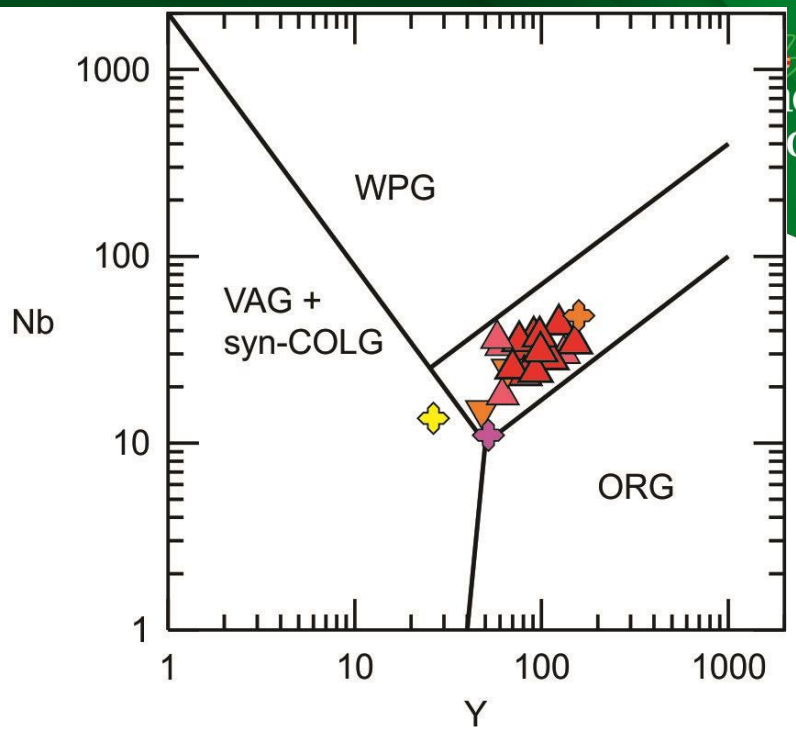

Y/15
* Back arc basin
NMORB
VAT
EMORB
Alkaline
Calc-alkali
Intercontinental rifts
La/10
Nb/8

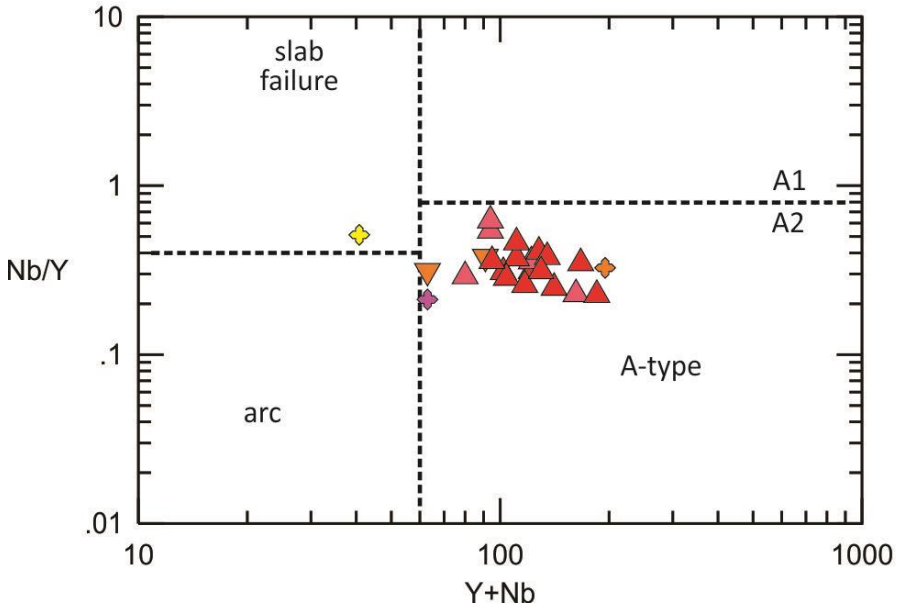

10
1
.1
.01
Th/Yb
EMORB
NMORB
.1
1
10
100
Nb/Yb


British Harbour basalt
Dam Pond basalt
PCvb basalt 1
PCvb basalt 2
Headland andesite
Headland basalt
Th
Alk
OIB
NMORB
10
1
.1
TiO_2/Yb
.1
1
10
100
Nb/Yb


PCvb Rhyolite 2
ca. 600 Ma HB Tuff
ca. 592 Ma PCvb Tuff
ca. 591 Ma PCvb Tuff
PCvb Rhyolite 1
PCvb Rhyolite 3
Rock/Primitive Mantle
100
10
1
.1
Rb Th La Pr Nd Hf Eu Gd Dy Y Lu
Sr Ba Nb Ce P Zr Sm Ti Tb Ho Yb



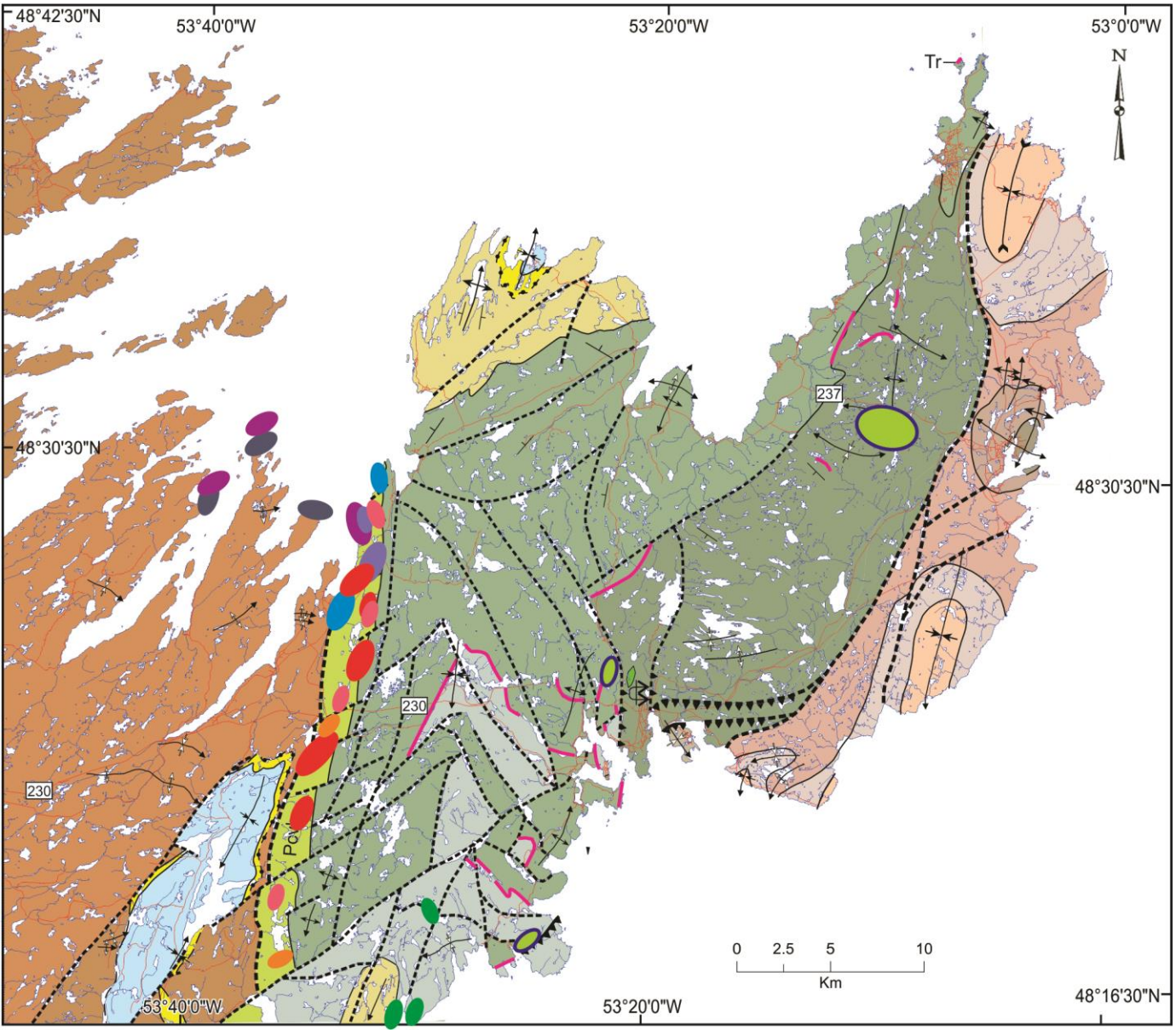




ca. 592 Ma PCvb Tuff
ca. 591 Ma PCvb Tuff
PCvb Rhyolite 3
PCvb Rhyolite 2
PCvb Rhyolite 1
ca. 600 Ma HB Tuff

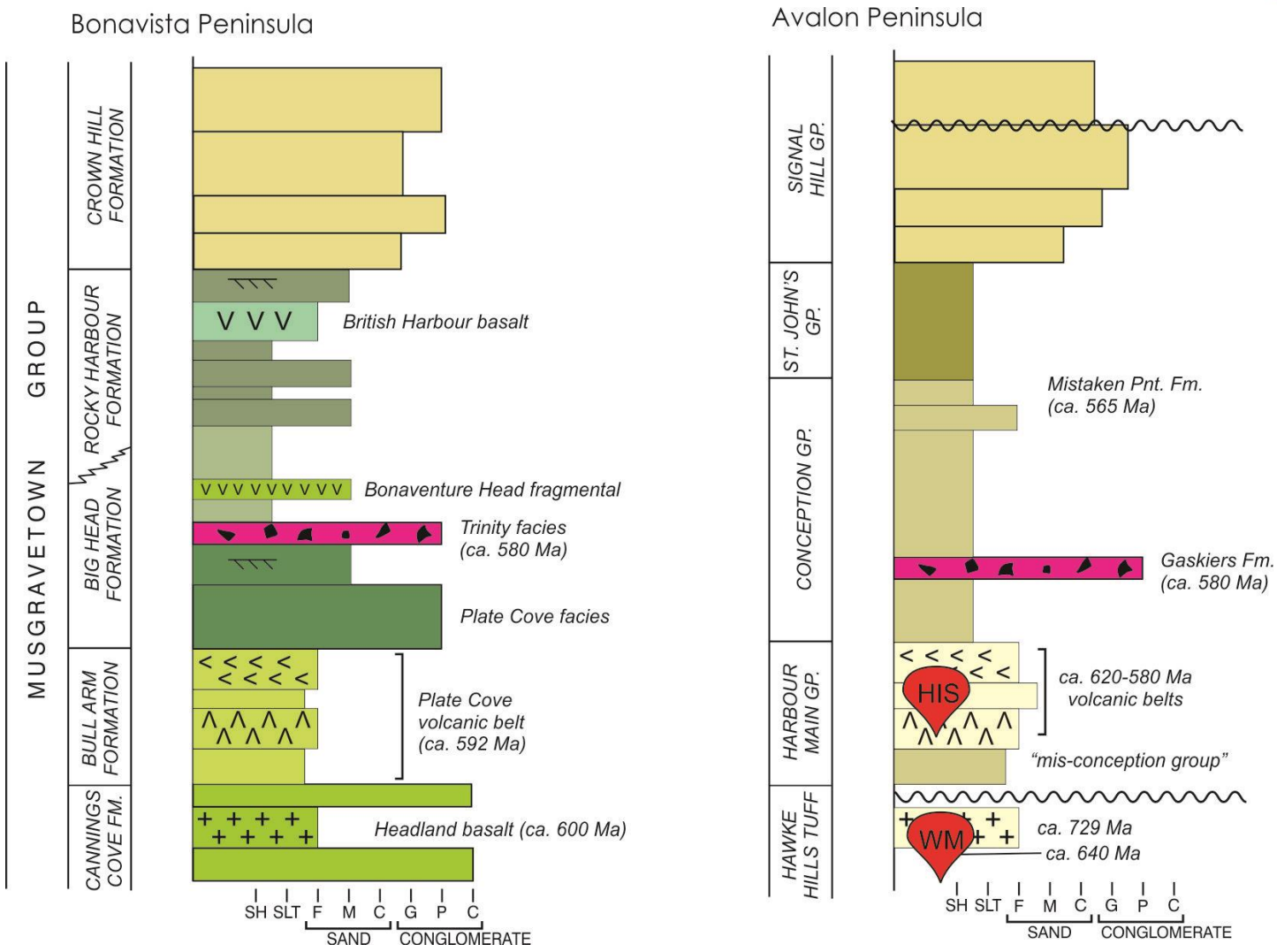
A2 (Eby 1992) Felsics of PCvb = melts of arc-type crust in an extensional setting

Conclusions



-Changing source
-Increased extension– continental tholeiites, including high-Ti Basalts, alkaline rhyolites.
-Pre-580 Ma – OIB-like Dam Pond basalts are extruded (link to onset of Gaskiers deglacial event?)
-Post-580 Ma – renewed, alkaline magmatism from a less-enriched EMORB-like source
-MG = extensional basin
-not correlative to SHG

Bonavista vs. Avalon Pens.



Possible correlations between MG and volcanic units of the Harbour Main Gp

Acknowledgements

- Zoe Goodyear, Jesse Wilson, Cameron Peddle and David Haynes, field assistance
- Colleagues at GSNL and MUN

References

Colman-Sadd et al. 1990

King 1988

Knight and O'Brien 1988

Myrow 1995

van Staal et al. 2020

Normore 2011

Pu et al. 2016

Mills et al. 2020

Eby 1992

Cabanis and Lecolle 1989

Pearce et al. 1984

Pearce 1996

Pearce 2008

Whalen et al. 1987

Whalen and Hildebrand 2019