IRON OXIDE-ALKALI ALTERATION WITHIN THE MORAN LAKE AREA OF LABRADOR: TIMING, GEOCHEMISTRY AND POTENTIAL REGIONAL ASSOCIATIONS

Greg Sparkes

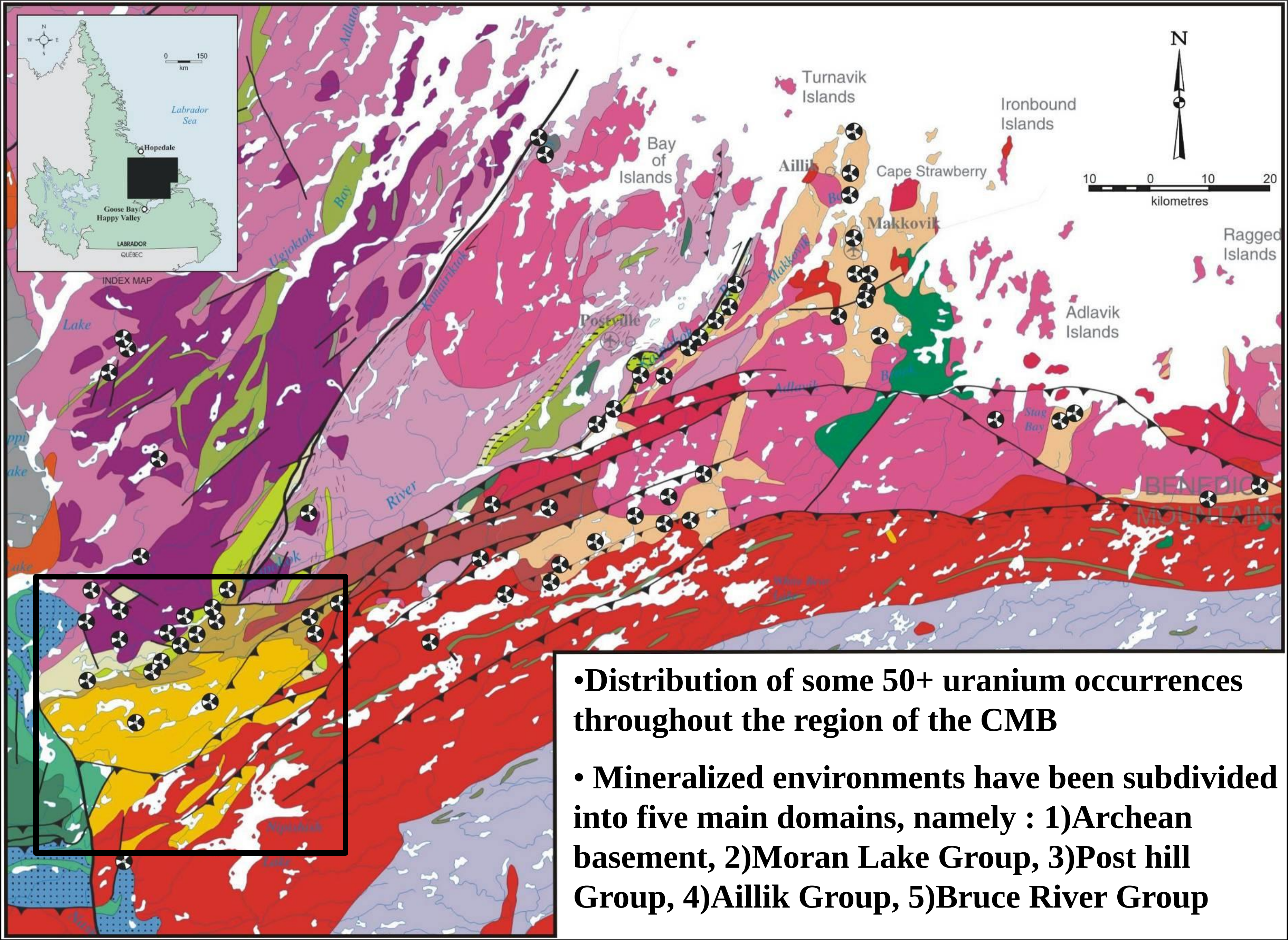
Mineral Deposits Section

Geological Survey of Newfoundland and Labrador

DEPOSIT MODELS:

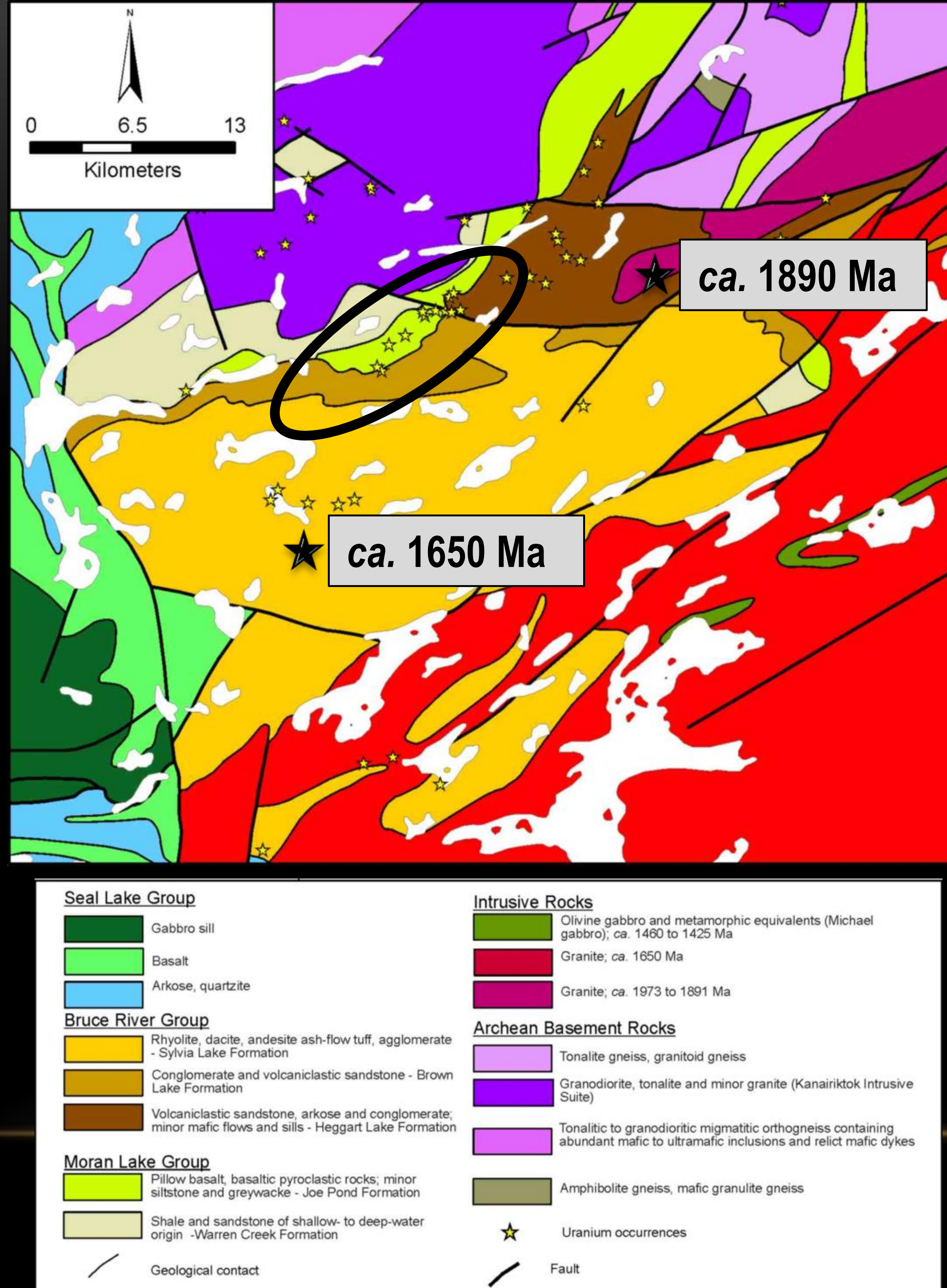
Iron Oxide-Alkali Altered (IOAA) Systems

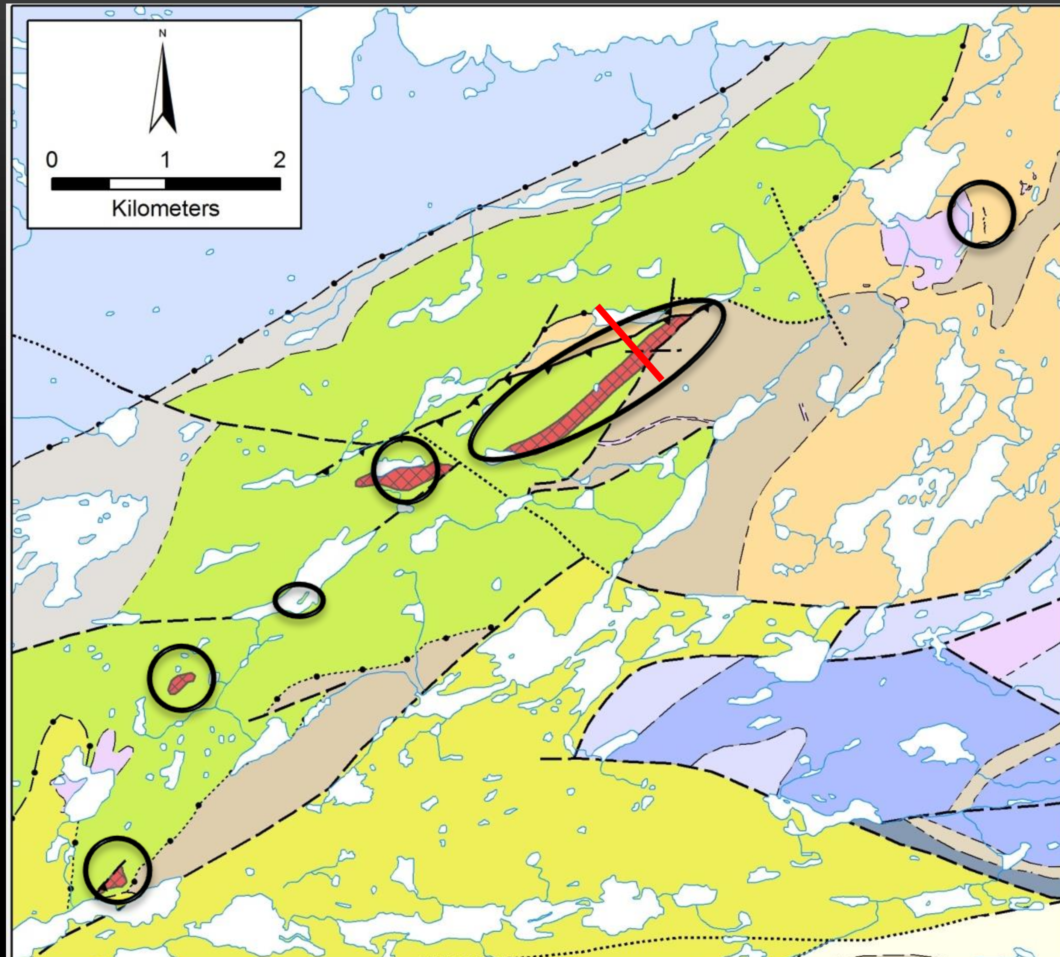
- **Iron Oxide-Copper-Gold Deposits**
- **Iron Oxide-Apatite Deposits**
- **Albitite–U Deposits**



•Distribution of some 50+ uranium occurrences throughout the region of the CMB

• Mineralized environments have been subdivided into five main domains, namely : 1)Archean basement, 2)Moran Lake Group, 3)Post hill Group, 4)Aillik Group, 5)Bruce River Group


N
0 6.5 13
Kilometers
ca. 1890 Ma
ca. 1650 Ma
Seal Lake Group
Gabbro sill
Basalt
Arkose, quartzite
Bruce River Group
Rhyolite, dacite, andesite ash-flow tuff, agglomerate - Sylvia Lake Formation
Conglomerate and volcaniclastic sandstone - Brown Lake Formation
Volcaniclastic sandstone, arkose and conglomerate; minor mafic flows and sills - Heggart Lake Formation
Moran Lake Group
Pillow basalt, basaltic pyroclastic rocks; minor siltstone and greywacke - Joe Pond Formation
Shale and sandstone of shallow- to deep-water origin -Warren Creek Formation
Geological contact
Intrusive Rocks
Olivine gabbro and metamorphic equivalents (Michael gabbro); ca. 1460 to 1425 Ma
Granite; ca. 1650 Ma
Granite; ca. 1973 to 1891 Ma
Archean Basement Rocks
Tonalite gneiss, granitoid gneiss
Granodiorite, tonalite and minor granite (Kanairiktok Intrusive Suite)
Tonalitic to granodioritic migmatitic orthogneiss containing abundant mafic to ultramafic inclusions and relict mafic dykes
Amphibolite gneiss, mafic granulite gneiss
Uranium occurrences
Fault



Legend

- Unconformity, defined
- Unconformity, approximate
- Unconformity, assumed
- Contact; defined
- Contact; approximate
- Contact; assumed
- Thrust, high angle, defined
- Thrust, high angle, approximate
- Fault, high angle, defined
- Fault, high angle, approximate
- Fault, high angle, assumed

- Hematitic breccia
- Mafic/Intermediate intrusive rocks

Bruce River Gp. - Sylvia Lake Fm.

- Plagioclase Porphyry
- Volcaniclastic mudstone, sandstone and conglomerate
- Trachyte and rhyolite flows and volcaniclastic sediments
- Undivided basalt, andesite and trachyandesite and volcaniclastic sediments
- Plagioclase-phyric andesite and tracyandesite
- Andesite and basalt

- Rhyolite

Bruce River Gp. - Brown Lake Fm.

- Volcaniclastic Sandstone

Bruce River Gp. - Heggart Lake Fm.

- Conglomerate
- Sandstone

Moran Lake Gp. - Joe Pond Fm.

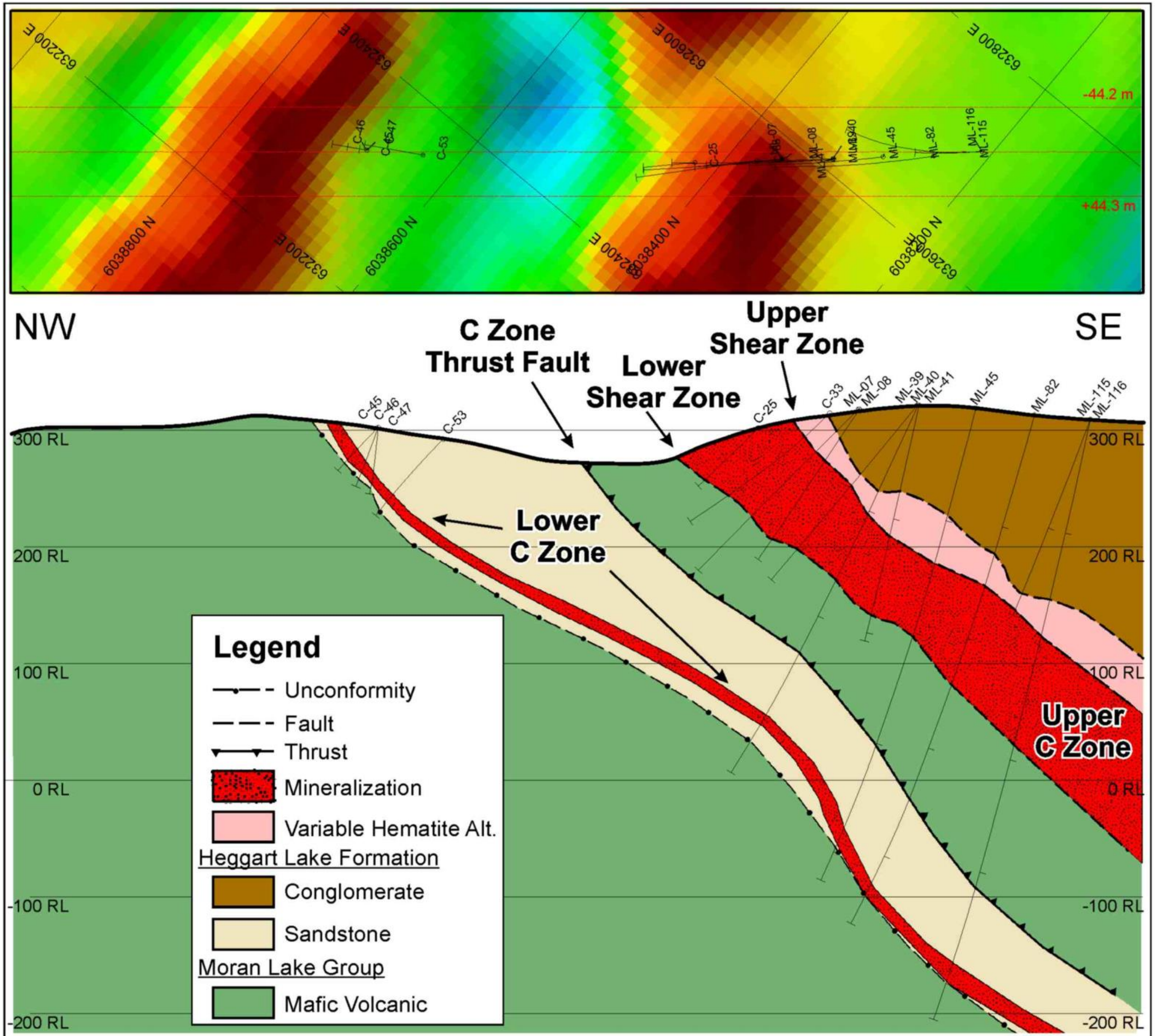
- Pillow Basalt

Moran Lake Gp. - Warren Creek Fm.

- Siltstone

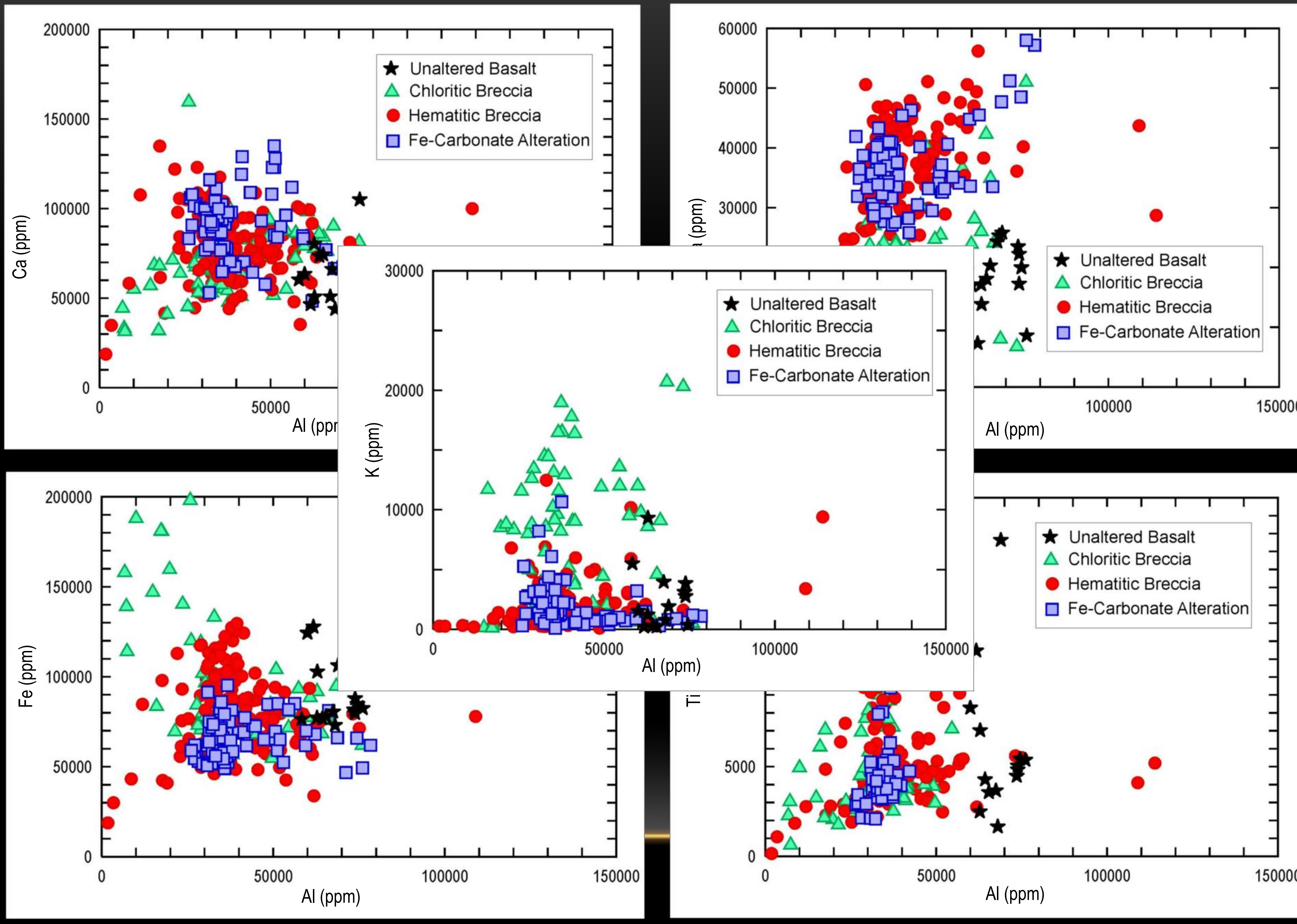
Kanairiktok Intrusive Suite

- Granite, granodiorite and tonalite

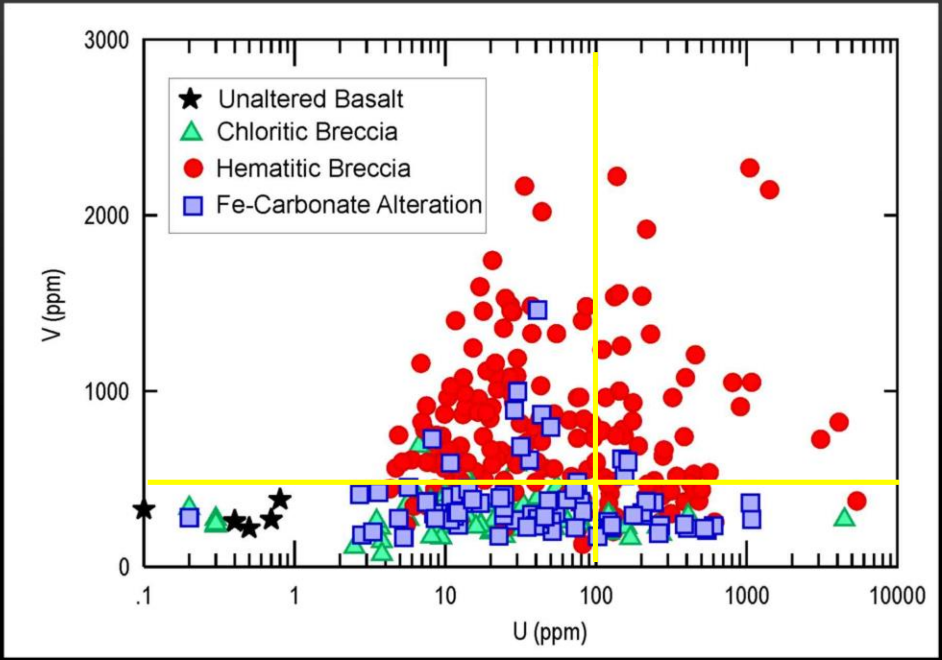


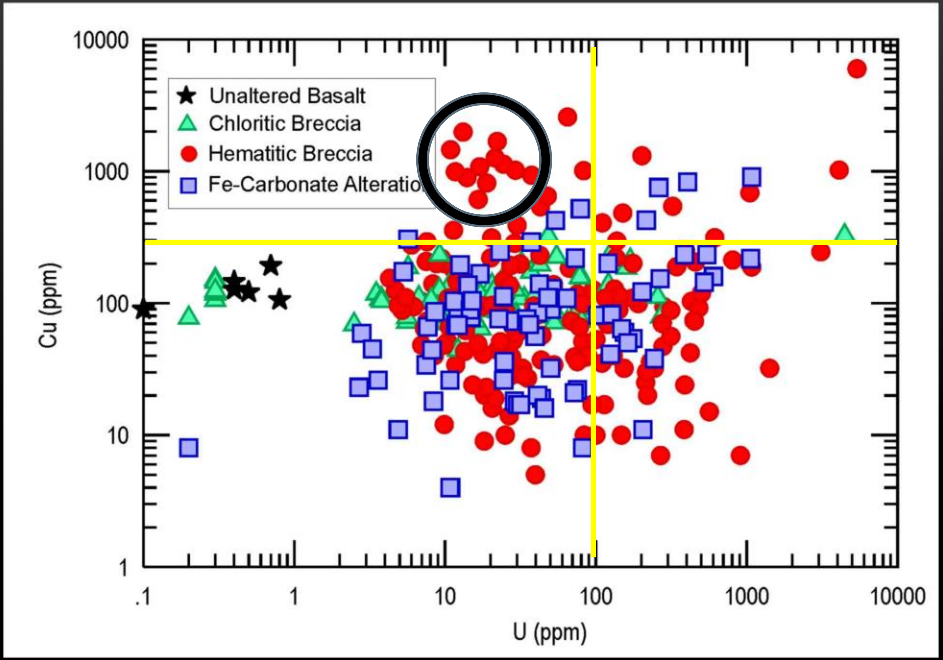
NW
SE
C Zone Thrust Fault
Lower Shear Zone
Upper Shear Zone
Lower C Zone
Upper C Zone
300 RL
200 RL
100 RL
0 RL
-100 RL
-200 RL
-44.2 m
+44.3 m
Legend
Unconformity
Fault
Thrust
Mineralization
Variable Hematite Alt.
Heggart Lake Formation
Conglomerate
Sandstone
Moran Lake Group
Mafic Volcanic

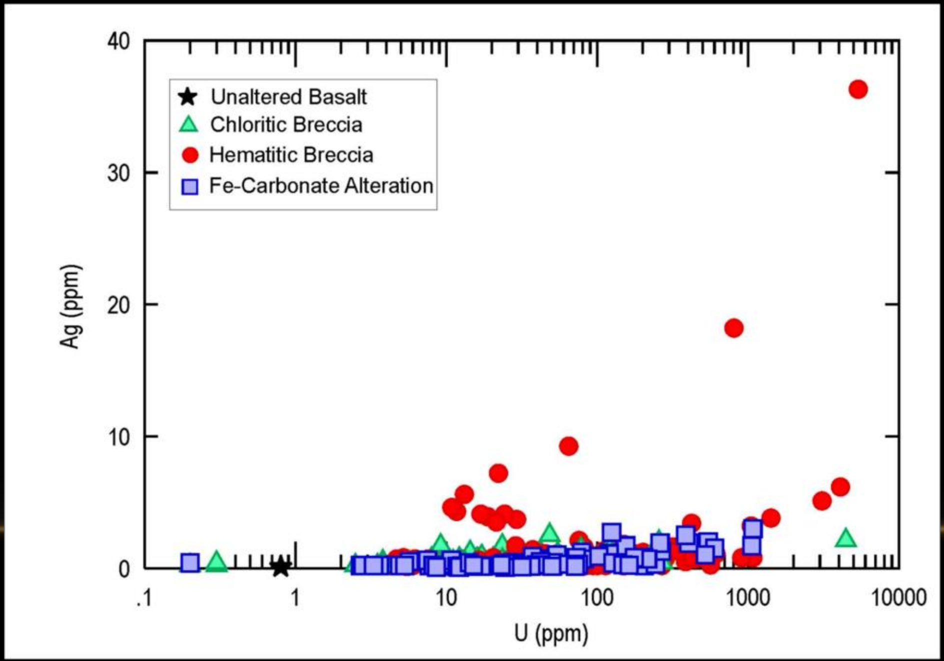

15
GS-07-207
0 1 2 3
CENT
4/0

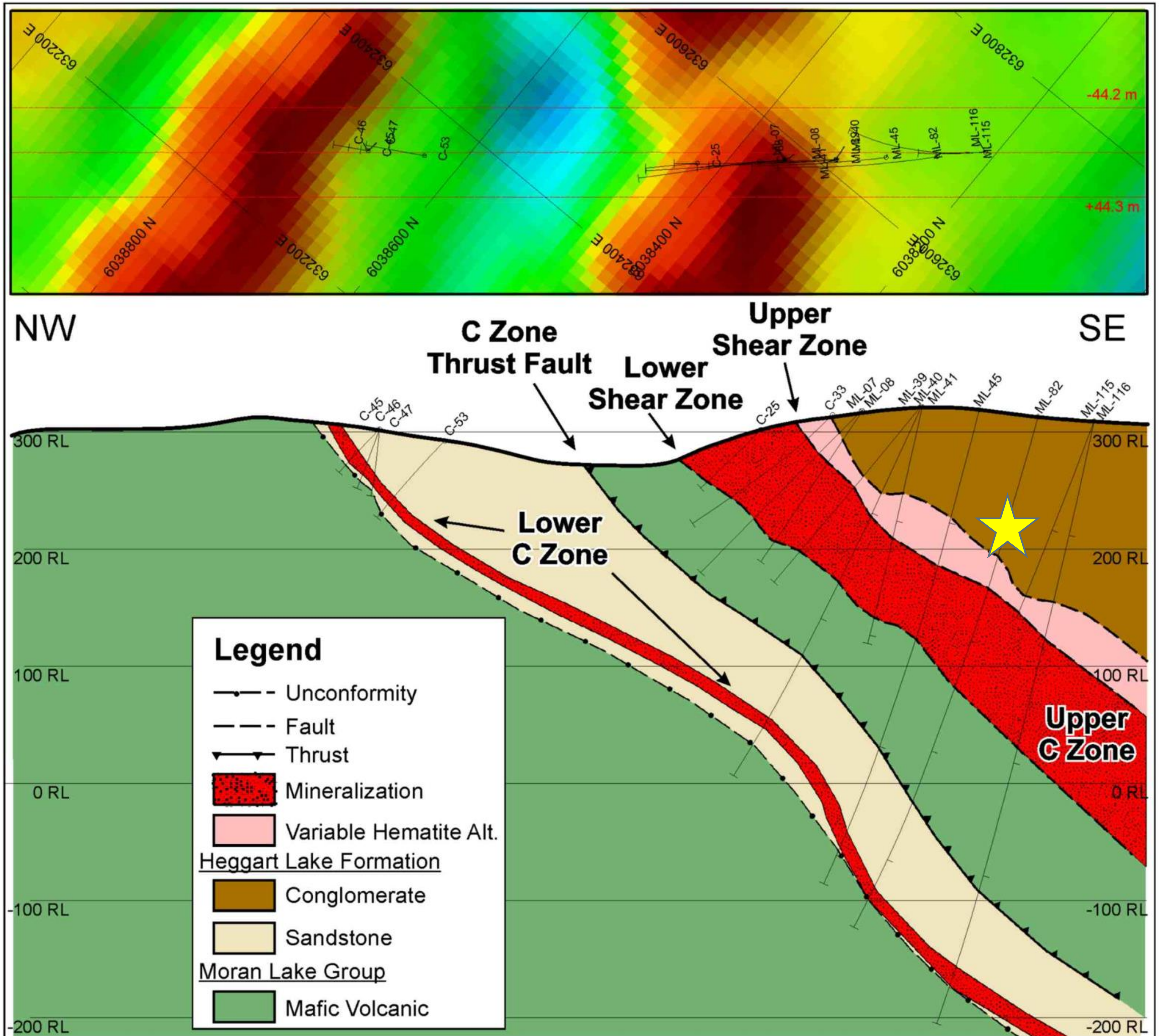


Unaltered Basalt
Chloritic Breccia
Hematitic Breccia
Fe-Carbonate Alteration
Ca (ppm)
Fe (ppm)
K (ppm)
Al (ppm)
0
50000
100000
150000
200000
10000
20000
30000
40000
50000
60000
5000


Unaltered Basalt
Chloritic Breccia
Hematitic Breccia
Fe-Carbonate Alteration
V (ppm)
U (ppm)
3000
2000
1000
0
.1
1
10
100
1000
10000

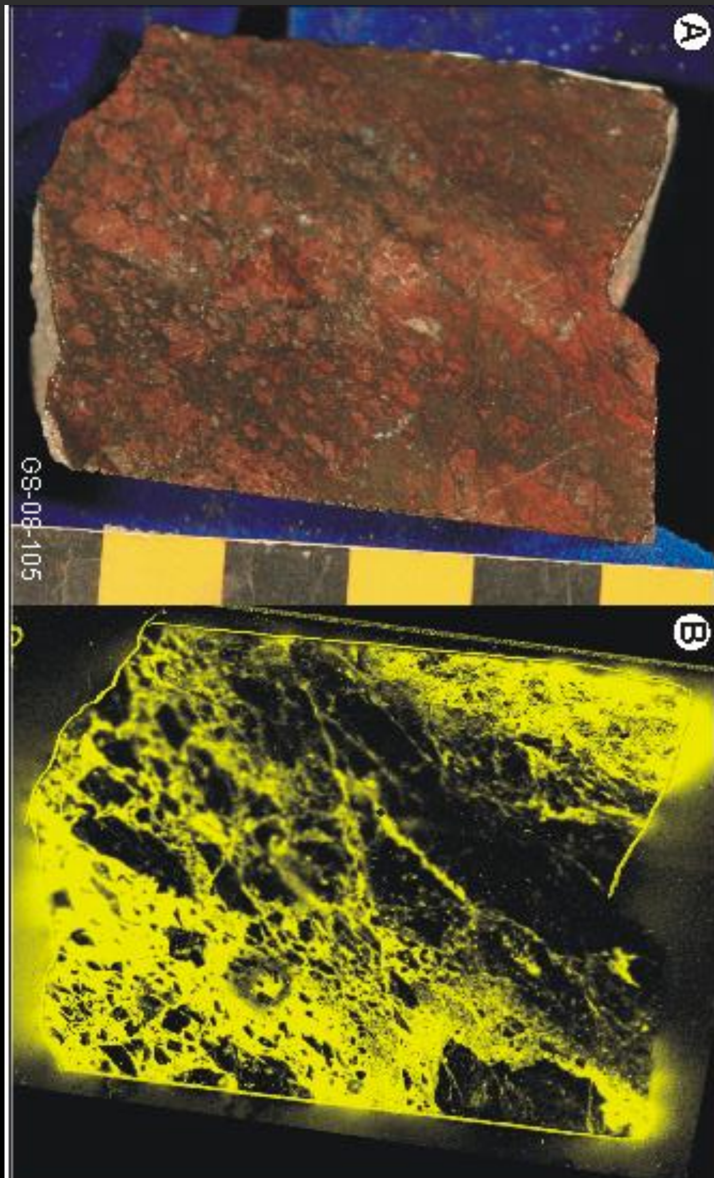

Unaltered Basalt
Chloritic Breccia
Hematitic Breccia
Fe-Carbonate Alteratio
Cu (ppm)
U (ppm)
10000
1000
100
10
1
.1
1
10
100
1000
10000

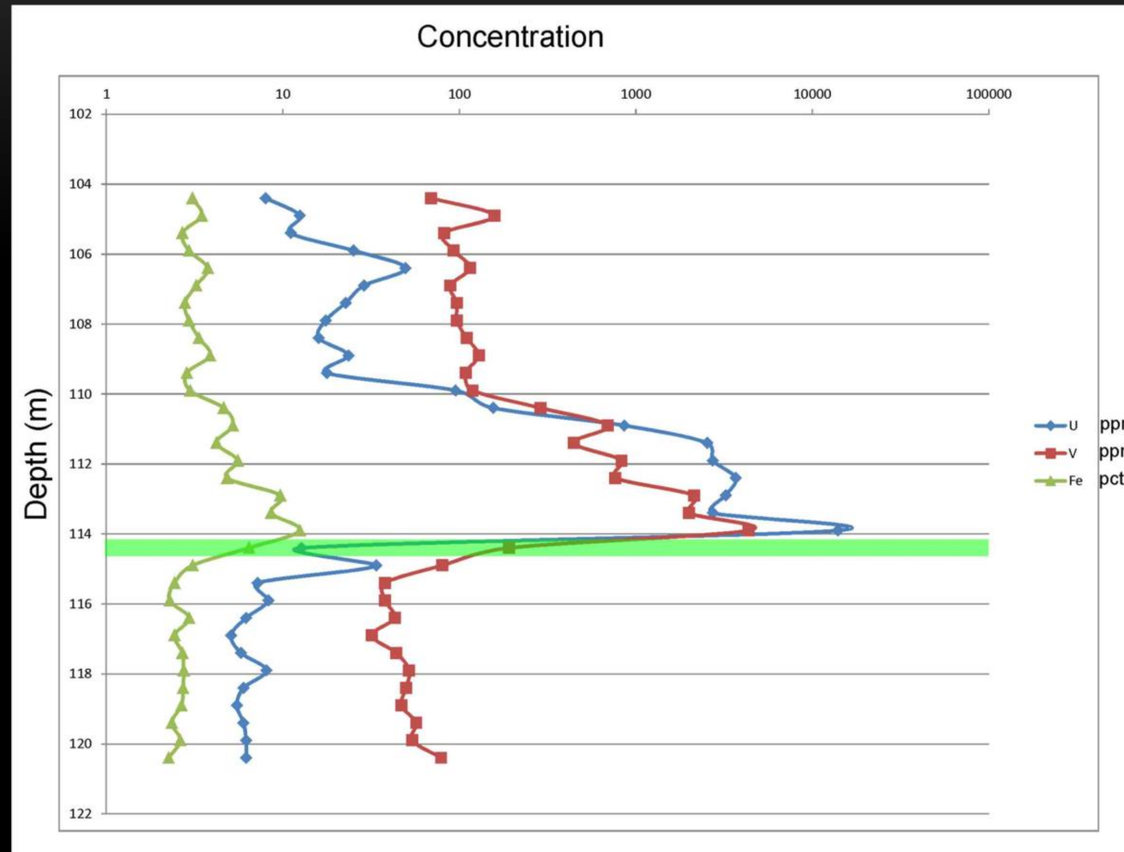

Unaltered Basalt
Chloritic Breccia
Hematitic Breccia
Fe-Carbonate Alteration
Ag (ppm)
U (ppm)
40
30
20
10
0
.1
1
10
100
1000
10000

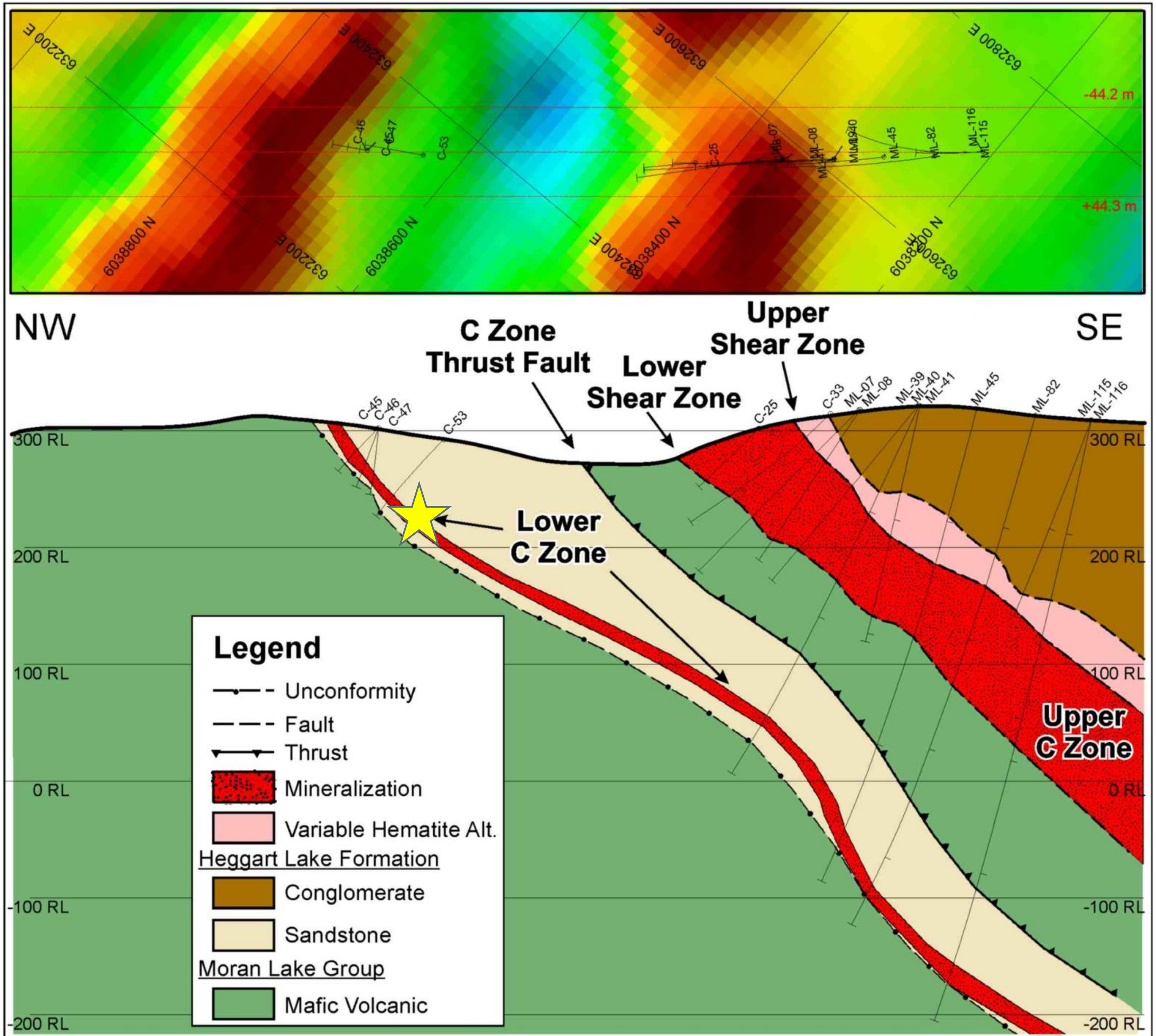


NW
SE
C Zone
Thrust Fault
Lower
Shear Zone
Upper
Shear Zone
Lower
C Zone
Upper
C Zone
300 RL
200 RL
100 RL
0 RL
-100 RL
-200 RL
-44.2 m
+44.3 m
632200 E
632400 E
632600 E
632800 E
6038800 N
6038600 N
6038400 N
C-45
C-46
C-47
C-53
C-25
C-33
ML-07
ML-08
ML-39
ML-40
ML-41
ML-45
ML-82
ML-115
ML-116
Legend
Unconformity
Fault
Thrust
Mineralization
Variable Hematite Alt.
Heggart Lake Formation
Conglomerate
Sandstone
Moran Lake Group
Mafic Volcanic

Box 25
ML-82
30796
30797
30798
30801
30802
30803
30804
30805
30806
108.29
Box 26
ML-82
30807
30808
30809
30810
30811
30812
30813
30814
112.37
Box 27
ML-82
30815
30816
30817
30818
30819
30821
30822
30823
116.61
Box 28
ML-82
30824
30825
30826
30827
30828
30829
30830
30831
30832
120.77

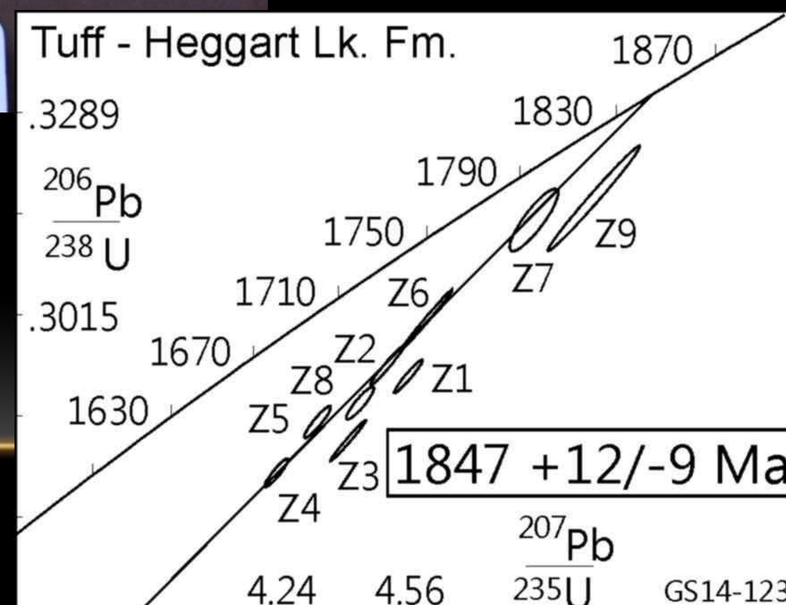

A
B
GS-08-105

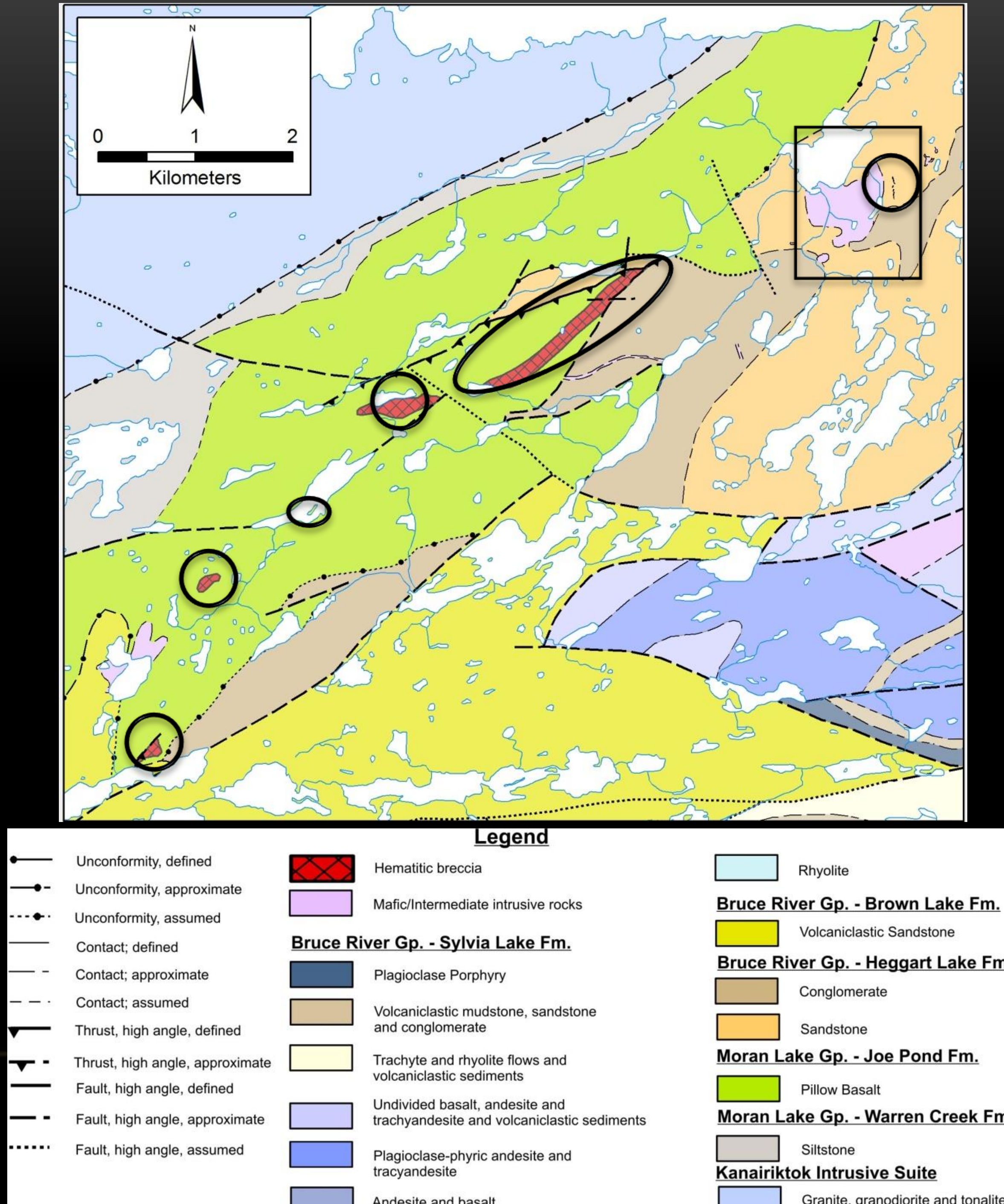

Concentration
1
10
100
1000
10000
100000
102
104
106
108
110
112
114
116
118
120
122
Depth (m)
U ppm
V ppm
Fe pct

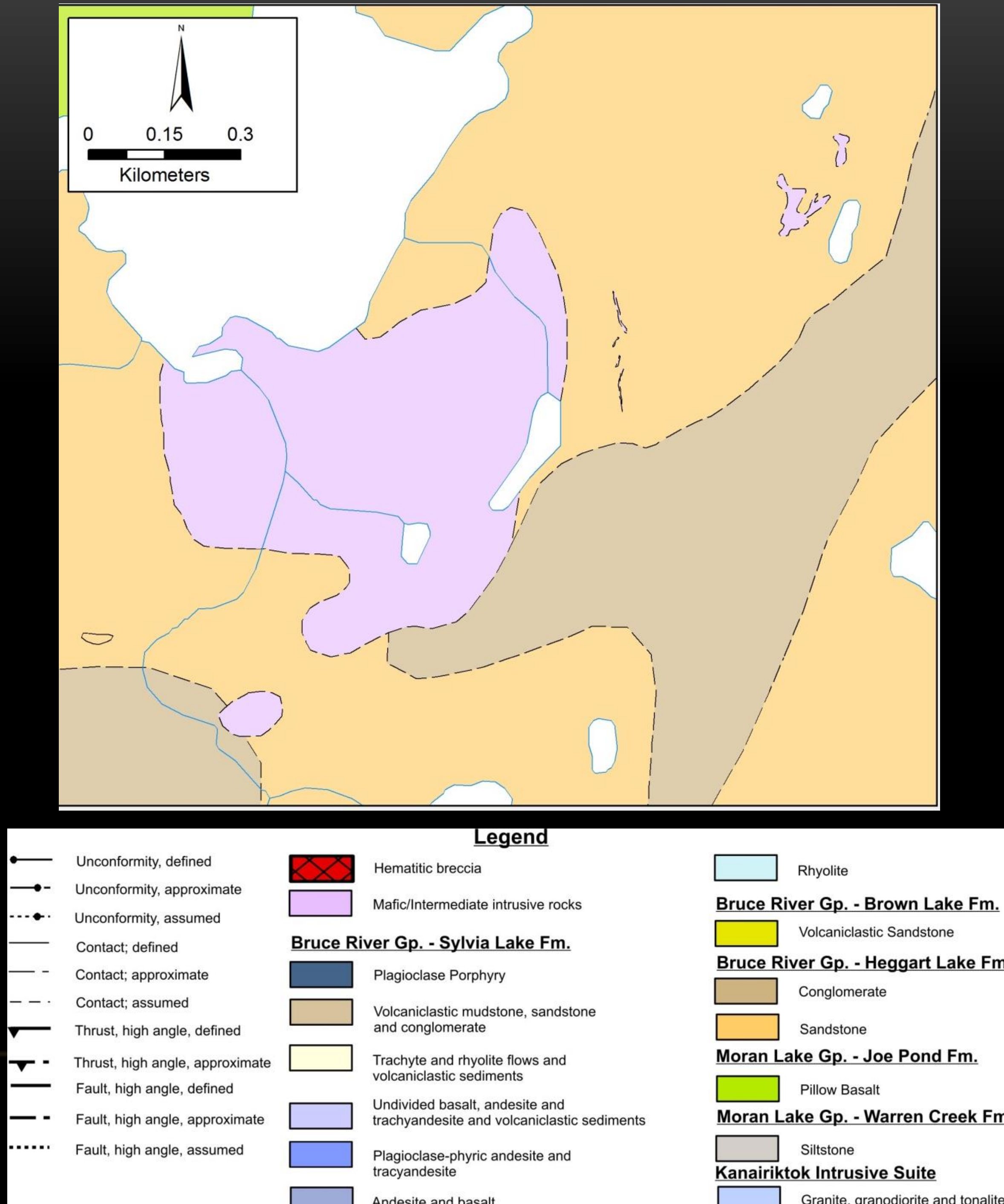


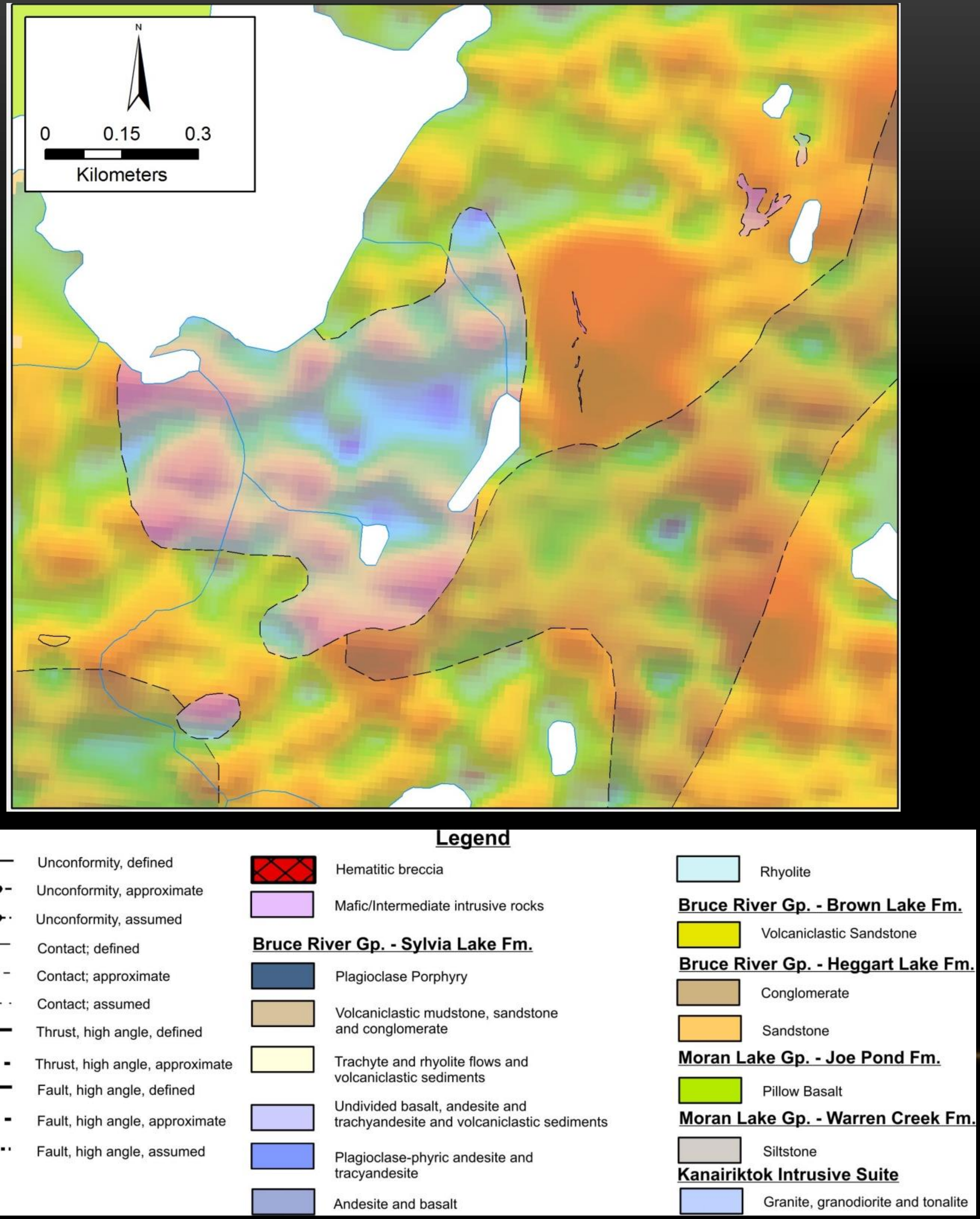
632200 E
632400 E
632600 E
632800 E
-44.2 m
+44.3 m
6038800 N
6038600 N
6038400 N
NW
SE
C Zone
Thrust Fault
Lower
Shear Zone
Upper
Shear Zone
C-45
C-46
C-47
C-53
C-25
C-33
ML-07
ML-08
ML-39
ML-40
ML-41
ML-45
ML-82
ML-115
ML-116
300 RL
200 RL
100 RL
0 RL
-100 RL
-200 RL
Lower
C Zone
Upper
C Zone
Legend
Unconformity
Fault
Thrust
Mineralization
Variable Hematite Alt.
Heggart Lake Formation
Conglomerate
Sandstone
Moran Lake Group
Mafic Volcanic

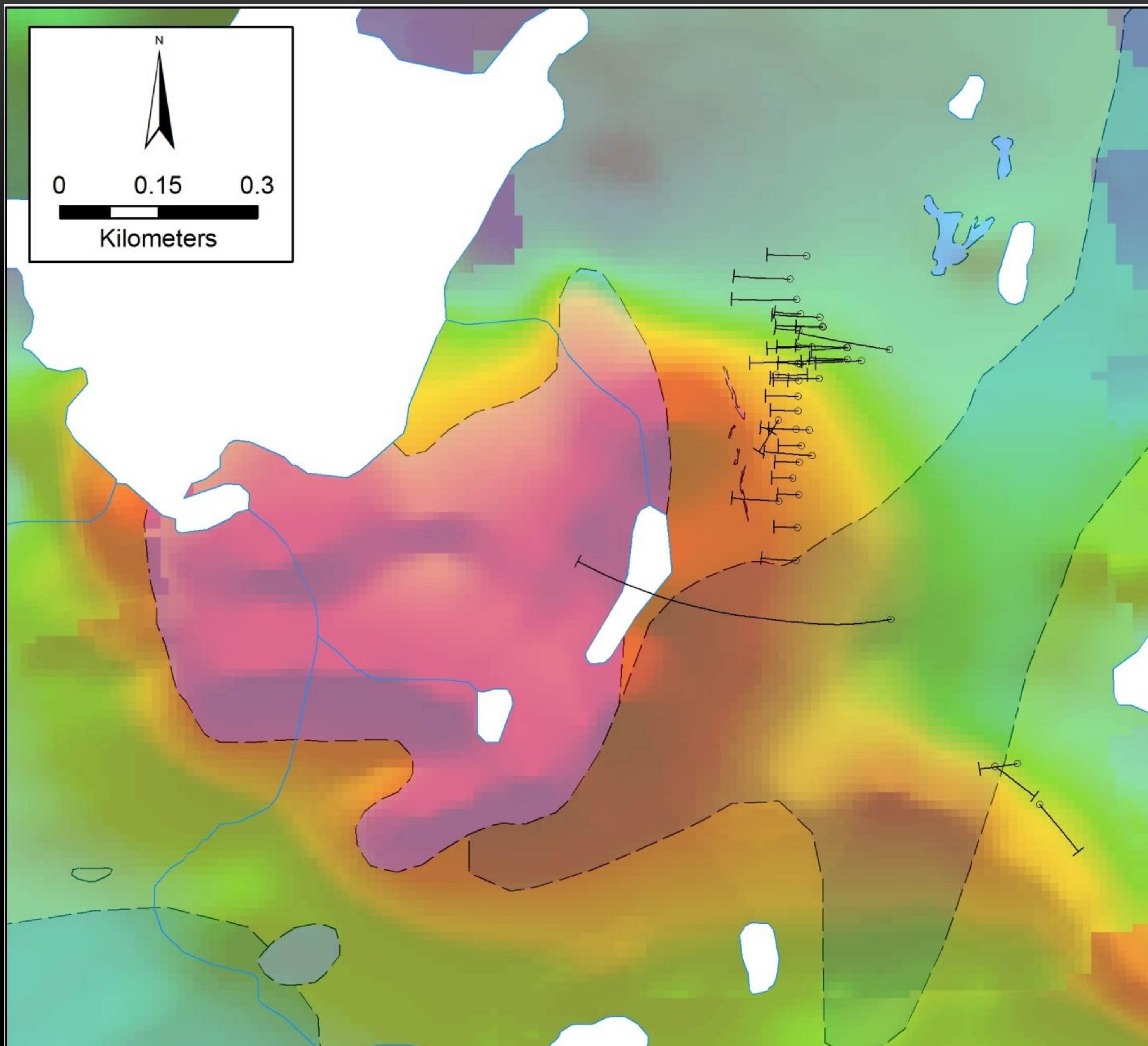

1256
0
1
2
3
4
5
6
7
8
CENTIMETRES

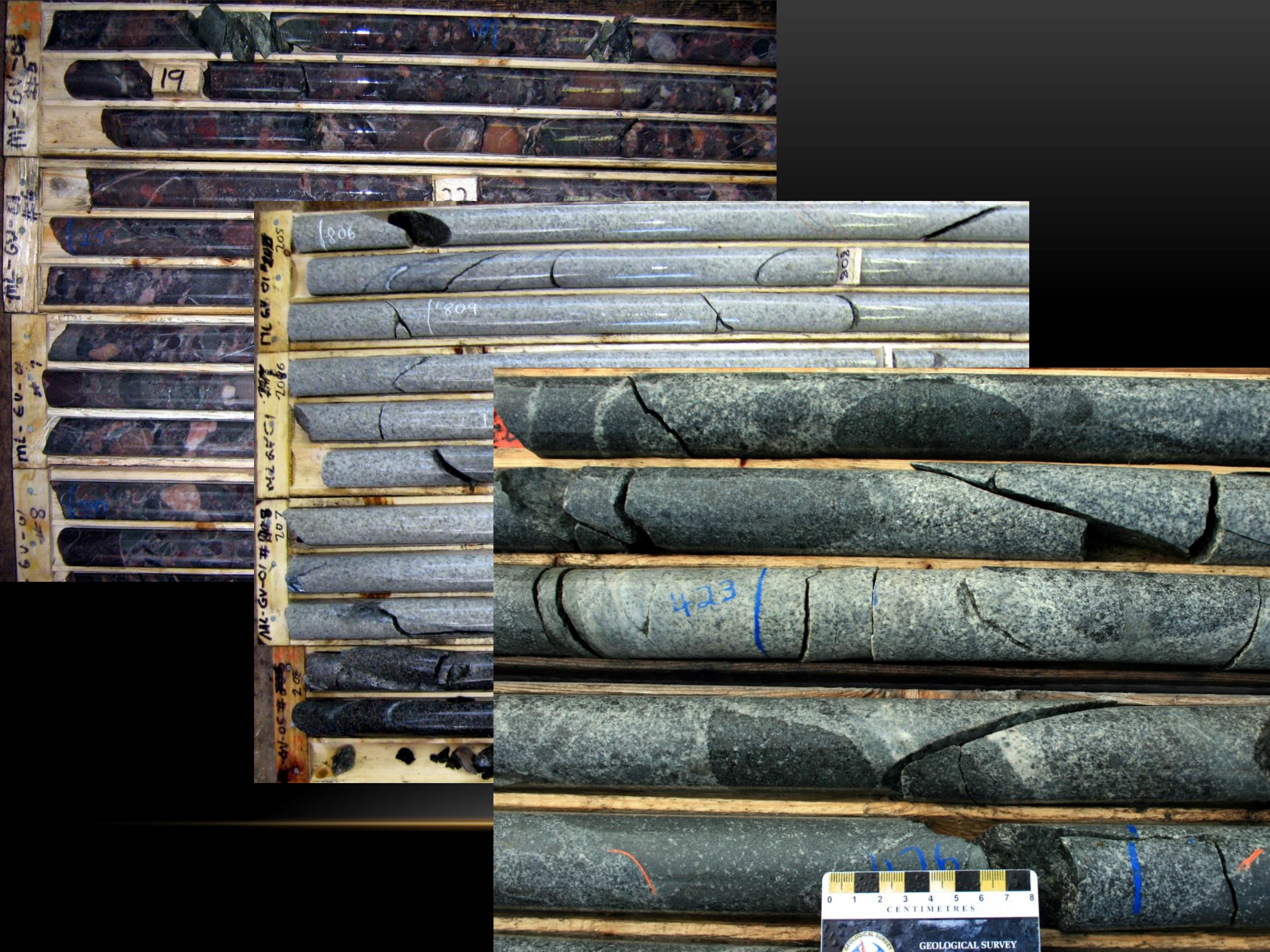

Tuff - Heggart Lk. Fm.
1870
1830
1790
1750
1710
1670
1630
.3289
.3015
206Pb/238U
Z9
Z7
Z6
Z2
Z8
Z1
Z5
Z3
Z4
1847 +12/-9 Ma
207Pb/235U
4.24
4.56
GS14-123

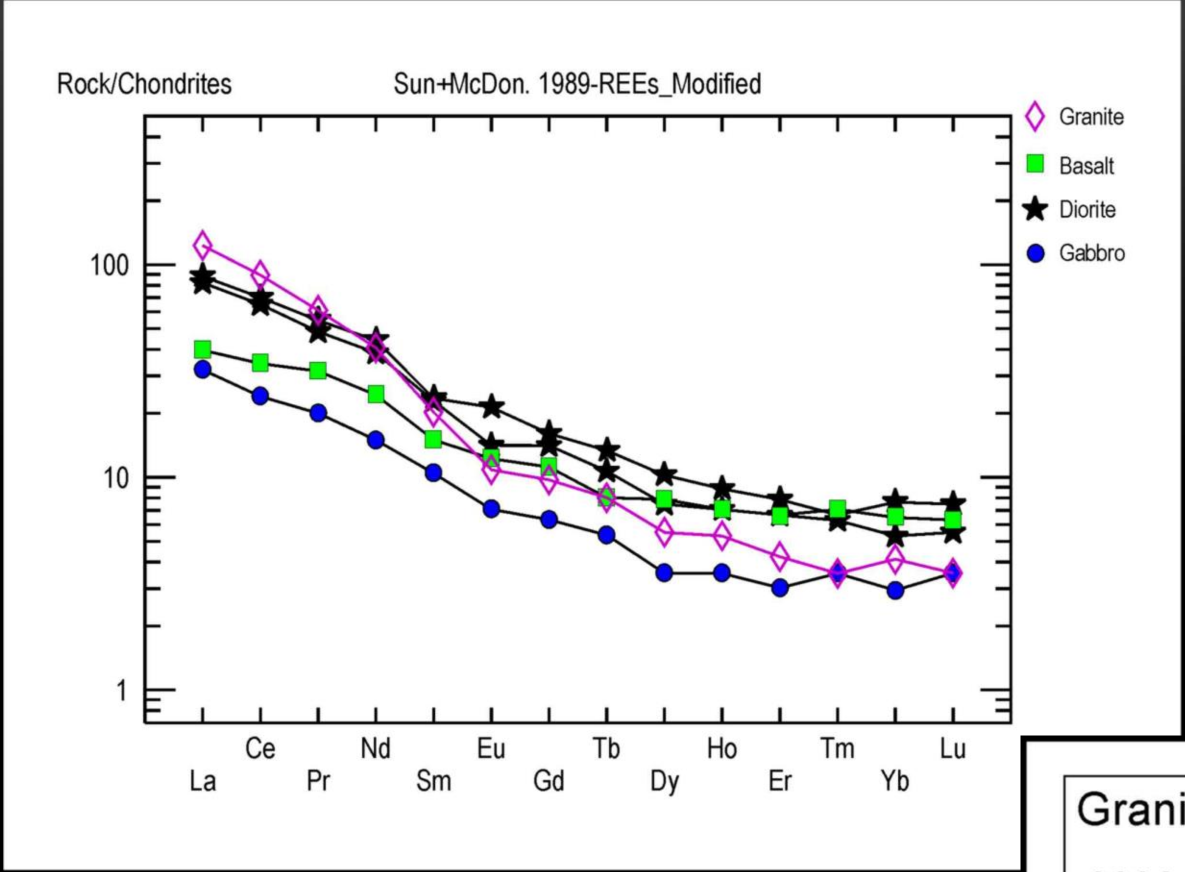

N
0
1
2
Kilometers
Legend
Unconformity, defined
Unconformity, approximate
Unconformity, assumed
Contact; defined
Contact; approximate
Contact; assumed
Thrust, high angle, defined
Thrust, high angle, approximate
Fault, high angle, defined
Fault, high angle, approximate
Fault, high angle, assumed
Hematitic breccia
Mafic/Intermediate intrusive rocks
Bruce River Gp. - Sylvia Lake Fm.
Plagioclase Porphyry
Volcaniclastic mudstone, sandstone and conglomerate
Trachyte and rhyolite flows and volcaniclastic sediments
Undivided basalt, andesite and trachyandesite and volcaniclastic sediments
Plagioclase-phyric andesite and tracyandesite
Andesite and basalt
Rhyolite
Bruce River Gp. - Brown Lake Fm.
Volcaniclastic Sandstone
Bruce River Gp. - Heggart Lake Fm.
Conglomerate
Sandstone
Moran Lake Gp. - Joe Pond Fm.
Pillow Basalt
Moran Lake Gp. - Warren Creek Fm.
Siltstone
Kanairiktok Intrusive Suite
Granite, granodiorite and tonalite


N
0
0.15
0.3
Kilometers
Legend
Unconformity, defined
Unconformity, approximate
Unconformity, assumed
Contact; defined
Contact; approximate
Contact; assumed
Thrust, high angle, defined
Thrust, high angle, approximate
Fault, high angle, defined
Fault, high angle, approximate
Fault, high angle, assumed
Hematitic breccia
Mafic/Intermediate intrusive rocks
Bruce River Gp. - Sylvia Lake Fm.
Plagioclase Porphyry
Volcaniclastic mudstone, sandstone and conglomerate
Trachyte and rhyolite flows and volcaniclastic sediments
Undivided basalt, andesite and trachyandesite and volcaniclastic sediments
Plagioclase-phyric andesite and tracyandesite
Andesite and basalt
Rhyolite
Bruce River Gp. - Brown Lake Fm.
Volcaniclastic Sandstone
Bruce River Gp. - Heggart Lake Fm.
Conglomerate
Sandstone
Moran Lake Gp. - Joe Pond Fm.
Pillow Basalt
Moran Lake Gp. - Warren Creek Fm.
Siltstone
Kanairiktok Intrusive Suite
Granite, granodiorite and tonalite

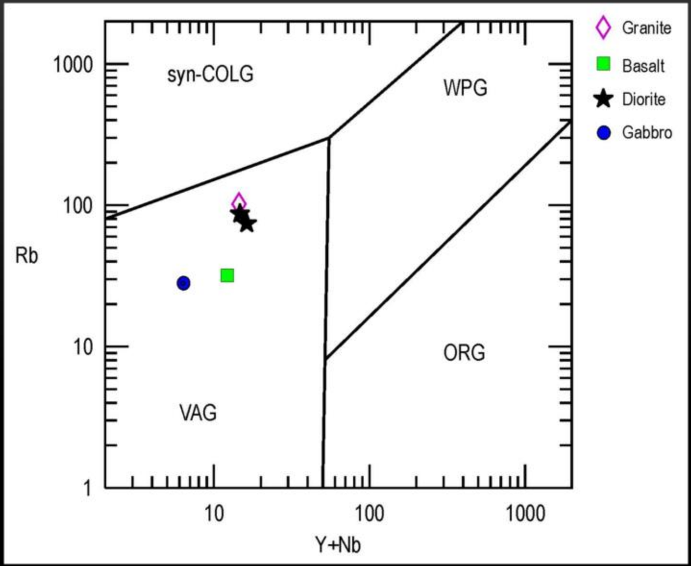

N
0
0.15
0.3
Kilometers
Legend
Unconformity, defined
Unconformity, approximate
Unconformity, assumed
Contact; defined
Contact; approximate
Contact; assumed
Thrust, high angle, defined
Thrust, high angle, approximate
Fault, high angle, defined
Fault, high angle, approximate
Fault, high angle, assumed
Hematitic breccia
Mafic/Intermediate intrusive rocks
Bruce River Gp. - Sylvia Lake Fm.
Plagioclase Porphyry
Volcaniclastic mudstone, sandstone and conglomerate
Trachyte and rhyolite flows and volcaniclastic sediments
Undivided basalt, andesite and trachyandesite and volcaniclastic sediments
Plagioclase-phyric andesite and tracyandesite
Andesite and basalt
Rhyolite
Bruce River Gp. - Brown Lake Fm.
Volcaniclastic Sandstone
Bruce River Gp. - Heggart Lake Fm.
Conglomerate
Sandstone
Moran Lake Gp. - Joe Pond Fm.
Pillow Basalt
Moran Lake Gp. - Warren Creek Fm.
Siltstone
Kanairiktok Intrusive Suite
Granite, granodiorite and tonalite


N
0
0.15
0.3
Kilometers

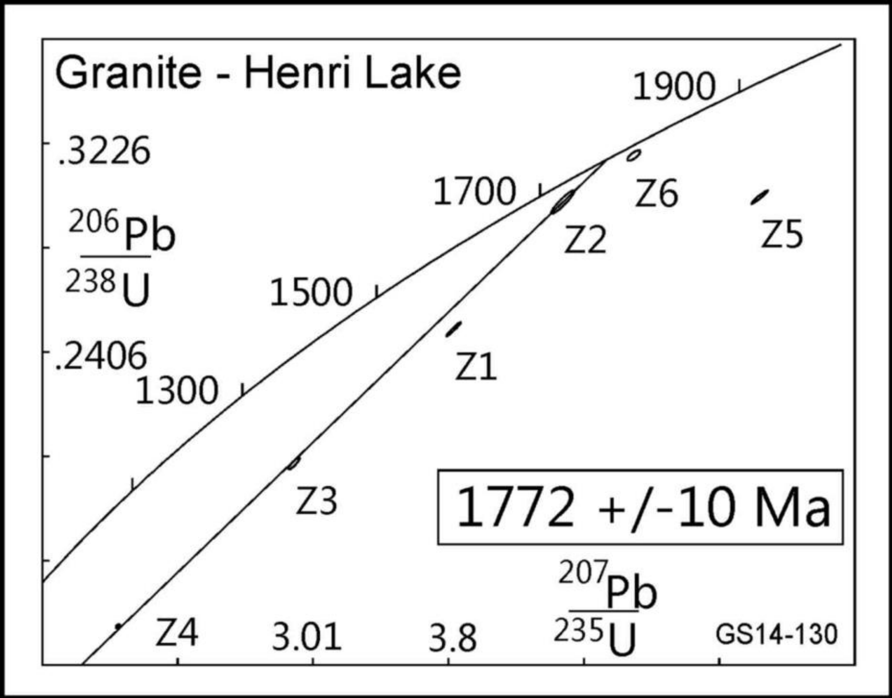

19
806
808
809
423
0 1 2 3 4 5 6 7 8
CENTIMETRES
GEOLOGICAL SURVEY



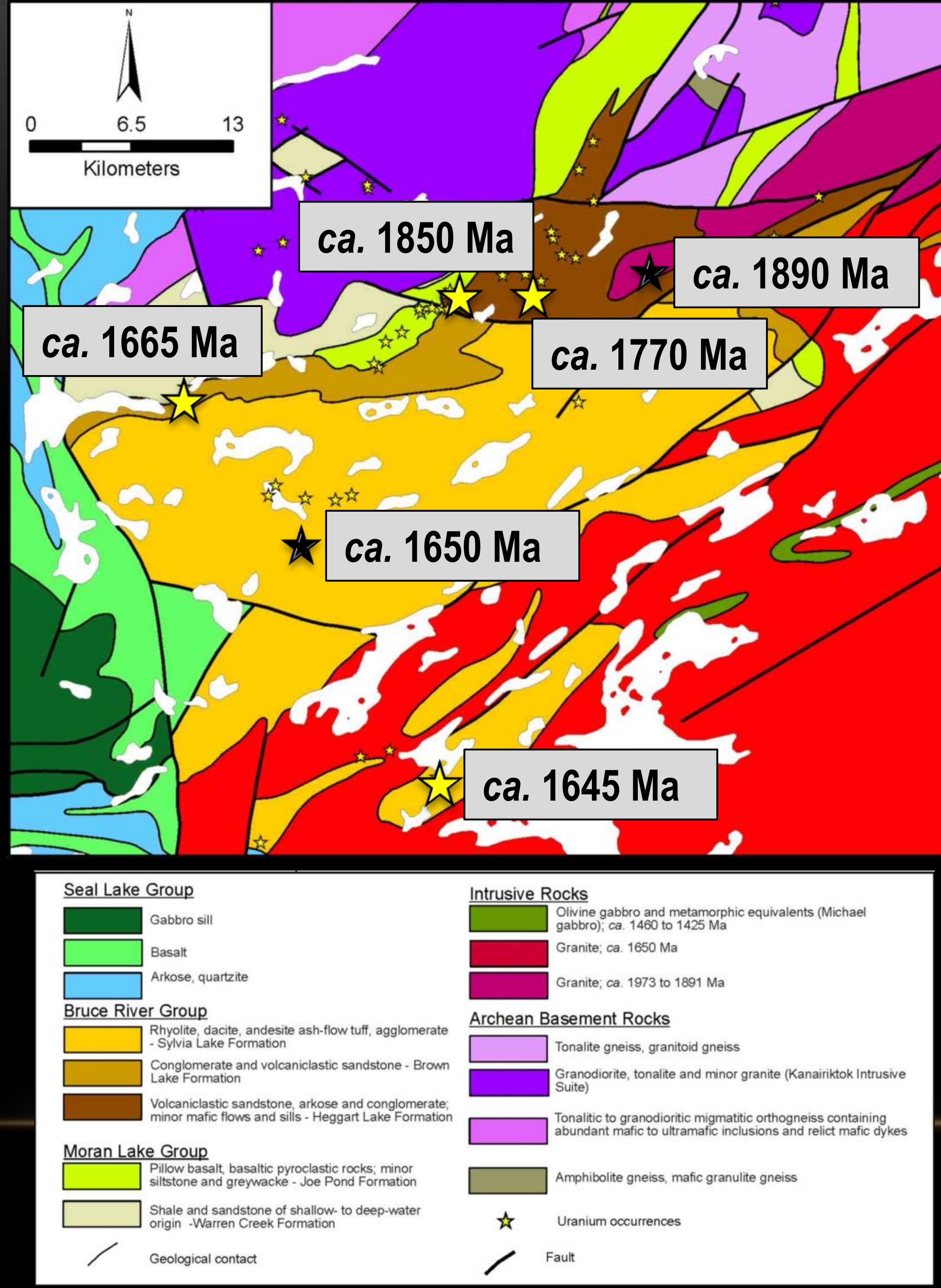
Rock/Chondrites
Sun+McDon. 1989-REEs_Modified
Granite
Basalt
Diorite
Gabbro
100
10
1
La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu

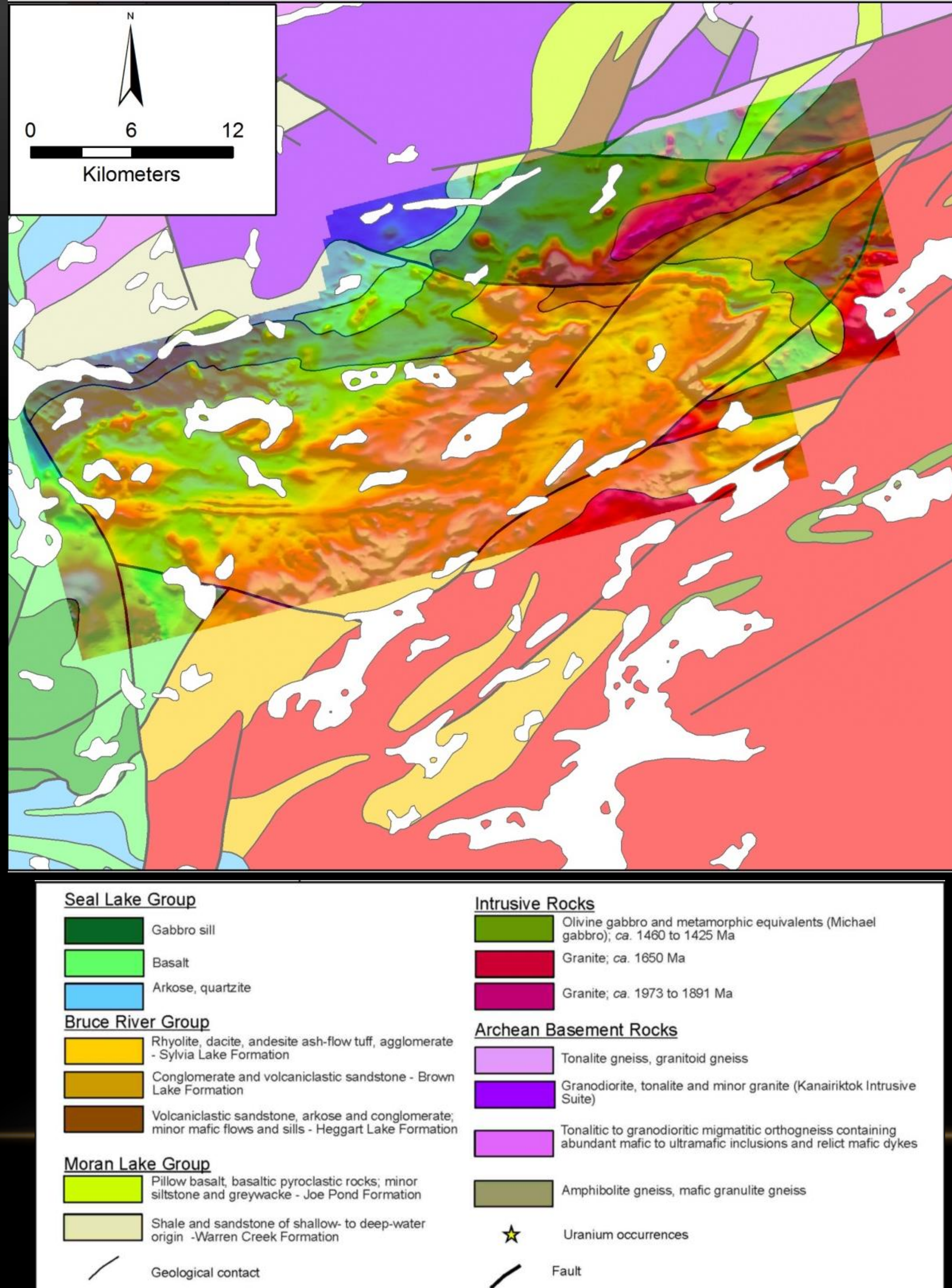


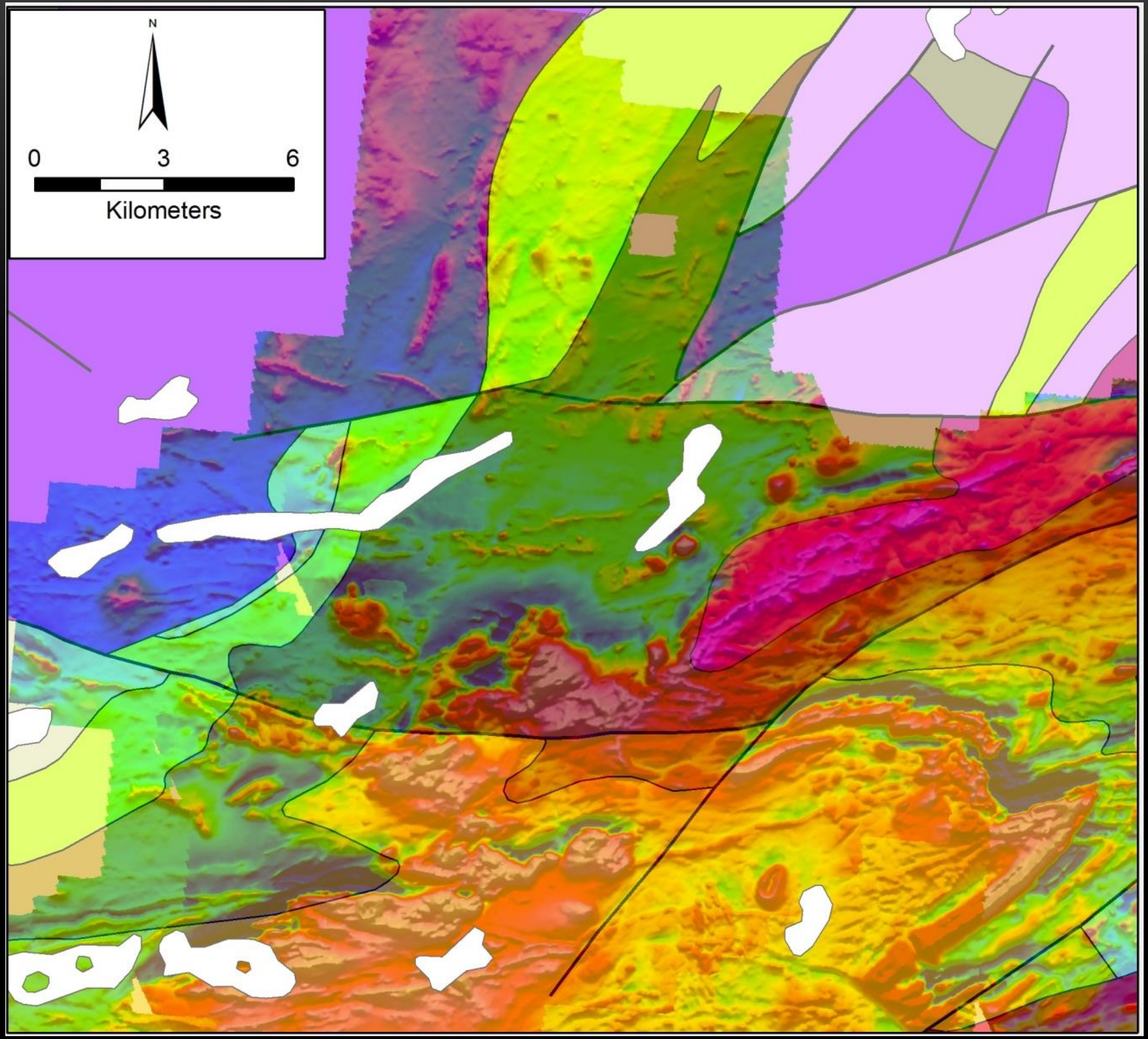
syn-COLG
WPG
VAG
ORG
Rb
Y+Nb
1000
100
10
1
Granite
Basalt
Diorite
Gabbro



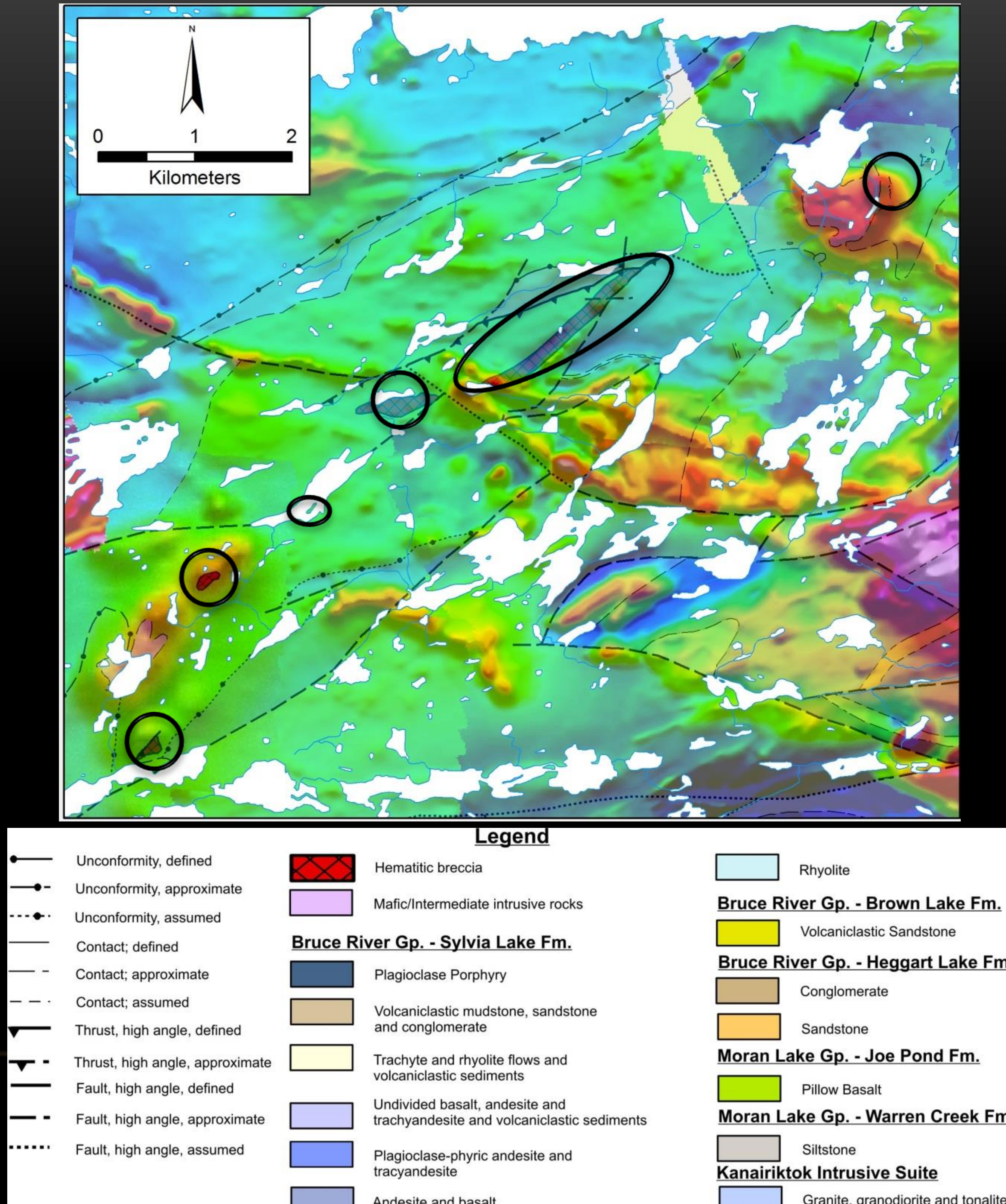
Granite - Henri Lake
1900
1700
1500
1300
.3226
.2406
206Pb/238U
207Pb/235U
Z1
Z2
Z3
Z4
Z5
Z6
3.01
3.8
1772 +/-10 Ma
GS14-130

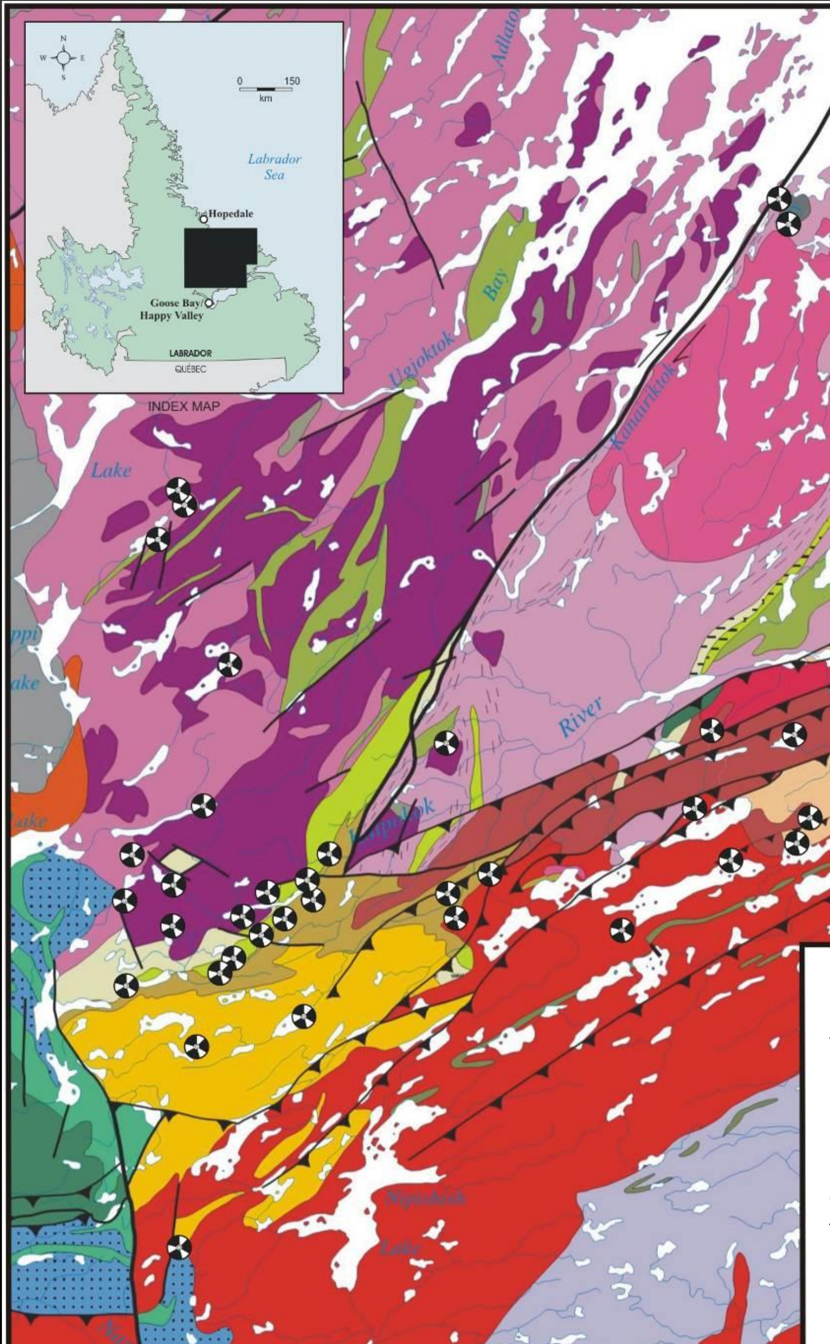

N
0
6.5
13
Kilometers
ca. 1850 Ma
ca. 1890 Ma
ca. 1665 Ma
ca. 1770 Ma
ca. 1650 Ma
ca. 1645 Ma
Seal Lake Group
Gabbro sill
Basalt
Arkose, quartzite
Bruce River Group
Rhyolite, dacite, andesite ash-flow tuff, agglomerate - Sylvia Lake Formation
Conglomerate and volcaniclastic sandstone - Brown Lake Formation
Volcaniclastic sandstone, arkose and conglomerate; minor mafic flows and sills - Heggart Lake Formation
Moran Lake Group
Pillow basalt, basaltic pyroclastic rocks; minor siltstone and greywacke - Joe Pond Formation
Shale and sandstone of shallow- to deep-water origin -Warren Creek Formation
Geological contact
Intrusive Rocks
Olivine gabbro and metamorphic equivalents (Michael gabbro); ca. 1460 to 1425 Ma
Granite; ca. 1650 Ma
Granite; ca. 1973 to 1891 Ma
Archean Basement Rocks
Tonalite gneiss, granitoid gneiss
Granodiorite, tonalite and minor granite (Kanairiktok Intrusive Suite)
Tonalitic to granodioritic migmatitic orthogneiss containing abundant mafic to ultramafic inclusions and relict mafic dykes
Amphibolite gneiss, mafic granulite gneiss
Uranium occurrences
Fault

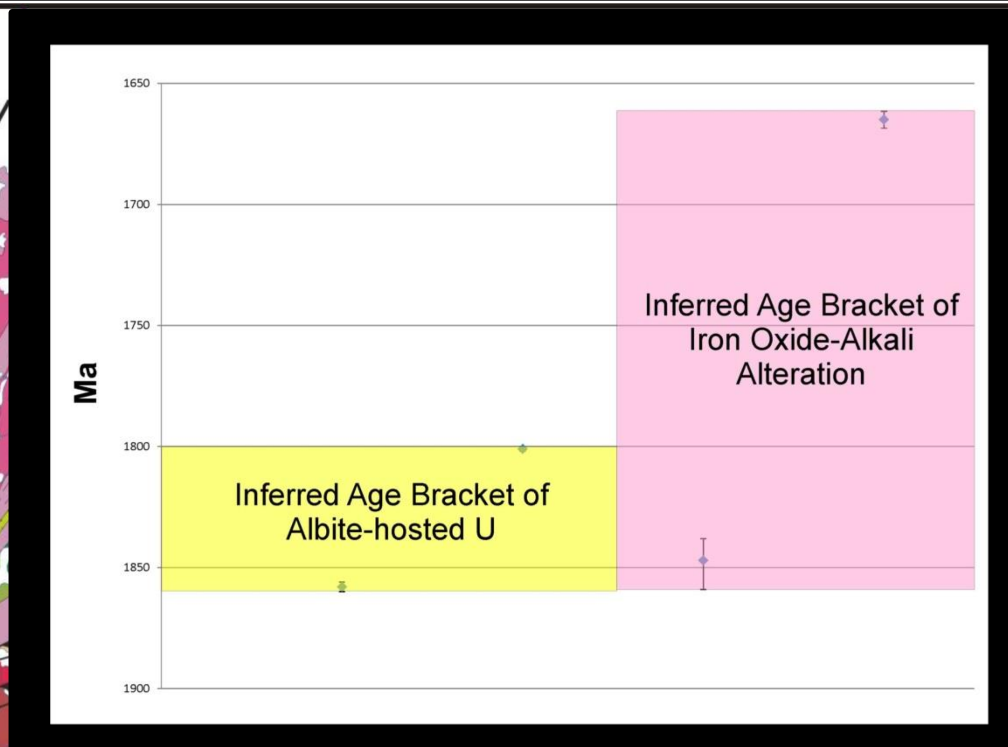

N
0
6
12
Kilometers
Seal Lake Group
Gabbro sill
Basalt
Arkose, quartzite
Bruce River Group
Rhyolite, dacite, andesite ash-flow tuff, agglomerate - Sylvia Lake Formation
Conglomerate and volcaniclastic sandstone - Brown Lake Formation
Volcaniclastic sandstone, arkose and conglomerate; minor mafic flows and sills - Heggart Lake Formation
Moran Lake Group
Pillow basalt, basaltic pyroclastic rocks; minor siltstone and greywacke - Joe Pond Formation
Shale and sandstone of shallow- to deep-water origin -Warren Creek Formation
Geological contact
Intrusive Rocks
Olivine gabbro and metamorphic equivalents (Michael gabbro); ca. 1460 to 1425 Ma
Granite; ca. 1650 Ma
Granite; ca. 1973 to 1891 Ma
Archean Basement Rocks
Tonalite gneiss, granitoid gneiss
Granodiorite, tonalite and minor granite (Kanairiktok Intrusive Suite)
Tonalitic to granodioritic migmatitic orthogneiss containing abundant mafic to ultramafic inclusions and relict mafic dykes
Amphibolite gneiss, mafic granulite gneiss
Uranium occurrences
Fault



N
0
3
6
Kilometers


N
0
1
2
Kilometers
Legend
Unconformity, defined
Unconformity, approximate
Unconformity, assumed
Contact; defined
Contact; approximate
Contact; assumed
Thrust, high angle, defined
Thrust, high angle, approximate
Fault, high angle, defined
Fault, high angle, approximate
Fault, high angle, assumed
Hematitic breccia
Mafic/Intermediate intrusive rocks
Bruce River Gp. - Sylvia Lake Fm.
Plagioclase Porphyry
Volcaniclastic mudstone, sandstone and conglomerate
Trachyte and rhyolite flows and volcaniclastic sediments
Undivided basalt, andesite and trachyandesite and volcaniclastic sediments
Plagioclase-phyric andesite and tracyandesite
Andesite and basalt
Rhyolite
Bruce River Gp. - Brown Lake Fm.
Volcaniclastic Sandstone
Bruce River Gp. - Heggart Lake Fm.
Conglomerate
Sandstone
Moran Lake Gp. - Joe Pond Fm.
Pillow Basalt
Moran Lake Gp. - Warren Creek Fm.
Siltstone
Kanairiktok Intrusive Suite
Granite, granodiorite and tonalite





- •Distribution of some 50+ uranium occurrences throughout the region of the CMB
- • Mineralized environments have been subdivided into five main domains, namely : 1)Archean basement, 2)Moran Lake Group, 3)Post hill Group, 4)Aillik Group, 5)Bruce River Group

	Alteration Facies	*Breccia Type*	*Mineralization*
	6. LT silicification (epithermal assemblages)	(Veins/stockworks)	Epithermal deposits
Shallow & Lower Temp. (~350°C)	5. LT K-Fe (K-feldspar / sericite-hematite-carbonate - chlorite-epidote-sulphides)	Hydrothermal	Hem-group IOCG ±U
	4. 'Felsite' or skarns (K-feldspar or clinopyroxene- garnet-sulphides)	Hydrothermal	Mag- to hem-group IOCG and skarns
	3. HT K-Fe (K-feldspar / biotite - magnetite-sulphides)	Hydrothermal	Mag-group IOCG (Cu, Au, Co, Bi, ...)
Early Deeper/Core High Temp. (~700°C)	2. Ca-Fe (±Na) (amphibole-magnetite ± apatite)	Structural and incipient hydrothermal	Iron oxide apatite (IOA) deposits
	1. Na (albite - scapolite)	Structural	

After Corriveau et al. (2010)

SUMMARY:

- The Moran Lake region is host to extensive iron oxide-alkali alteration accompanied by hydrothermal brecciation
- This alteration system is accompanied by V, U, Cu and Ag enrichment, but not to the degree that would classify it as a typical IOCG deposit
- This system can be bracketed between *ca.* 1860 and 1665 Ma, with the new maximum age being some 200 Ma older than previously envisaged
- The new age bracket enables an overlap with albitite-hosted U mineralization elsewhere in the region and may highlight a link with a larger-scale IOAA system within the CMB


THANK YOU