

GEM URANIUM

Lithotectonic advances in the NE Thelon Basin region – context for U exploration

C.W. Jefferson, A. Anand, S. J. Pehrsson, T. Peterson, W. Davis, N. Bridge, J.M.J. Scott, P. Wollenberg, T. Riegler, V. Tschirhart, W. Morris, L.B. Chorlton, J. Patterson



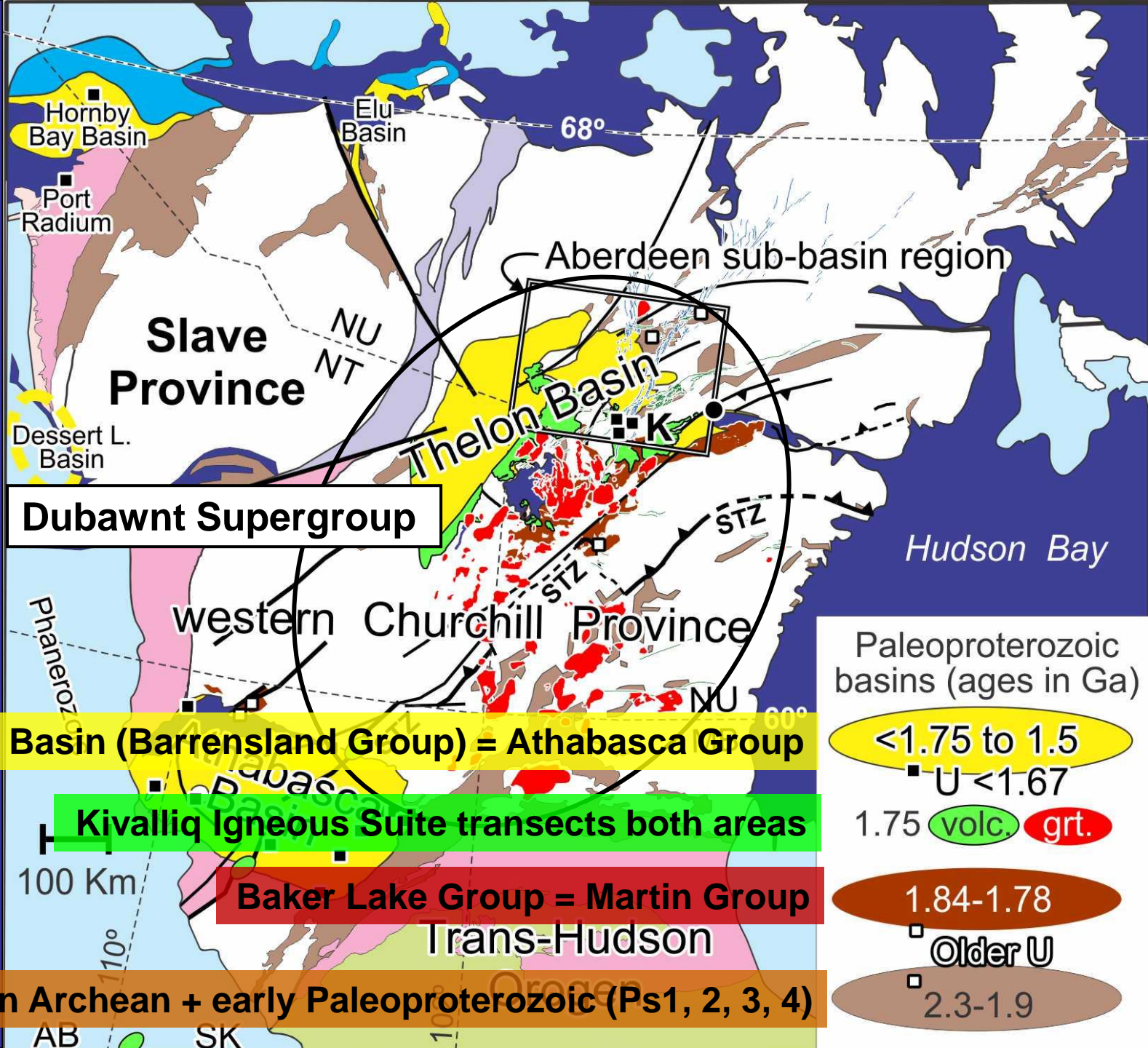
Natural Resources
Canada

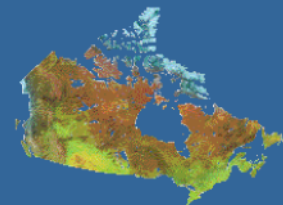
Ressources naturelles
Canada



Canada

**U in
NW
Can.
Shield
- our
study
area**



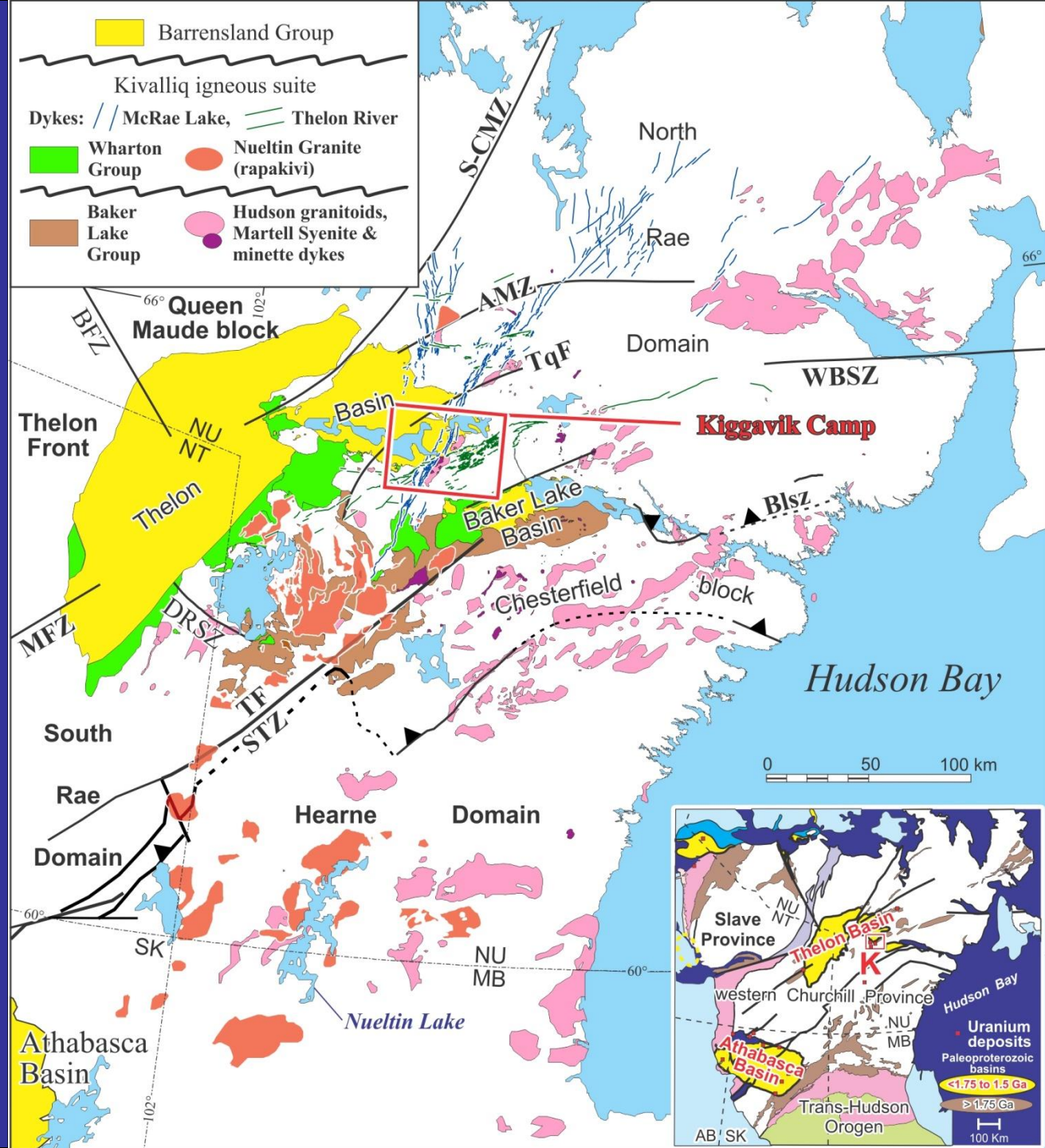


- Dubawnt Supergroup is a **LISP: Large Igneous and Sedimentary Province** wherein volcanics are intercalated with sedimentary rocks from 1.84 to <1.54 Ga
- Alteration and mineralization styles characterize each of the three groups constituting the Dubawnt Supergroup:
 - Barrenland Group (Thelon Fm., **Kiggavik U camp**):
 - * Low-T hematite, desilicification, illite, chlorite, U
 - Wharton Group: High T silicification, Au, Ag
 - Baker Lake Group: carbonate-chlorite, U
- Faults + dykes are co-located & link with groups + alteration
- Thelon vs. Athabasca U: similar ages, faults, alteration
Hosts differ: Neoarchean vs. Paleoproterozoic +1.75 granite

3



A bit more detail on the Dubawnt Supergroup in the Kivalliq Region of Nunavut



What is the Dubawnt Supergroup **LISP**?

Each Group has intrusive and extrusive igneous rocks



Spans 1.83 to <1.54 Ga: 2 **LISPs** and a final BLIP

#3 Barrenland Group: siliciclastics + minor ultrapotassic lavas

Thin Kuungmi ultra-K mafic lavas

#2 Wharton Group: bi-lavas + siliciclastics

Nuelin rapakivi granite, gabbro, diabase dykes & Pitz bimodal lavas

#1 Baker Lake Group: K-lavas + siliciclastics

Mid-crustal Hudson granite, minette lavas, dykes & syenite

On Paleoproterozoic and Archean metamorphic rocks

U_3O_8  Amer & Ketyet River groups
unconformity

ARCHEAN



Metamorphosed supracrustal groups on gneissic collage





Intrusive

1 cm

Undivided Archean (Rae Domain)

Hudson granodiorite

Martell Syenite: minette mingled with granitoid

Extrusive

1 cm

AMZ

Dubawnt Supergroup LISP #1

**~1.83-1.81 Ga:
Baker Lake Group
siliciclastics &
ultrapotassic lavas**

~ =

Mid-crustal Hudson Granitoid Suite

**Minette lavas in Baker Lake Basin
1.83 Ga**

STZ

Hearne Domain

Hudson Bay

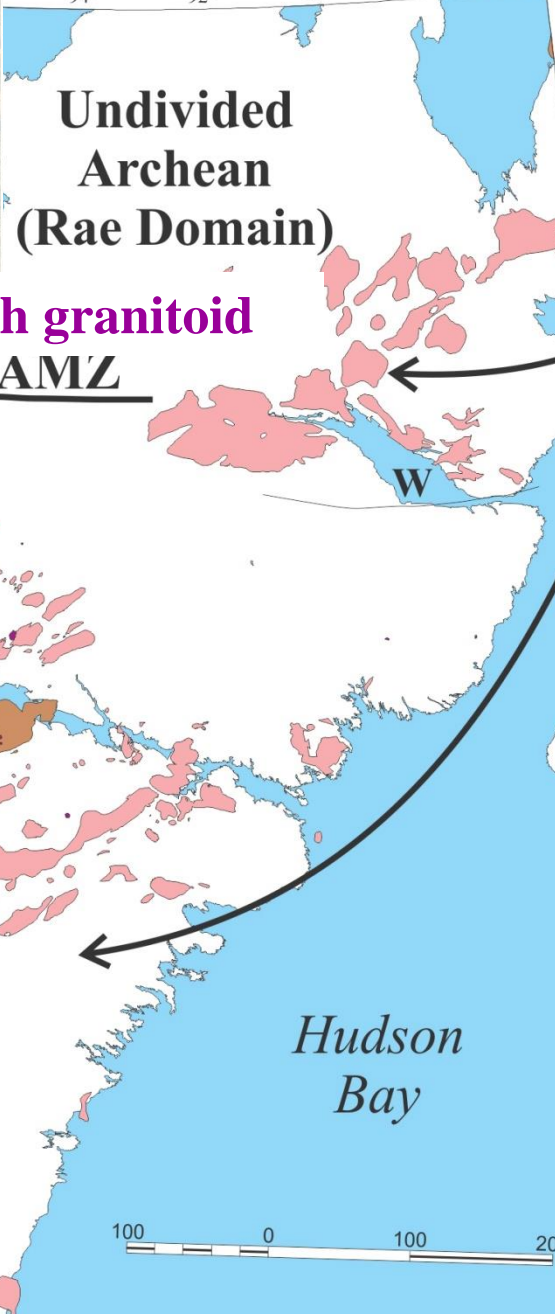
**Angilak U, 1.83 Ga
(Lac Cinquante)**

100 0 100 200

104° 102° 100° 98° 96° 94° 92° 90° 88°

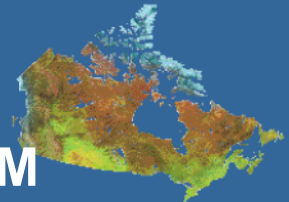
63°
62°
61°
60°

94° 92° 90° 88° 86°

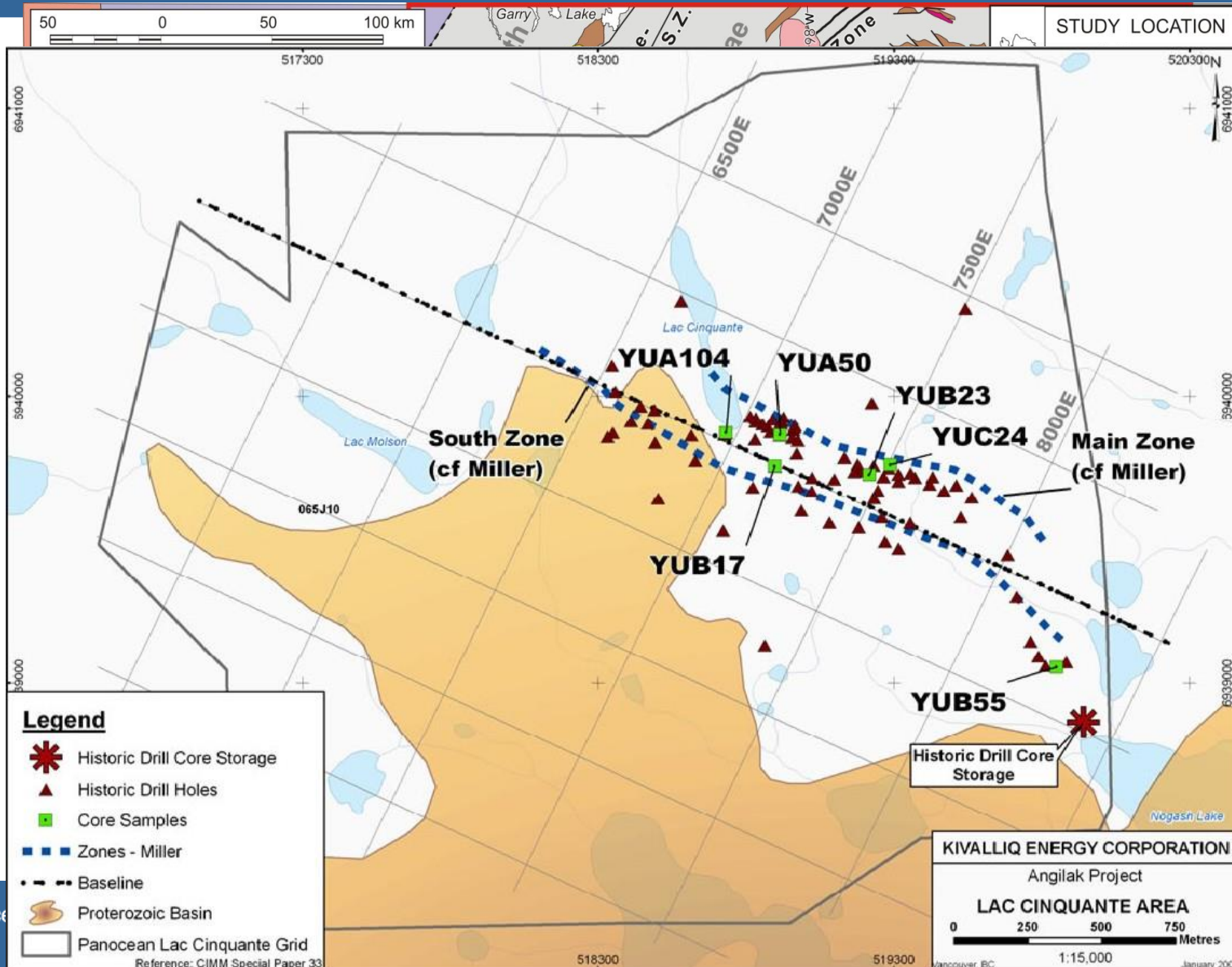


Lac Cinquante, Nunavut

Nathan Bridge, Neil Banerjee, Mostafa Fayek
Thanks to Kivalliq Energy – NTI – UWO – U of M



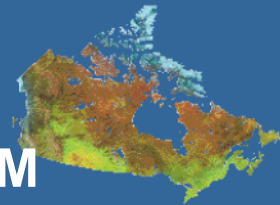
- 20.4 m lbs U_3O_8
@ >1% (historical)
- Structure > 1km long & 265 m deep
- 3 types of pitch.:
- disseminated in base metal tuff
- discrete veins
- Q-CO₃-sulphide gash veins
- Alteration: hem. calcite – chlorite
- in main zone tuff & porphyritic grt
- What type of deposit?



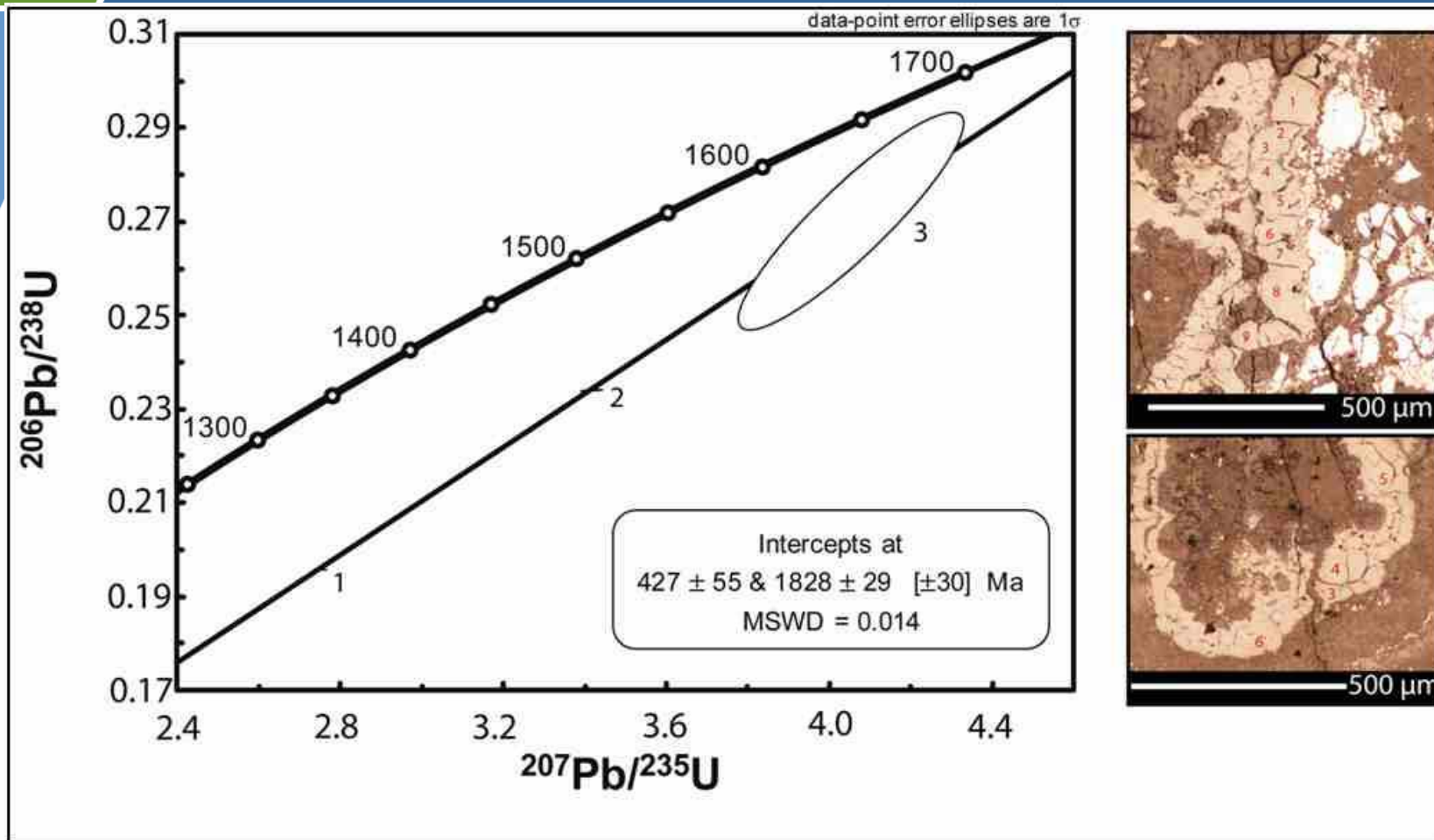
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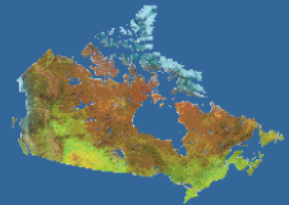
Thanks to Kivalliq Energy – NTI – UWO – U of M



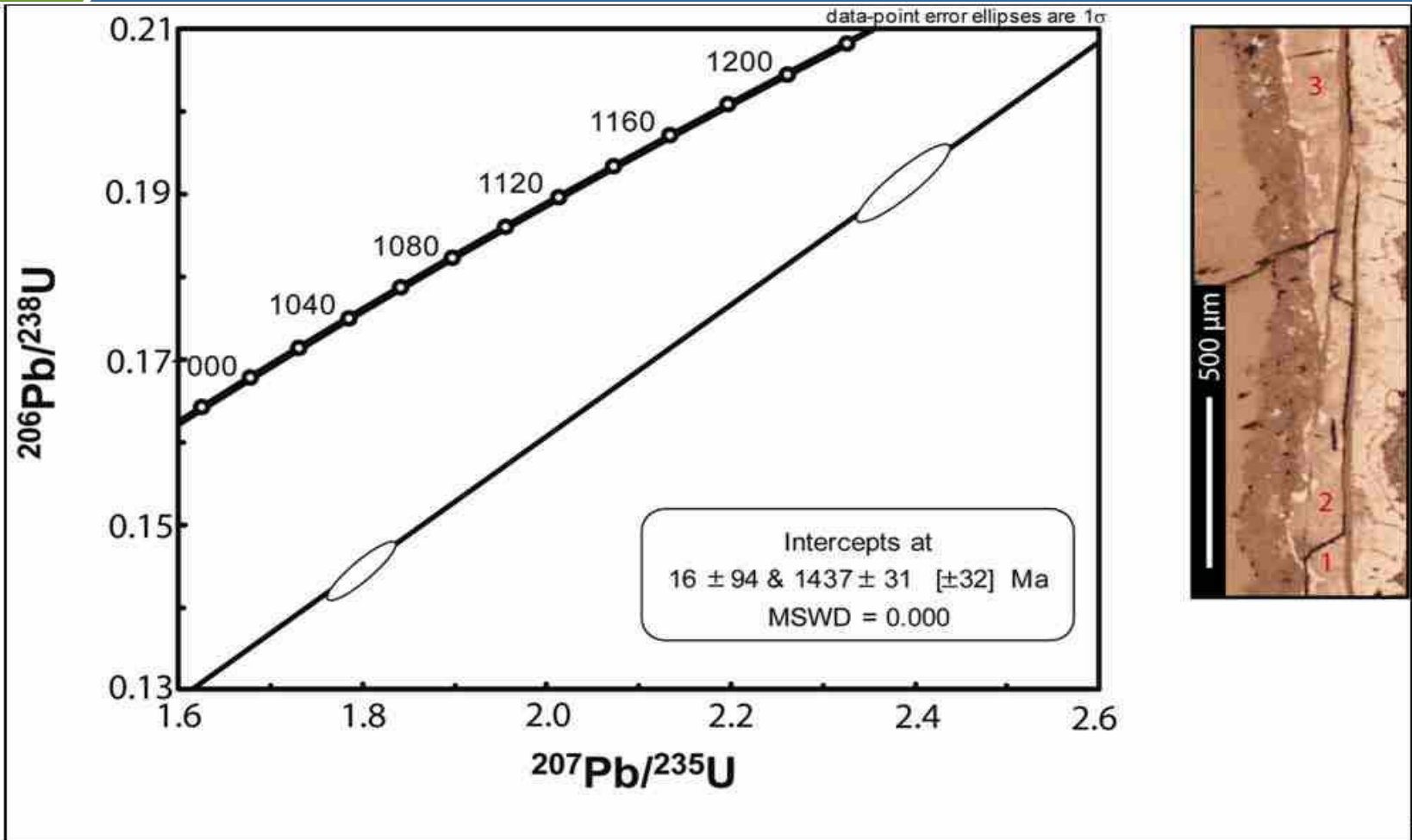
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Primary age fits with unconformity beneath 1830 Ma Baker L. Basin



9



1.4 Ga re-set age fits with Mallery Lk Au and plume / Berthoud orogen

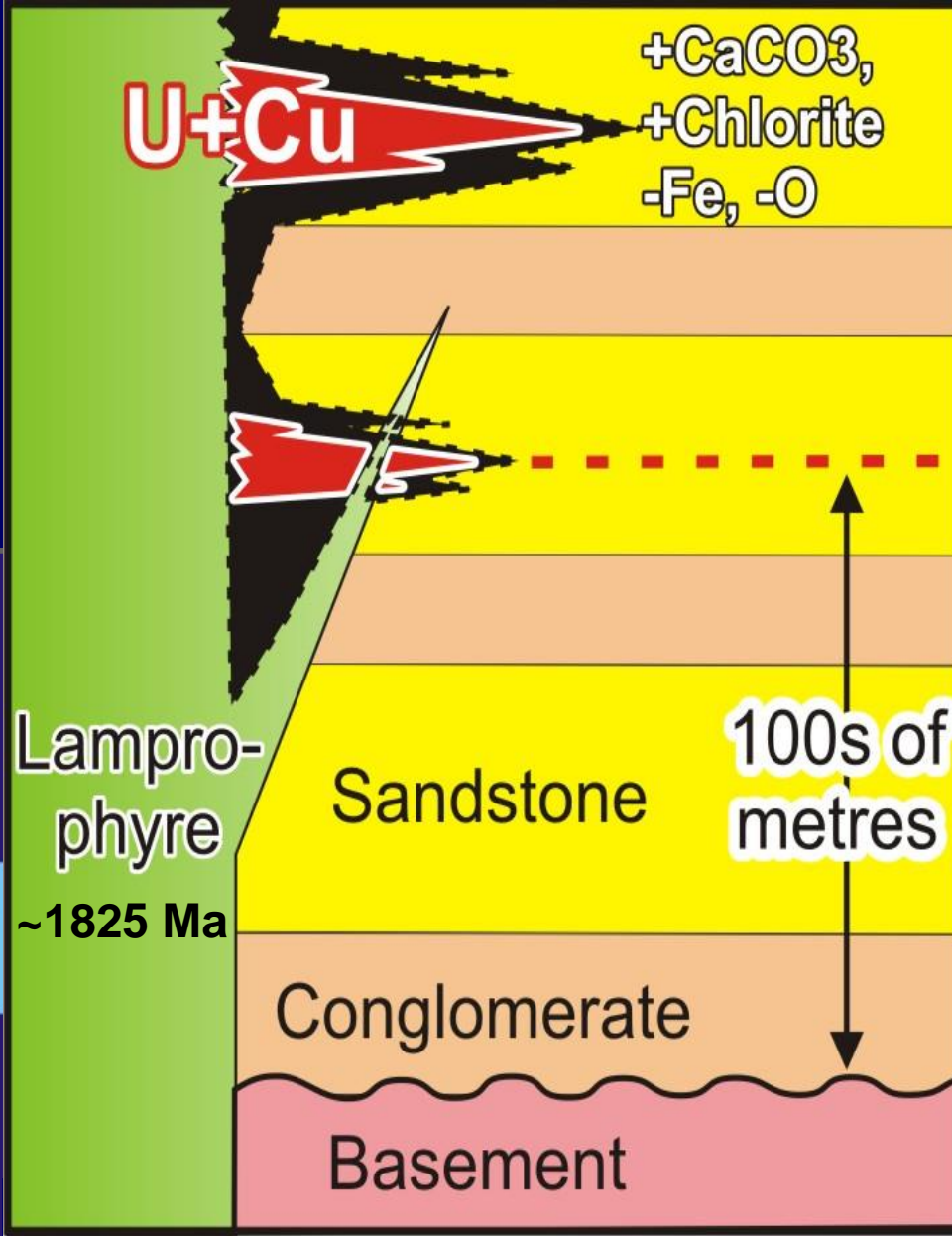


Clastic-hosted U: conglomerates, mafic dykes and alteration

Baker L. <1.85 Ga
Kazan U ~1.78 Ga



Lucky 7 Pac Ridge avg. 7
DDH 7.5 m @ 0.22% U₃O₈

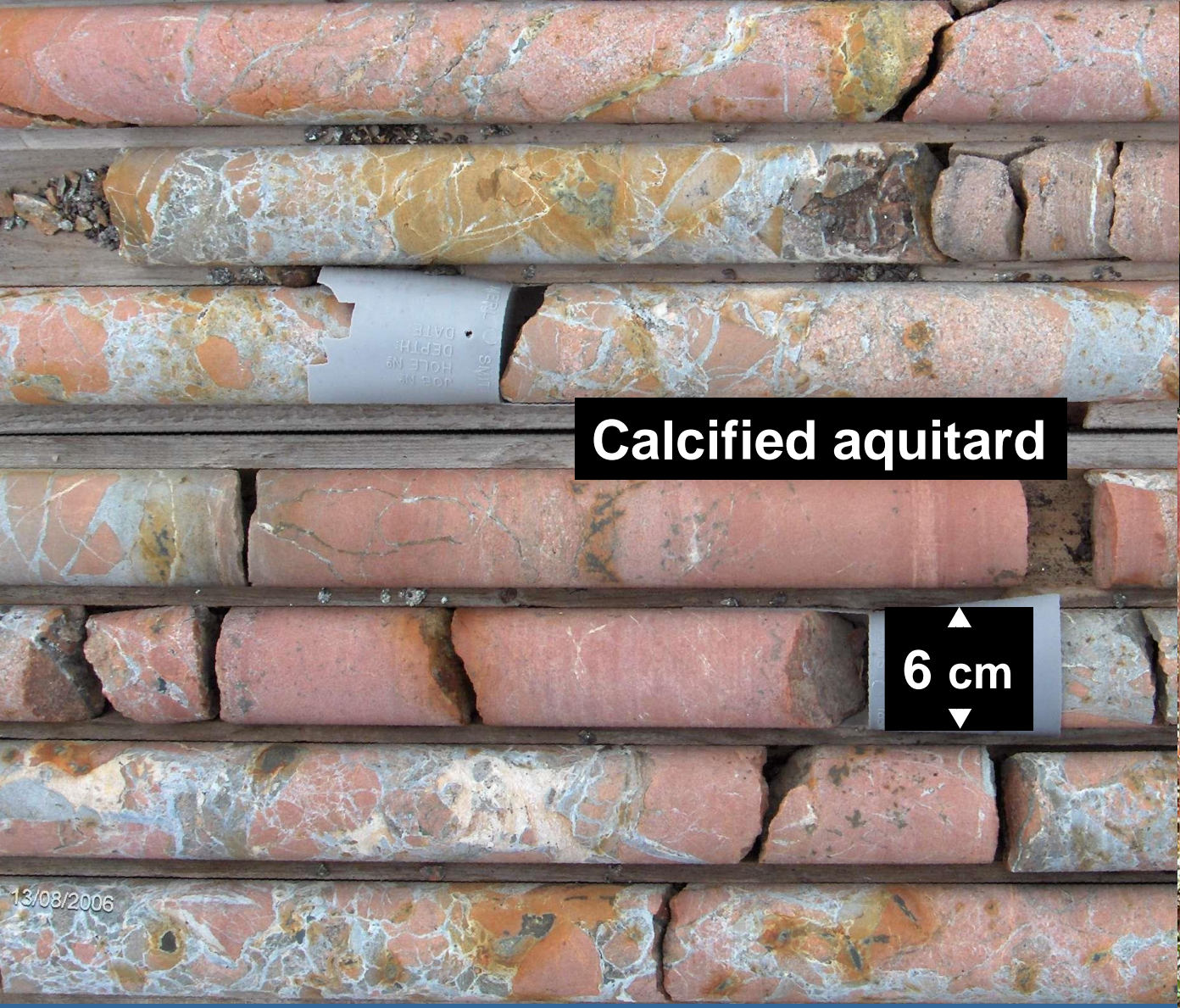
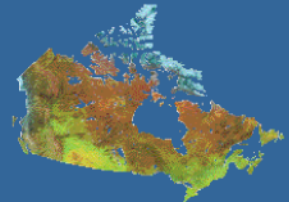


Kazan:
Stanton, 1979



GEM

Conglomerate + sandstone of Kazan Fm., Baker Lake Basin



Calcified aquitard

**Mineralized
aquifer**

▲
6 cm
▼

13/08/2006

**Dubawnt
Supergroup
LISP #2:
~1.79-1.74 Ga
Kivalliq Igneous
Suite (KIS):**

**Nuelin rapakivi
granite, gabbro and
multiple diabase
dyke swarms
+
Pitz bimodal lavas
and epiclastic
rocks**

Bathurst Inlet

Thelon Wildlife
Sanctuary

Wager Bay

Lone Gull (Kiggavik)

Mallery Lake

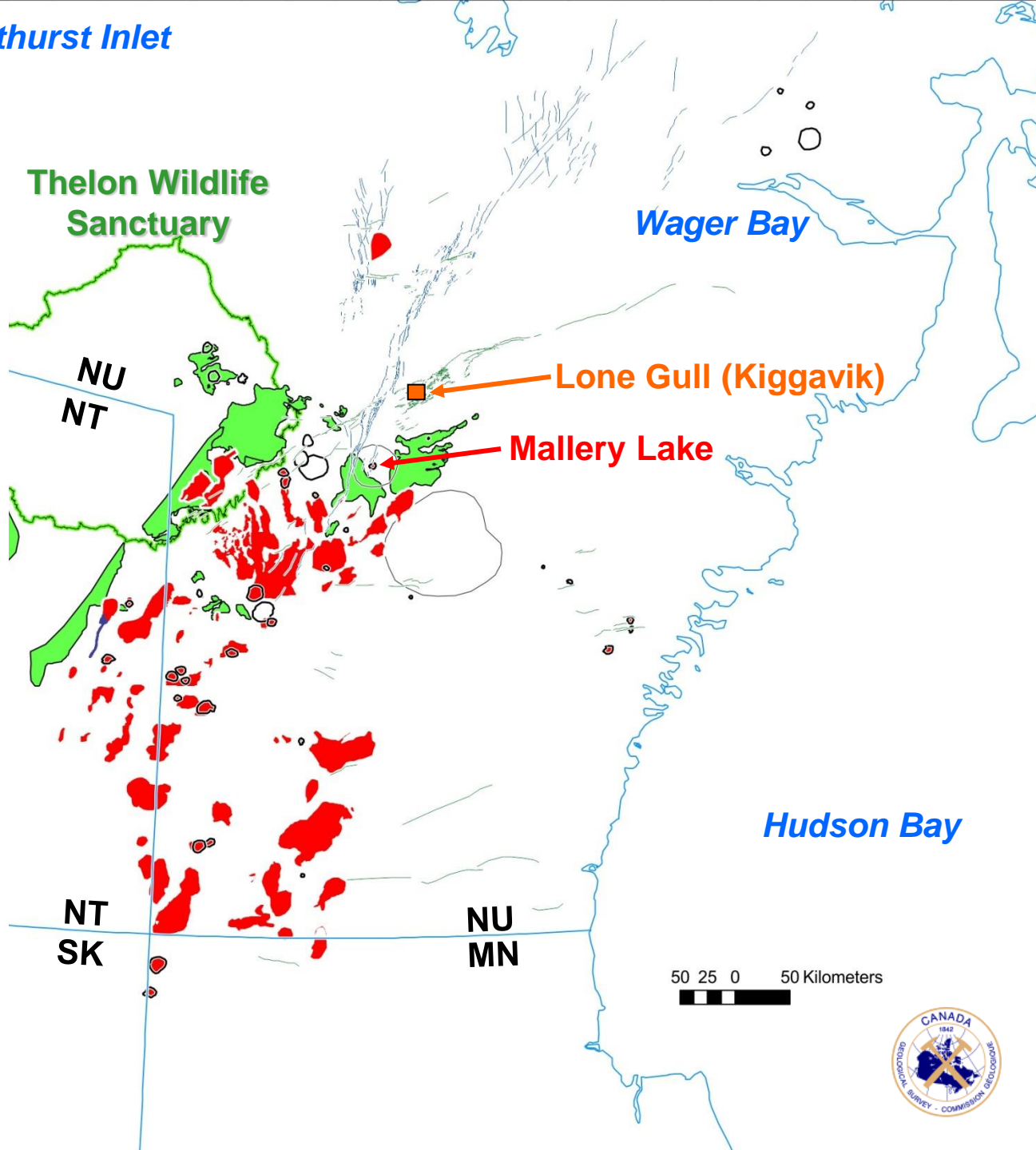
Hudson Bay

NU
NT

NT
SK

NU
MN

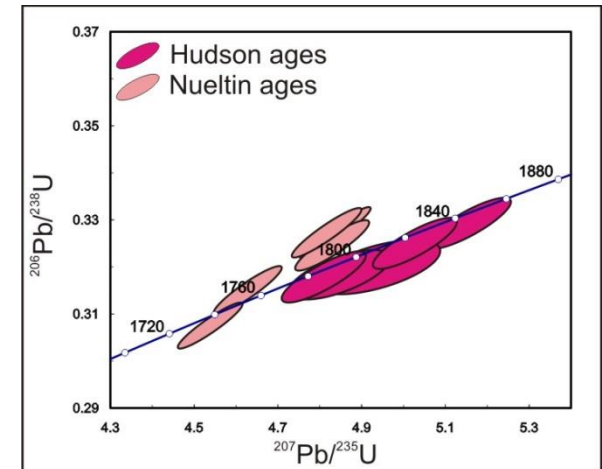
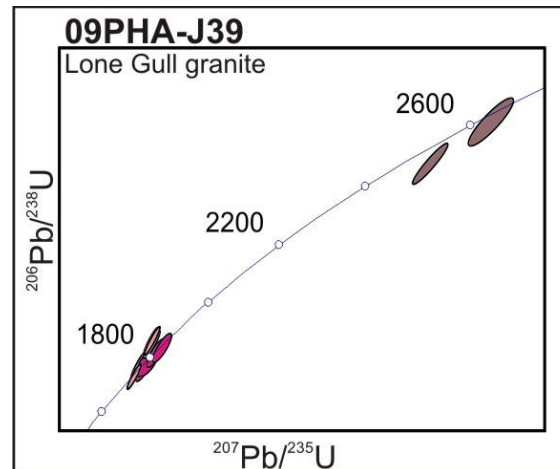
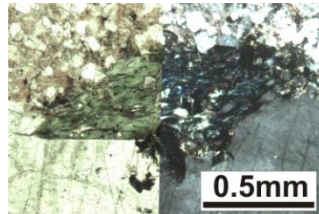
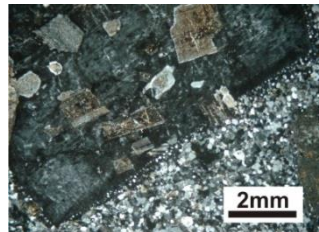
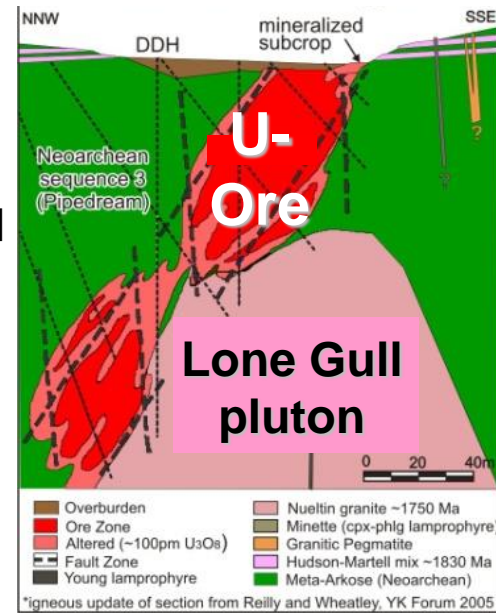
50 25 0 50 Kilometers

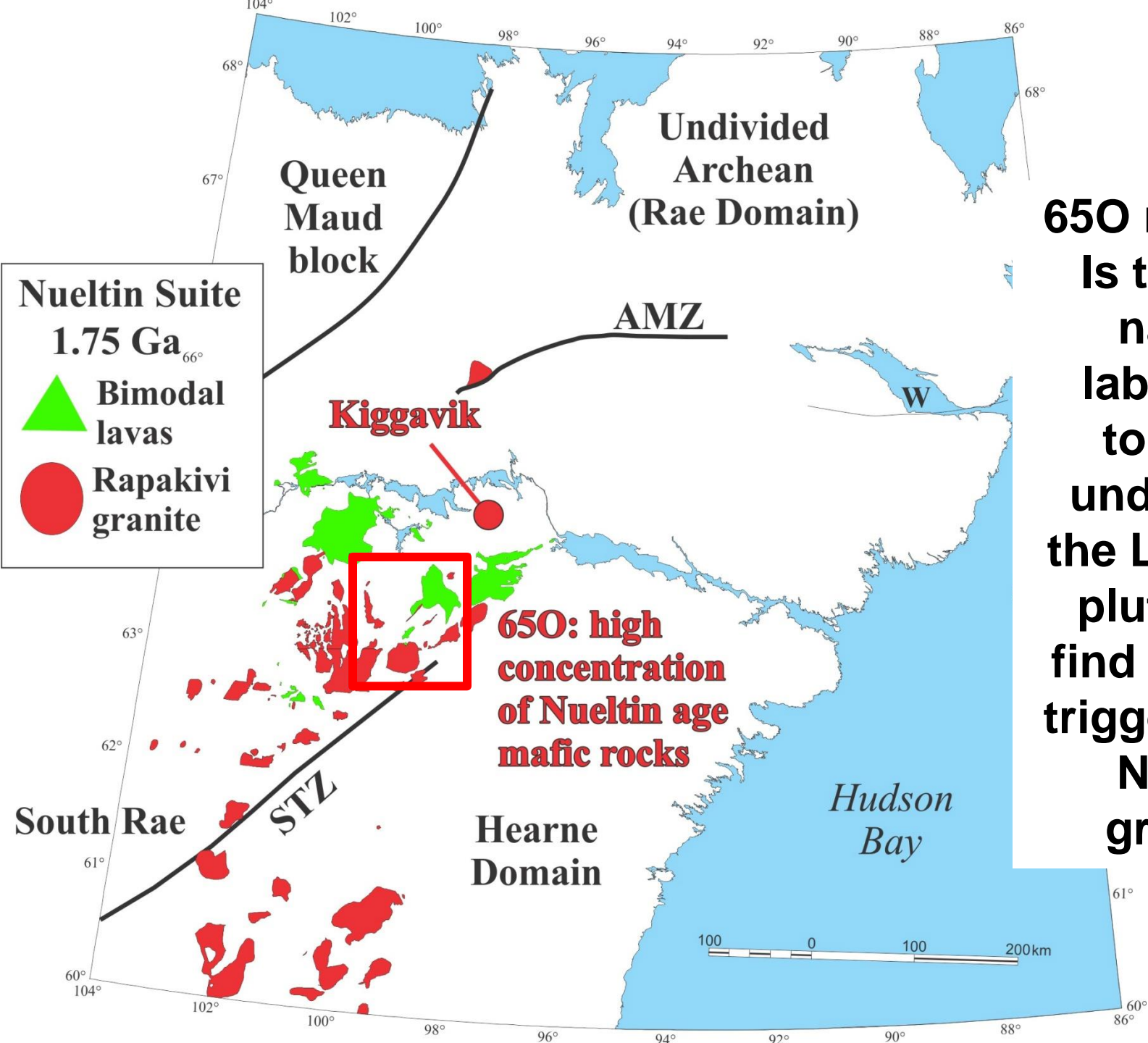


Investigating **ground preparation for uranium deposit:** **Lone Gull (Kiggavik) granite zircon SHRIMP** **geochronology (Scott, Davis, et al., in prep)**

- **Complex petrography, with aspects of both granites and xenoliths/inclusions of lower DSG minette, typical of mixed Hudson/minette (Martell syenite)**
- **Geochronology+petrology indicate 1.75 Ga hypabyssal porphyritic Nueltin Granite invaded 1.83 Ga (Hudson) granite with 2.6 Ga (Snow Island Suite) inherited zircons**
- **The spatial association suggests ground preparation for pitchblende (>1.4 Ga U replaces ?1.67 Ga apatite)**

Schematic Section



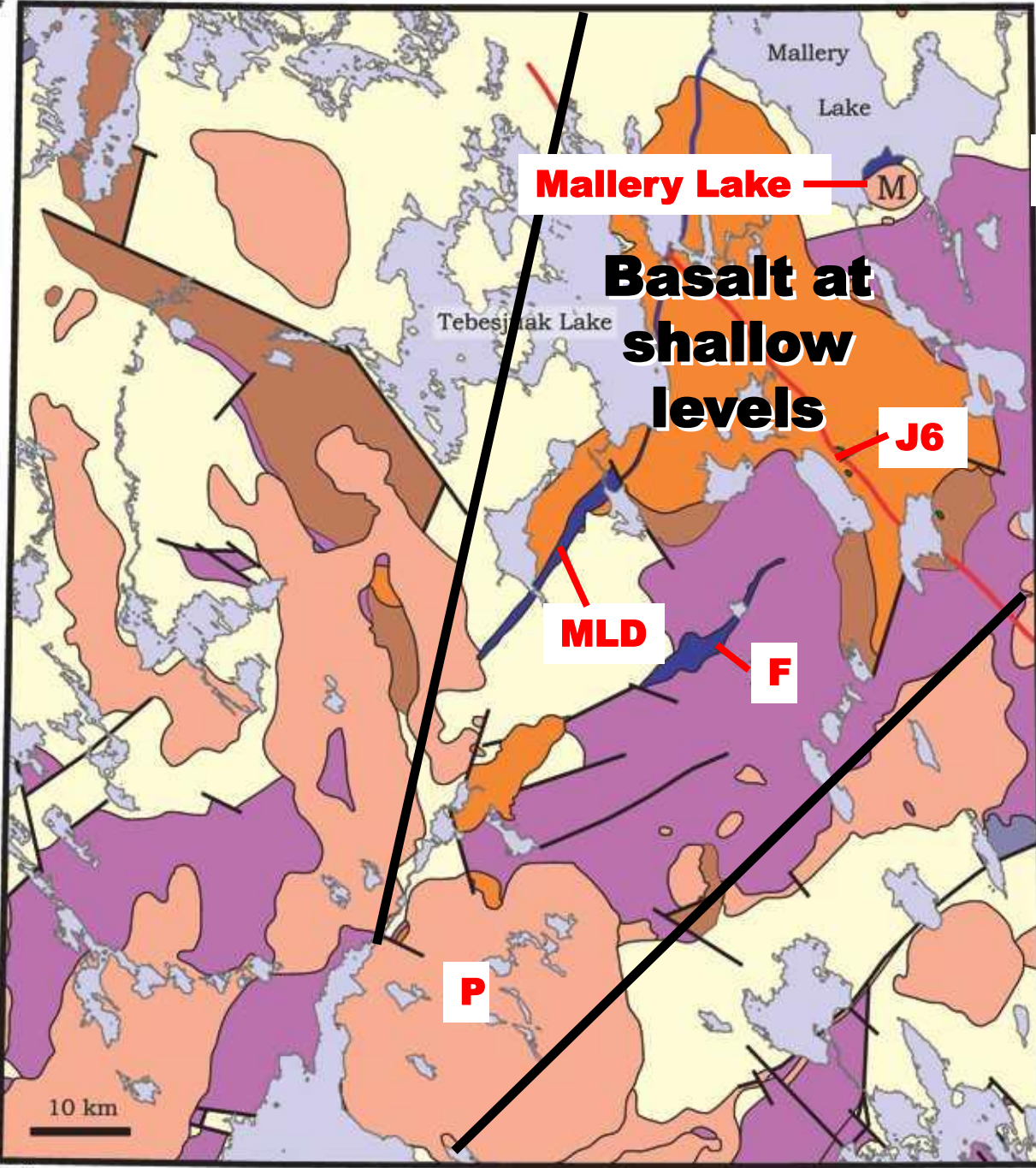


Nueltin Suite
1.75 Ga₆₆


- ▲ Bimodal lavas
- Rapakivi granite

650 map area is the best natural laboratory to better understand the Lone Gull pluton and find the mafic trigger for the Nueltin granites





Proterozoic

 Mackenzie dyke, ca. 1.27 Ga
diabase, minor granophyre

Dubawnt Supergroup

 McRae Lake dyke
(MLD)

 **Mafic rocks**

 **Pitz Formation**


 **Nueltin granite**


 **Kunwack Fm.**

 **Christopher I. Fm.**

 **Basal cgl. & ss.**

Archean

 undivided quartzofeldspathic gneiss
includes minor Hurwitz Group
(Aphebian)

 fault, type unspecified

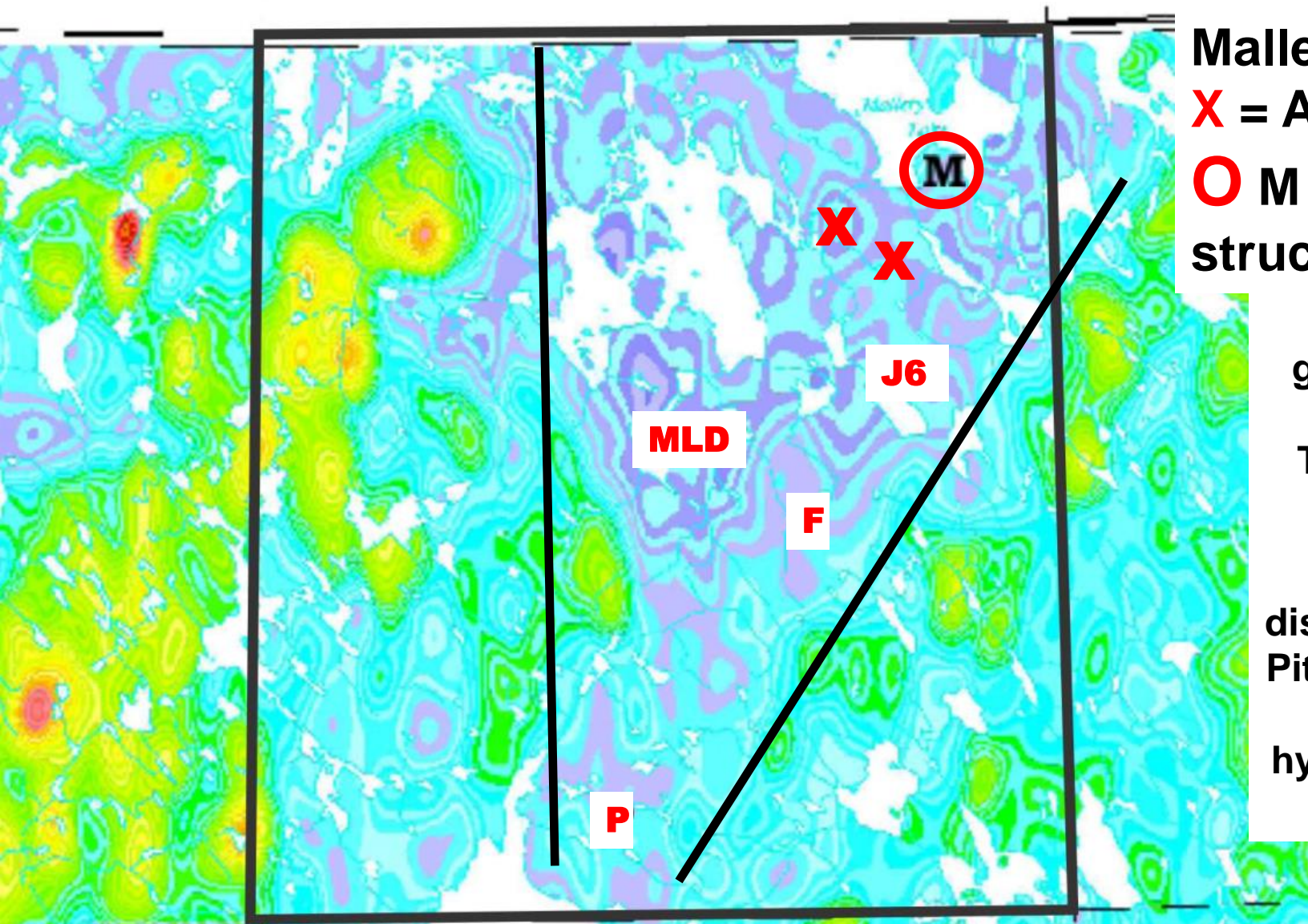


after LeCheminant, 1981

100°

99°

98°



Mallery Lake:

X = Au, Ag

O M = ring structure

Airborne gamma-ray in 650: Th/K low = high K.

Reflects distribution of Pitz rhyolite & possible hydrothermal alteration

High heat flow from shallow basaltic intrusions?





Au-Ag
(up to 24g/t)
in veins
with 150-220°
low salinity
inclusions

Alternate
with 90-150°
high salinity
inclusions

3rd veins
micro-
crystalline

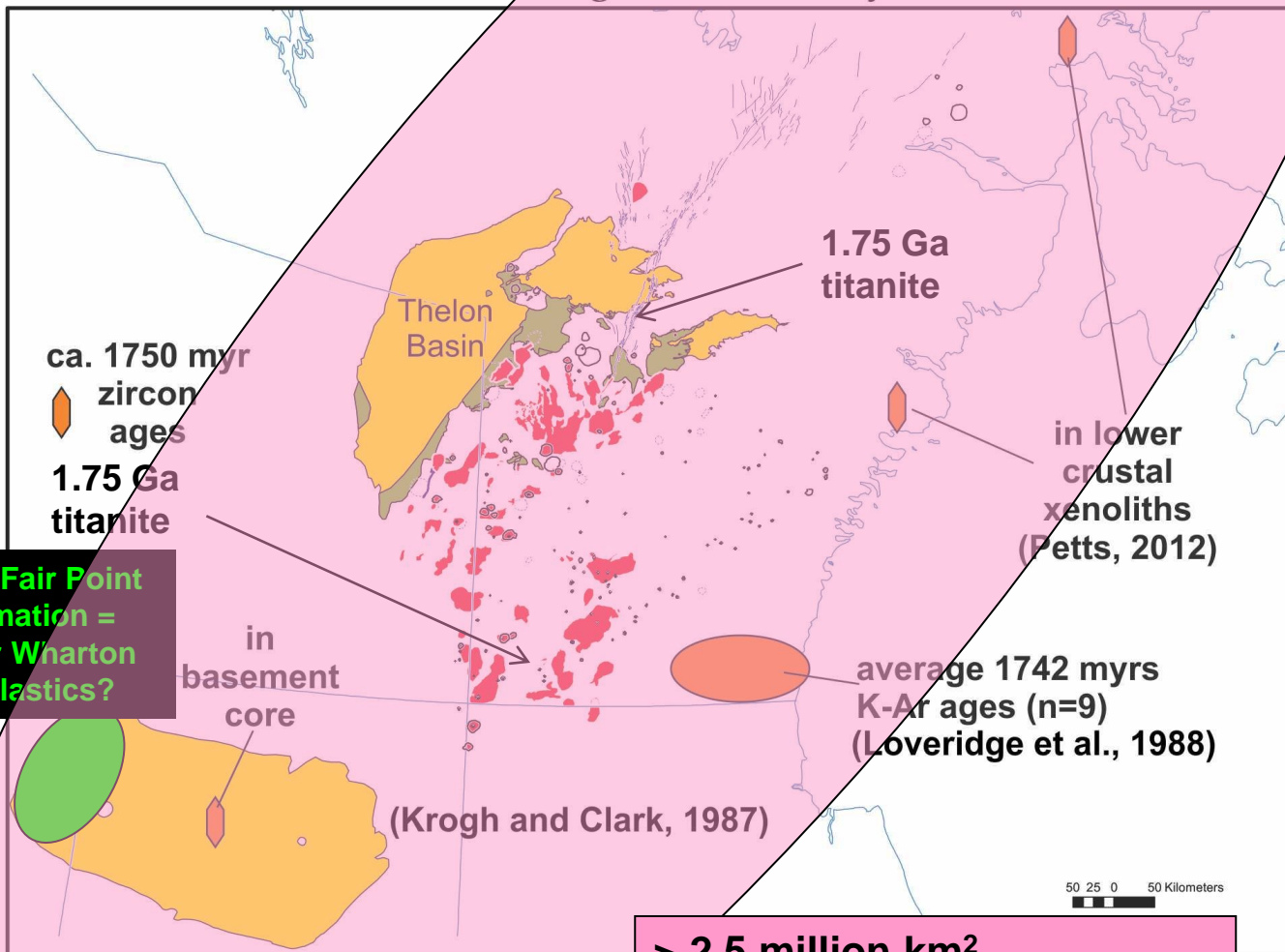
*Age of
veins?*

Related to
~1.769 Ga
intrusion

Sm-Nd age
of fluorite:
~1.44 Ga
(Turner 2000)
(re-setting)

Additional geochronological evidence
1.75 Ga igneous activity

**South Greenland
1.75 Ga rapakivi**



Is the Fair Point Formation = upper Wharton epiclastics?

**> 2.5 million km²
Presently known extent of Kivalliq Igneous Suite LISP:
Basaltic underplating at 1.77-1.74 Ga**

Swift Current
1.75 Ga rhyolite



Thelon Wildlife Sanctuary

Bouguer gravity provides a deeper understanding

NU
NT

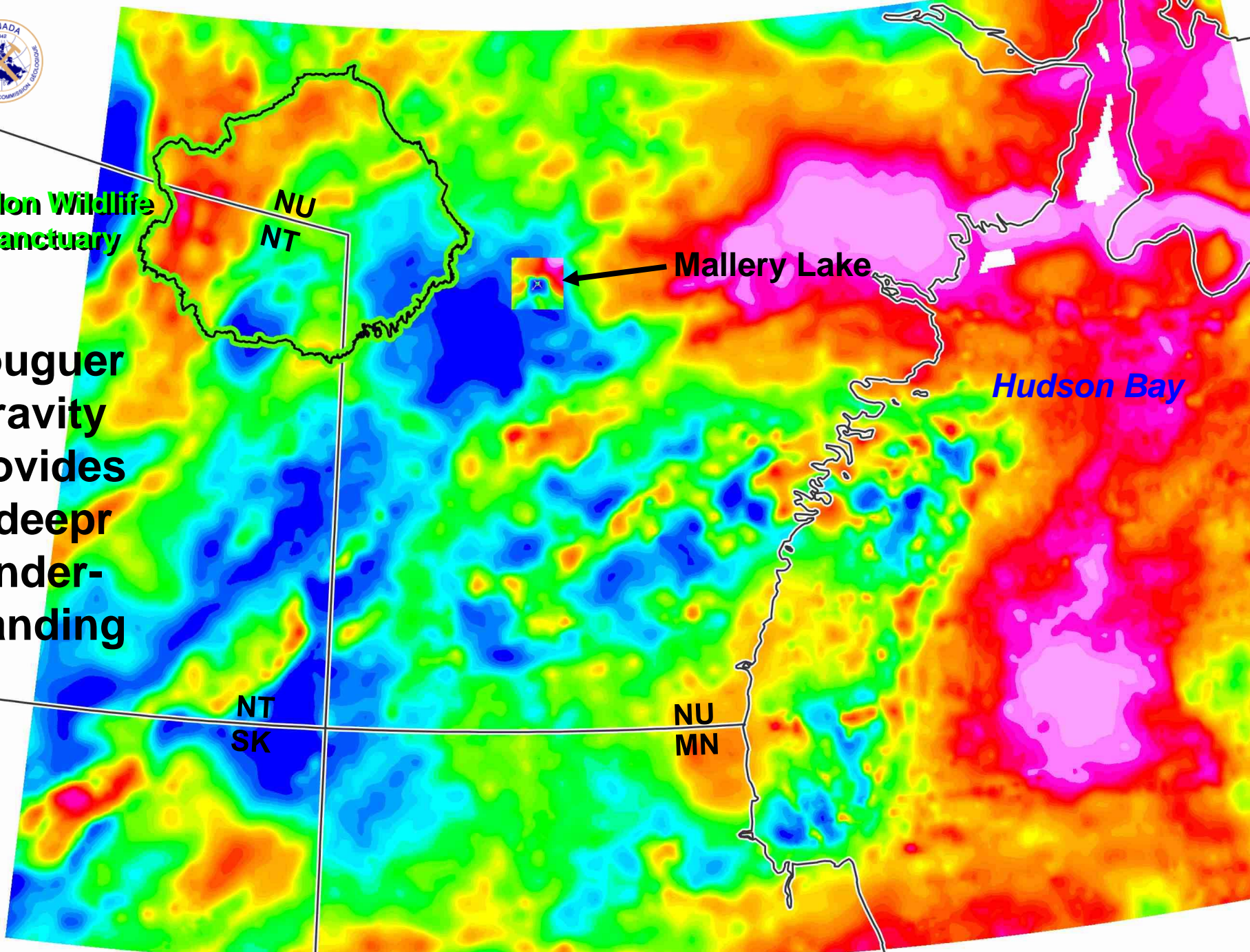


Mallery Lake

Hudson Bay

NT
SK

NU
MN





Economic analysis

Slave
indentor

Bathurst Ft.
McDonald Ft.

Kung

Kig

UG

BL, SL

McRae
Corridor

L50

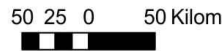
Volcaniclastics

STZ

REE, Au

Athabasca
Basin

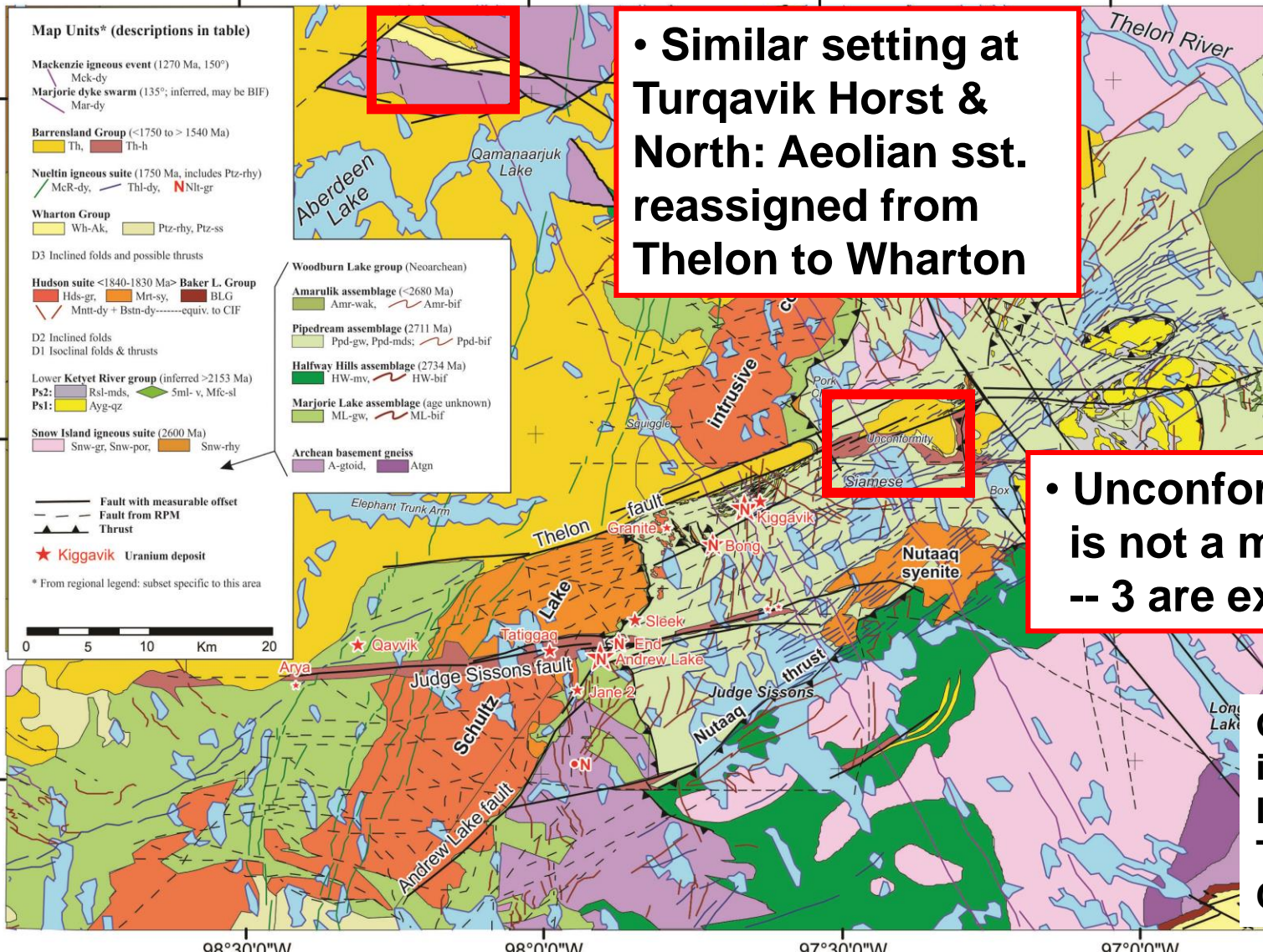
- Proximal U source
- Preservation in graben
- Reactivated faults, fluids



Conglomerates distinguish Wharton from Thelon near Kiggavik U deposits



98°30'0"W 98°0'0"W 97°30'0"W 97°0'0"W



• Similar setting at Turqavik Horst & North: Aeolian sst. reassigned from Thelon to Wharton

• Unconformity L. is not a misnomer -- 3 are exposed!

Kiggavik Open File 7241 (see poster) with some of the new results

GSC mapping integrated with legacy data: Thanks 2 AREVA, Cameco & Forum

98°30'0"W 98°0'0"W 97°30'0"W 97°0'0"W

64°45'0"N

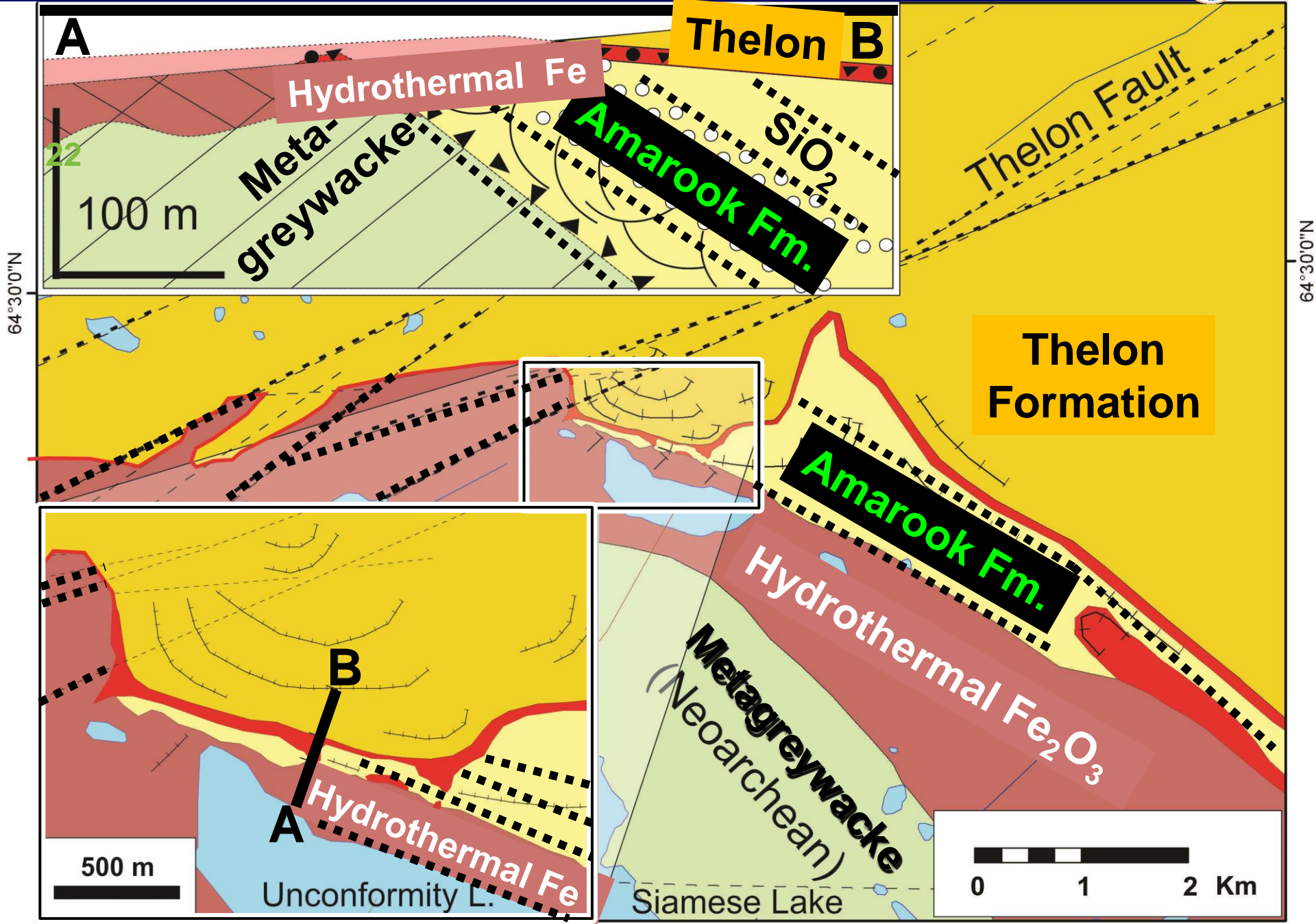
64°45'0"N

64°30'0"N

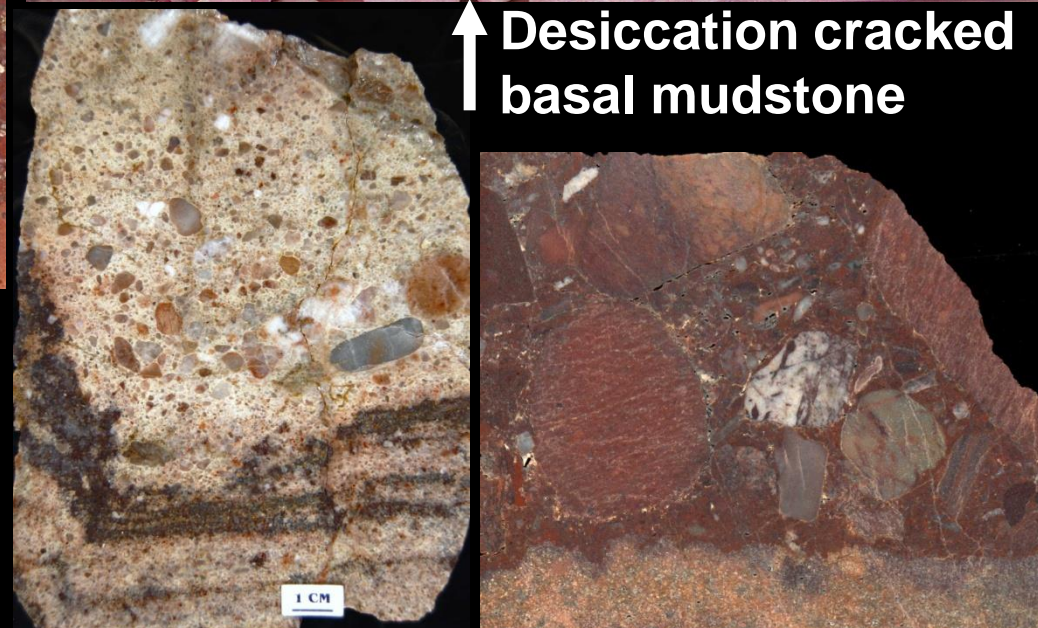
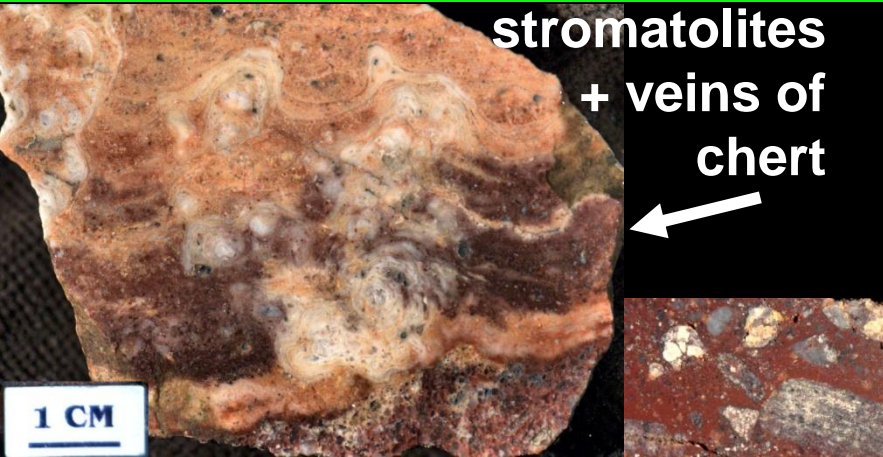
64°30'0"N

64°15'0"N

Amarook (Wharton) vs. Thelon at "Unconformity Lake"

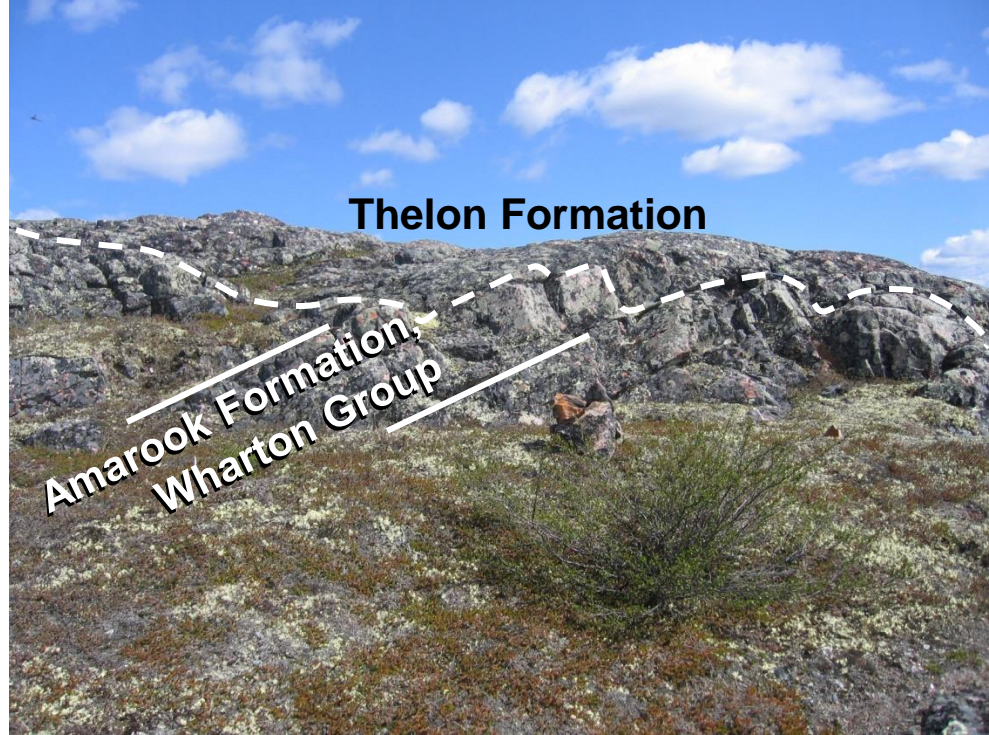


Conglomerates at “Unconformity Lake” Wharton Group vs. Thelon Formation



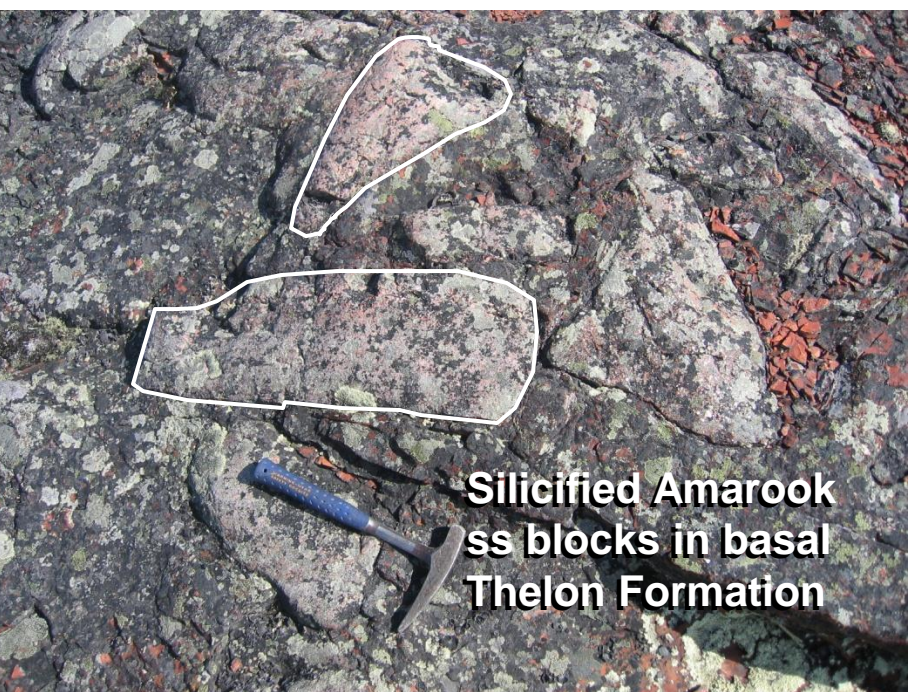


Microcrystalline quartz veins cutting silicified Amarook Formation sandstone



Thelon Formation

Amarook Formation, Wharton Group



Silicified Amarook ss blocks in basal Thelon Formation



Looking down on downward-terminating quartz breccia vein in hematitized metagreywacke

Kuungmi: thin, K-rich mafic lavas ~1.54 Ga

Wager Bay

NU
NT

Thelon
Wildlife
Sanctuary

Thelon
Basin

Kiggavik camp:

1.67 Ga

1.69 Ga
Boomerang L.

Hydrothermal
apatite replaced
by U_3O_8

Epiclastic rocks
reassigned from
Thelon Formation to
upper Wharton Group

Douglas: black
shale ~1.54 Ga

NT
SK

NU
MN

World class unconformity U camp:
Hydrothermal apatite 1.63 Ga
followed by U_3O_8

Athabasca
Basin

50 25 0 50 Kilometers

Hudson Bay

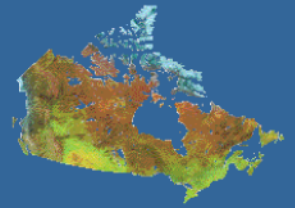
Dubawnt
Supergroup:
**Barrenland
Group -**

3rd siliciclastic
sequence;
unconformity
U deposits
with de-
silicification;
illite-chlorite
(Riegler 2013,
Sharpe 2013)



GEM

Recap of Dubawnt Supergroup LISP: magmatism & alteration keyed to Proterozoic sedimentation & U



Questions?

LISP 2
Kivalliq Suite

U TH1?

+ faults
+ clays
+ hem.

U TH2?

Predicted

U TH3

Kiggavik,
Lac 50.
Au at
Mallery L.

U TH4,5,6

+ faults
+ clays

Faulting
+ Ap-Pb

1540
Kuungmi
BLIP

~1750-1270: Thelon Fm.

Soft-sed.

Lookout Point
dolostone

1270, 1100...
Mackenzie etc.

LISP1
+ U:
Lac 50

~1750: Kivalliq Suite + Wharton Grp: Nueltin Grt., bimodal Pitz volc, diabase, quartzite, faulting, Q1 silicification, Au, Ag.

1.83 Ga: Hudson Suite, Christopher Is. Fm., Baker L. Gr., CO₃, S

1800

1700

1600

1500

1400

1300 Ma

1688, 1667

2
6

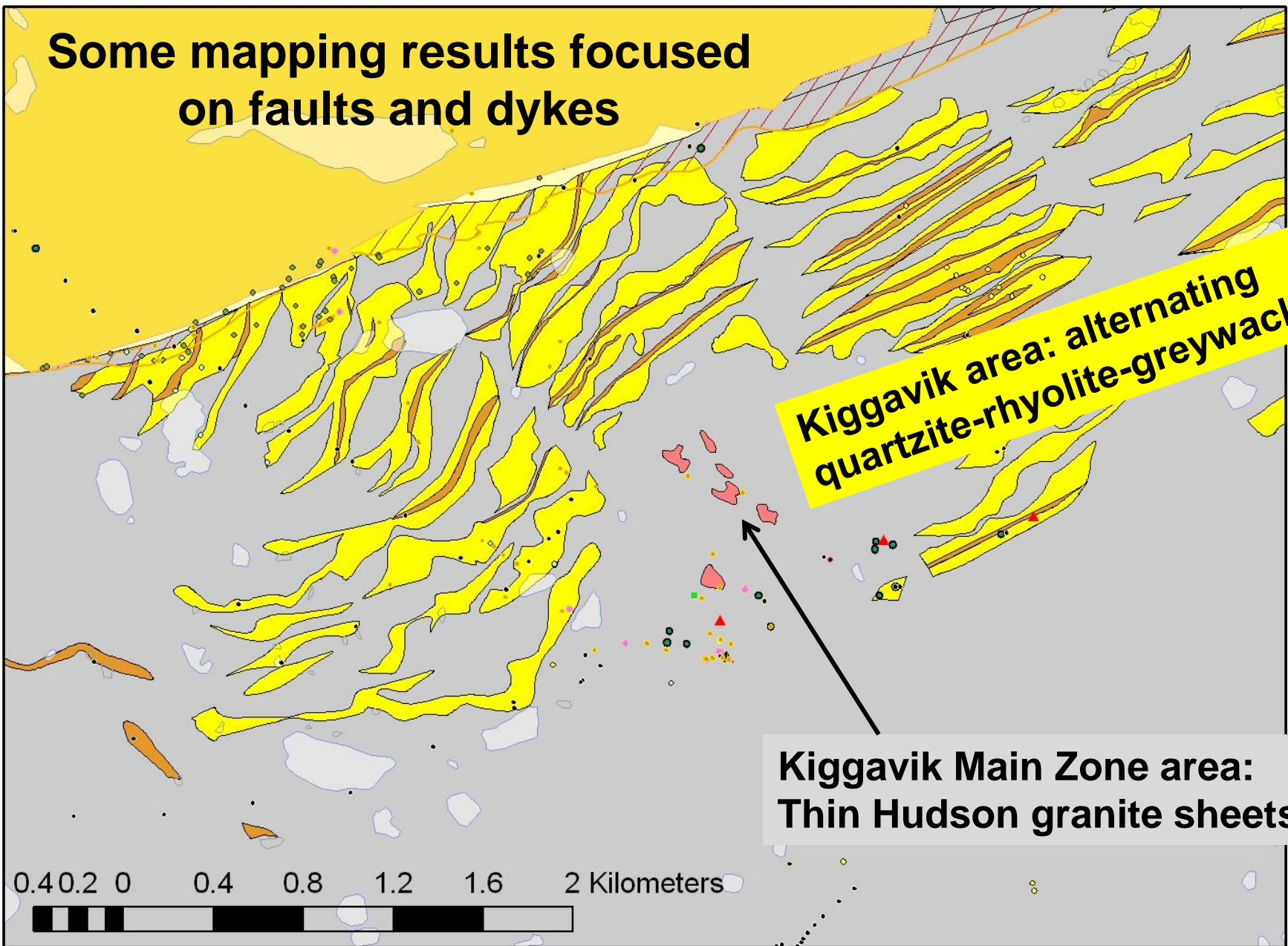


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Kyser et al. 2000, Beyer et al., 2011; Scott et al., 2011; Bridge et al., 2012; Davis et al., 2011+12; Robinson et al. 2012, Peterson et al. in prep.

Canada

Some mapping results focused on faults and dykes

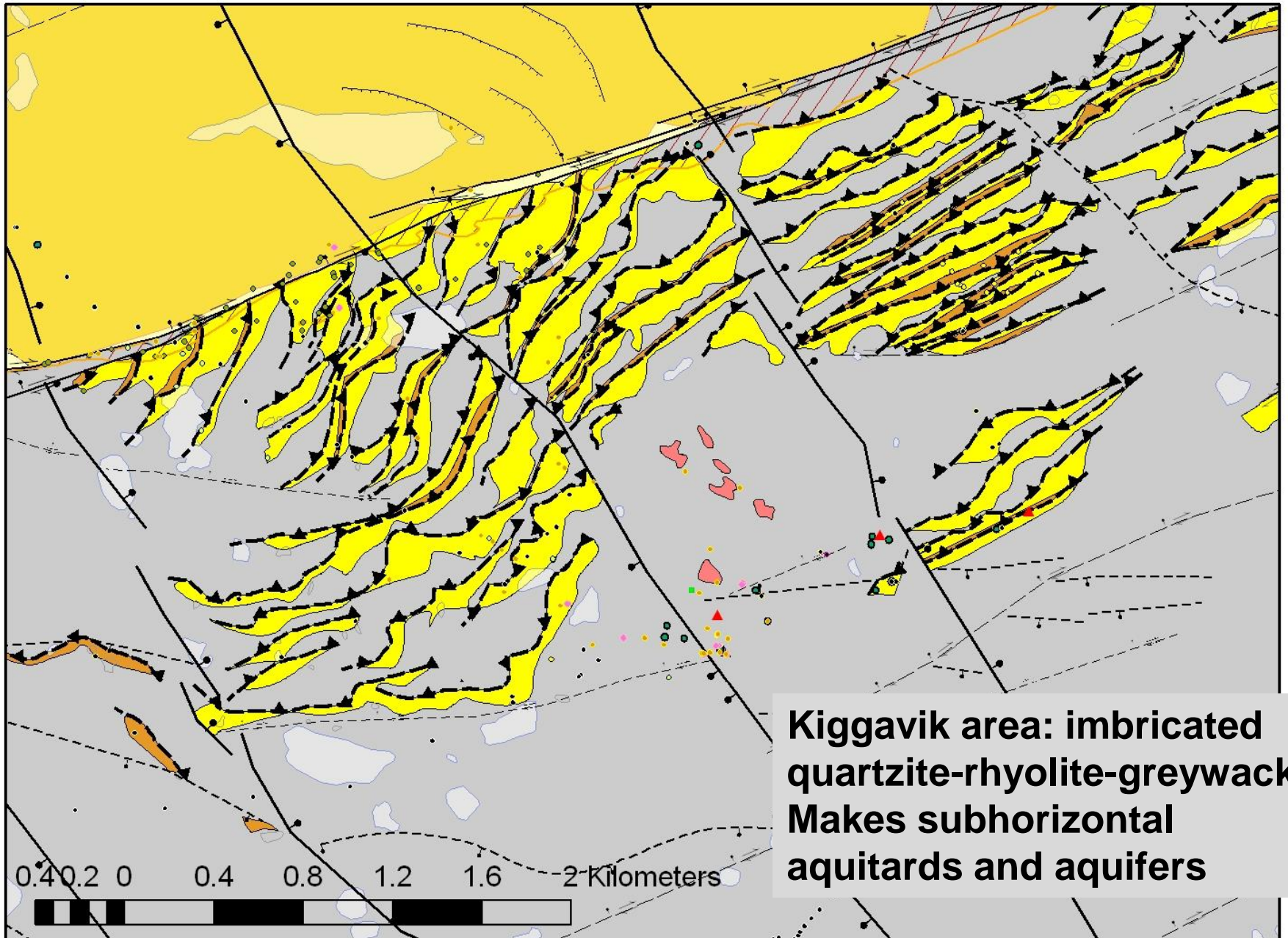


Kiggavik area: alternating quartzite-rhyolite-greywacke

Kiggavik Main Zone area: Thin Hudson granite sheets

0.4 0.2 0 0.4 0.8 1.2 1.6 2 Kilometers





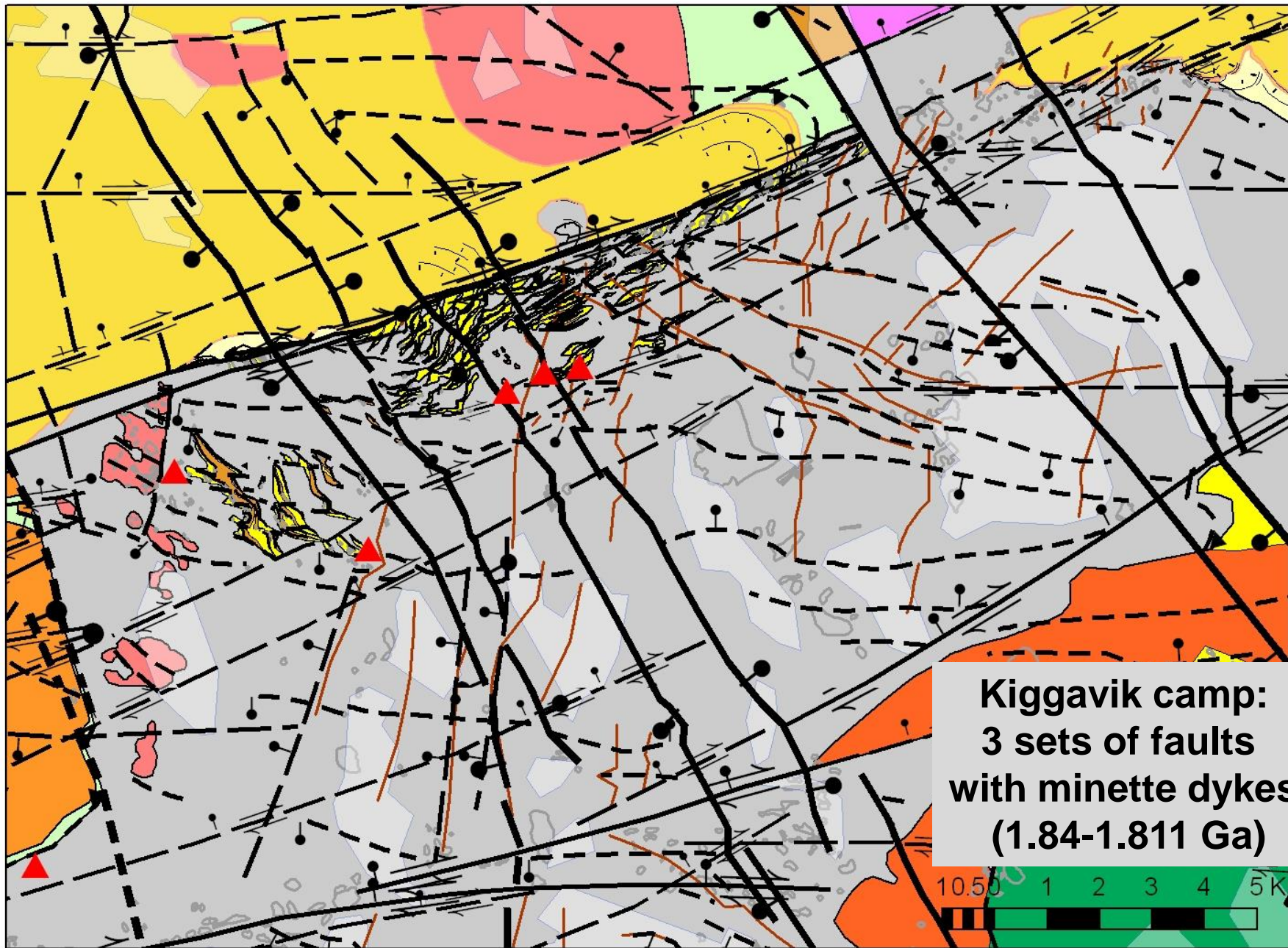
**Kiggavik area: imbricated quartzite-rhyolite-greywacke
Makes subhorizontal aquitards and aquifers**

4. Bostonite ~1.81Ga @ 350-020°
3. Bostonite ~1.81Ga @ 085-095°
2. Minette ~1.82 Ga @130 (115-145)°
1. Bostonite ~1.83 Ga @ 070°

**Kiggavik region:
3-5 swarms of
Minette & bostonite dykes
(1.84-1.811 Ga):**

15 km.



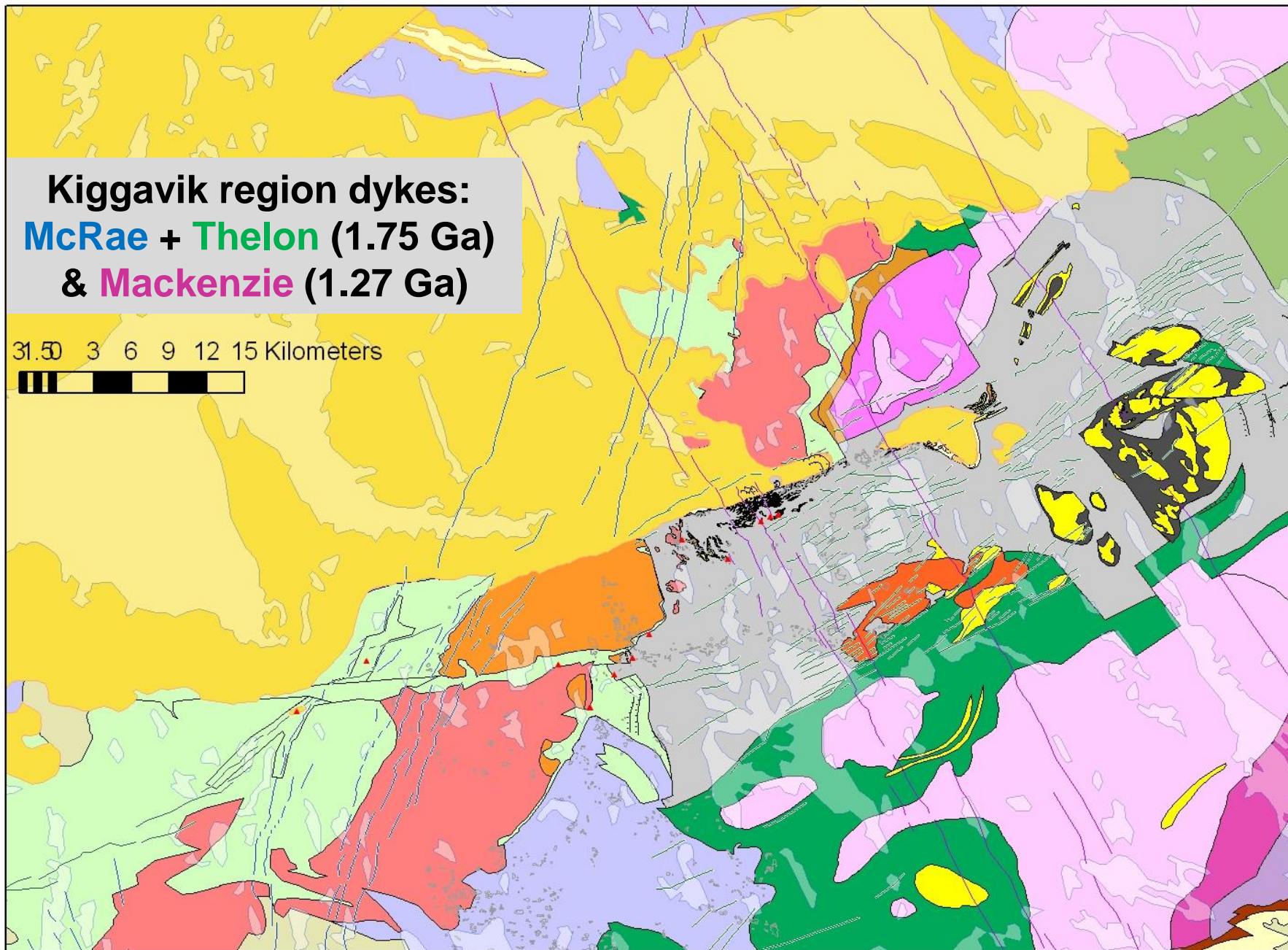


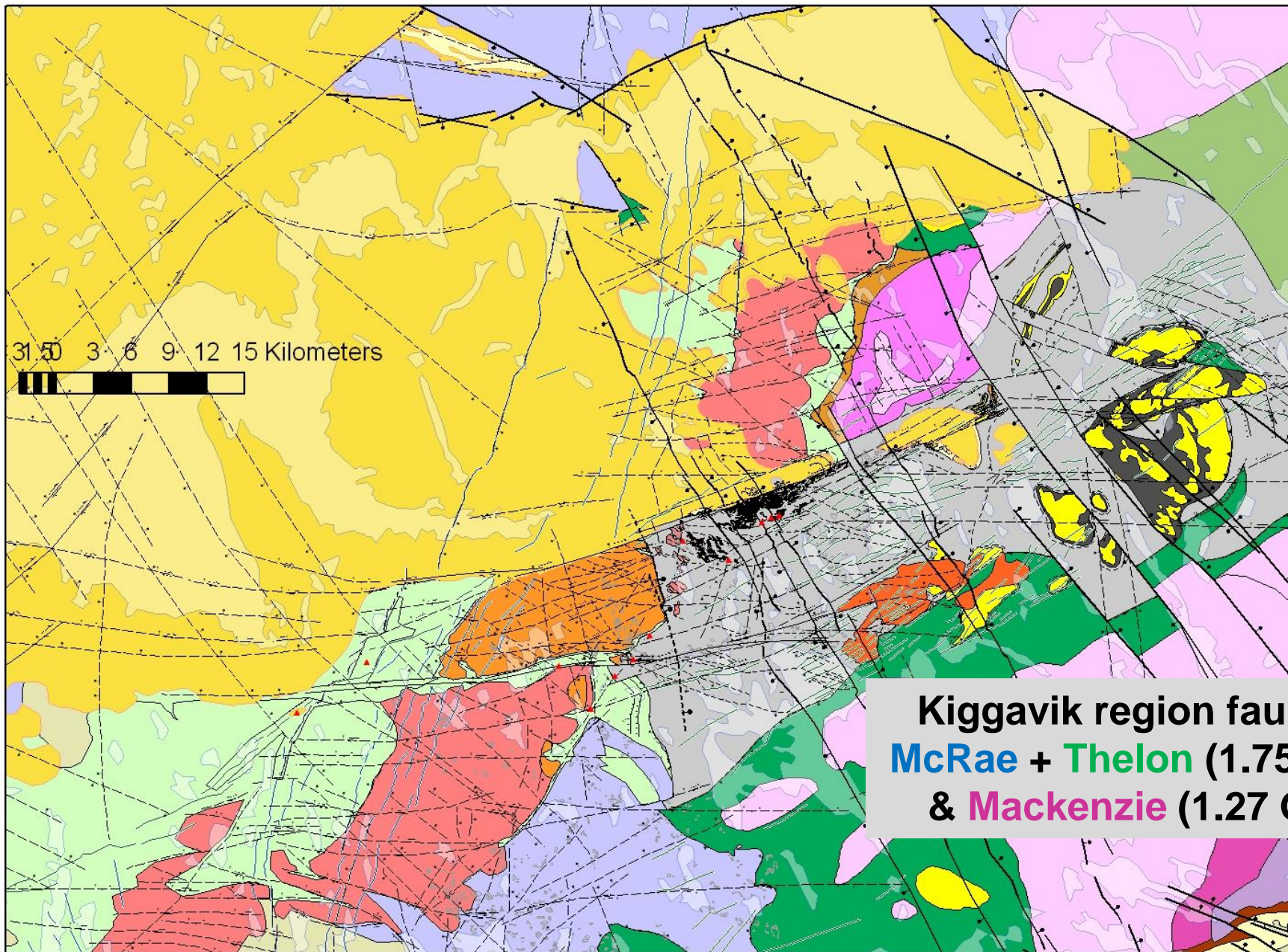
**Kiggavik camp:
3 sets of faults
with minette dykes
(1.84-1.811 Ga)**

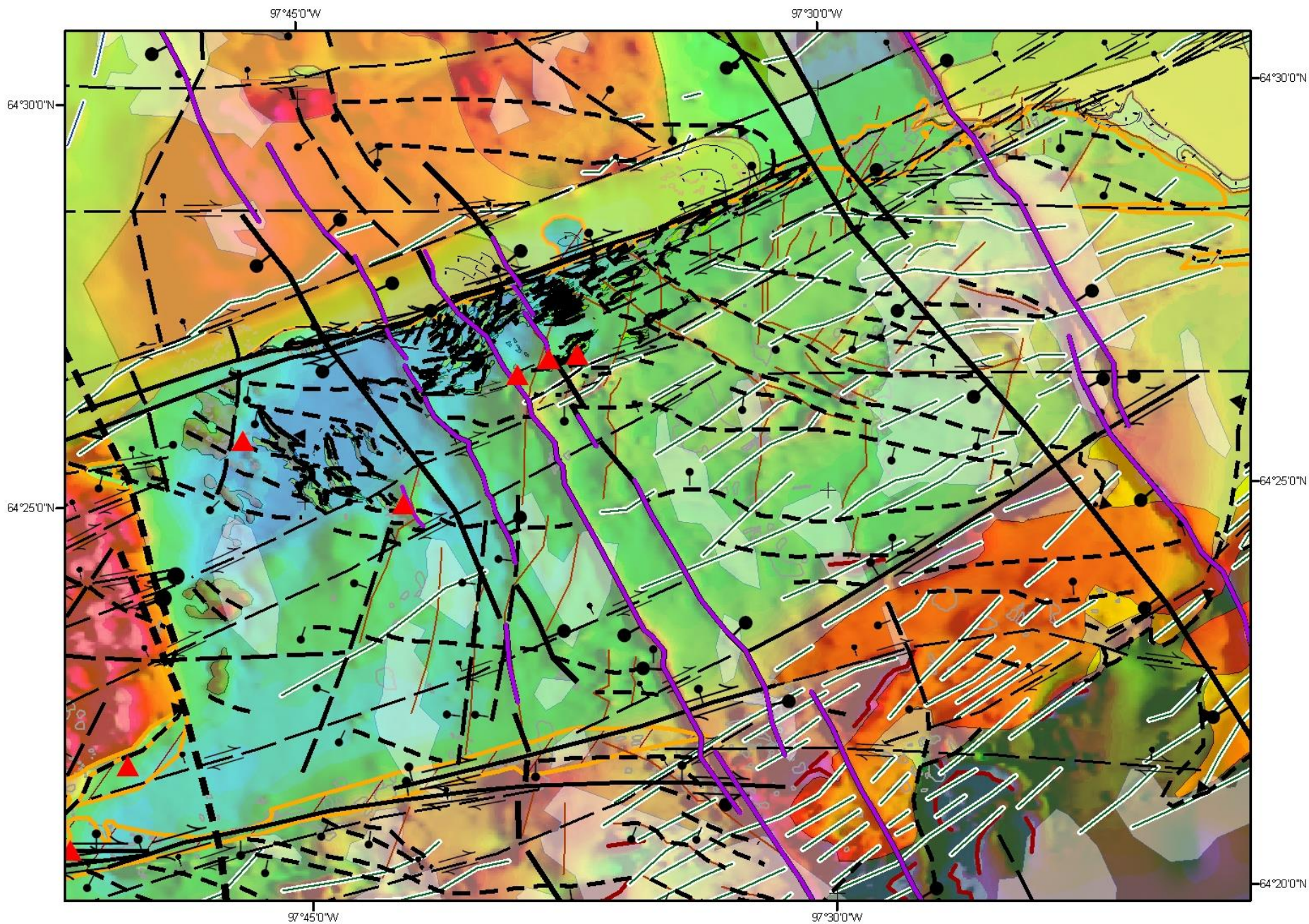


**Kiggavik region dykes:
McRae + Thelon (1.75 Ga)
& Mackenzie (1.27 Ga)**

31.5 3 6 9 12 15 Kilometers





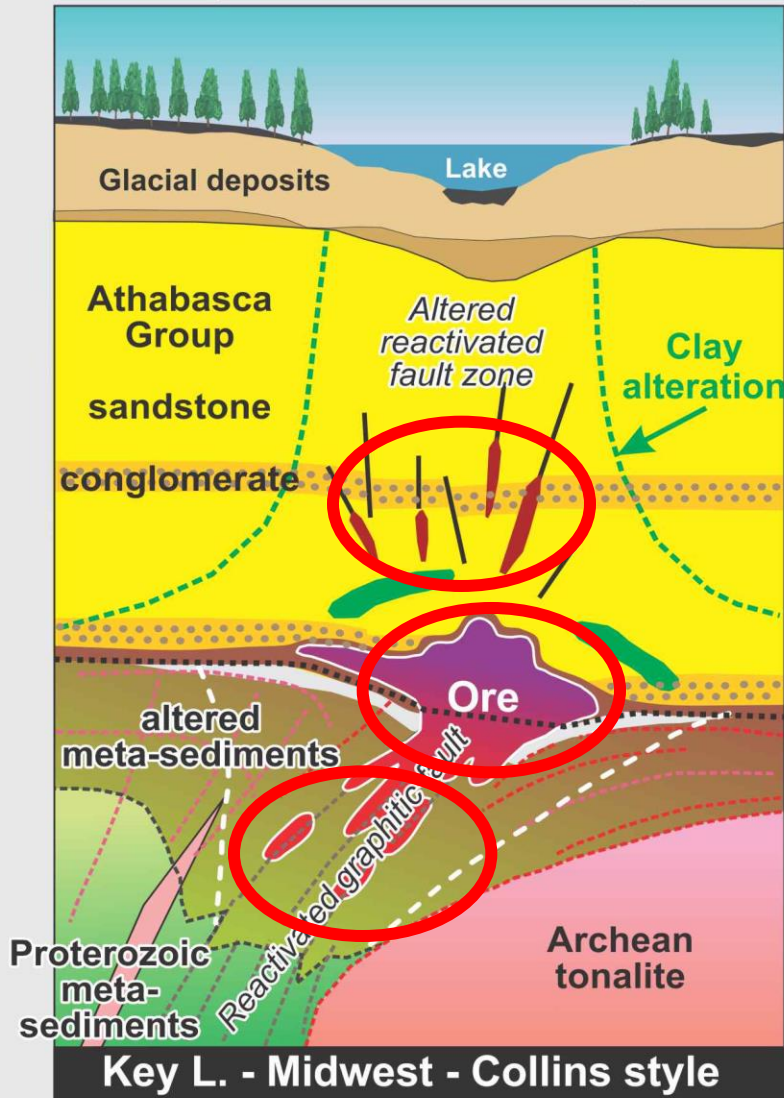


Kiggavik has many more fault intersections to think about!

Strategy: adapt the empirical model to the intrinsic

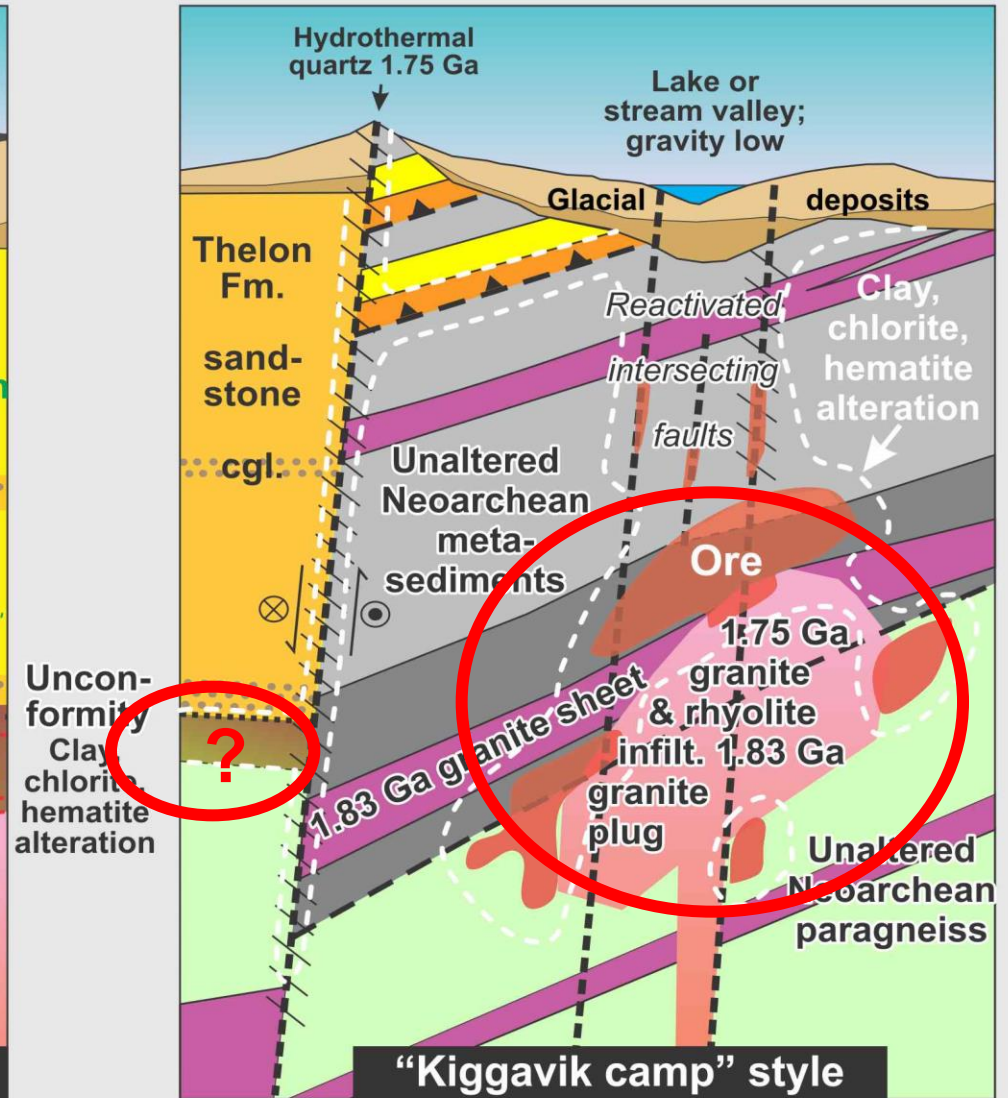
Athabasca Basin

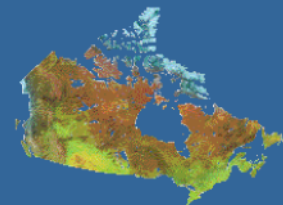
(after Jefferson et al. 2007)



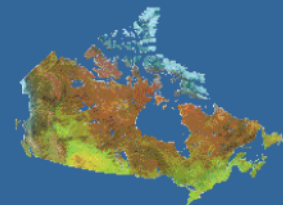
NE Thelon Basin

(after Wollenberg, Reilly, Wheatley, Hunter)

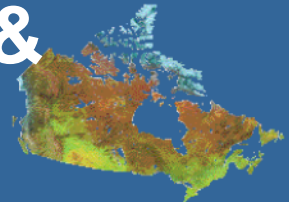




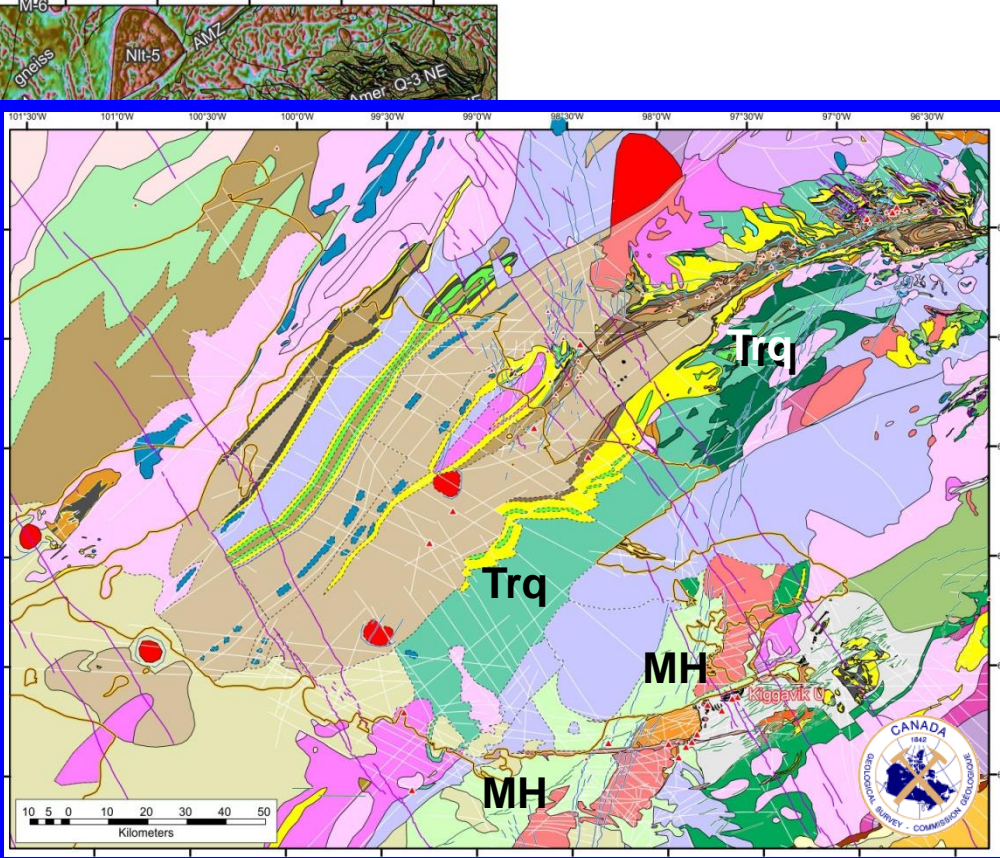
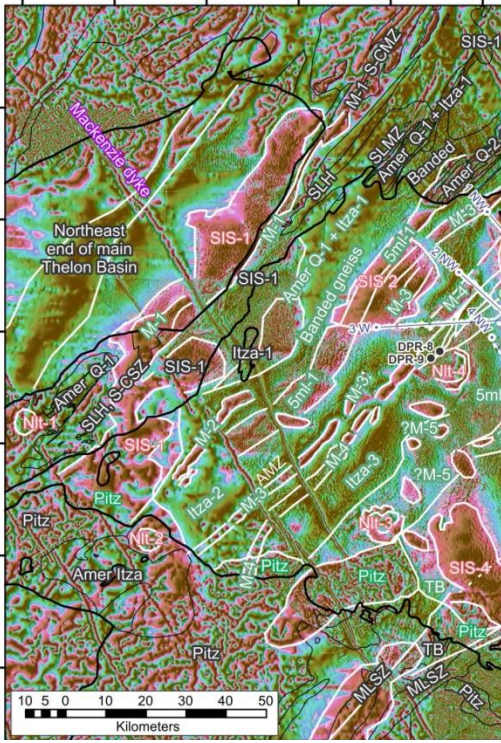
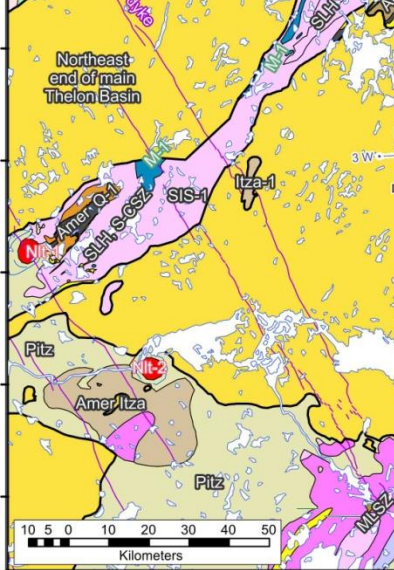
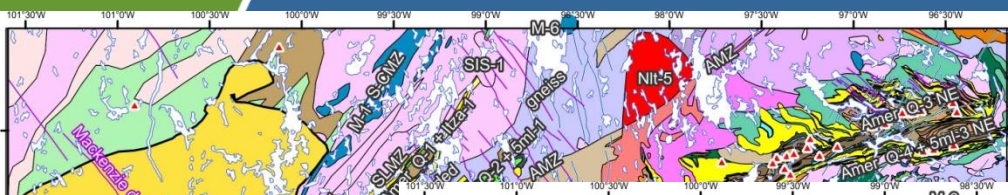
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- *Open File 7241: Bedrock geology of the western Marjorie-Tehek supracrustal belt and Northeast Thelon Basin margin in parts of NTS 66A and 66B, Nunavut – map and illustrations of Kiggavik camp*
- *Open File 7242: Bedrock geology of the Amer Belt, adjacent Neoproterozoic rocks and flanking northeast Thelon Basin in parts of NTS 66A, B, G and H, Nunavut*
- *Poster: Surficial geology of the Repulse Bay – Wager Bay area, Nunavut: results from the GEM Wager Bay activity (Campbell, McMartin et al.)*



- ¹Remote Predictive Mapping
- ²McMaster Univ., GSC, Gravity
- ³Univ. Regina, Univ. NB, GSC



New detailed bedrock geology in adjacent region

3
7
Edge detection methods on new aeromagnetic compilation

Integrated geology + magnetics + gravity; new map of basement under Aberdeen sub-basin



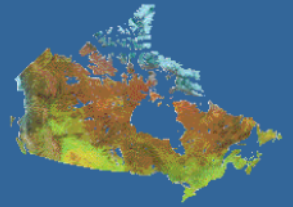


GEM



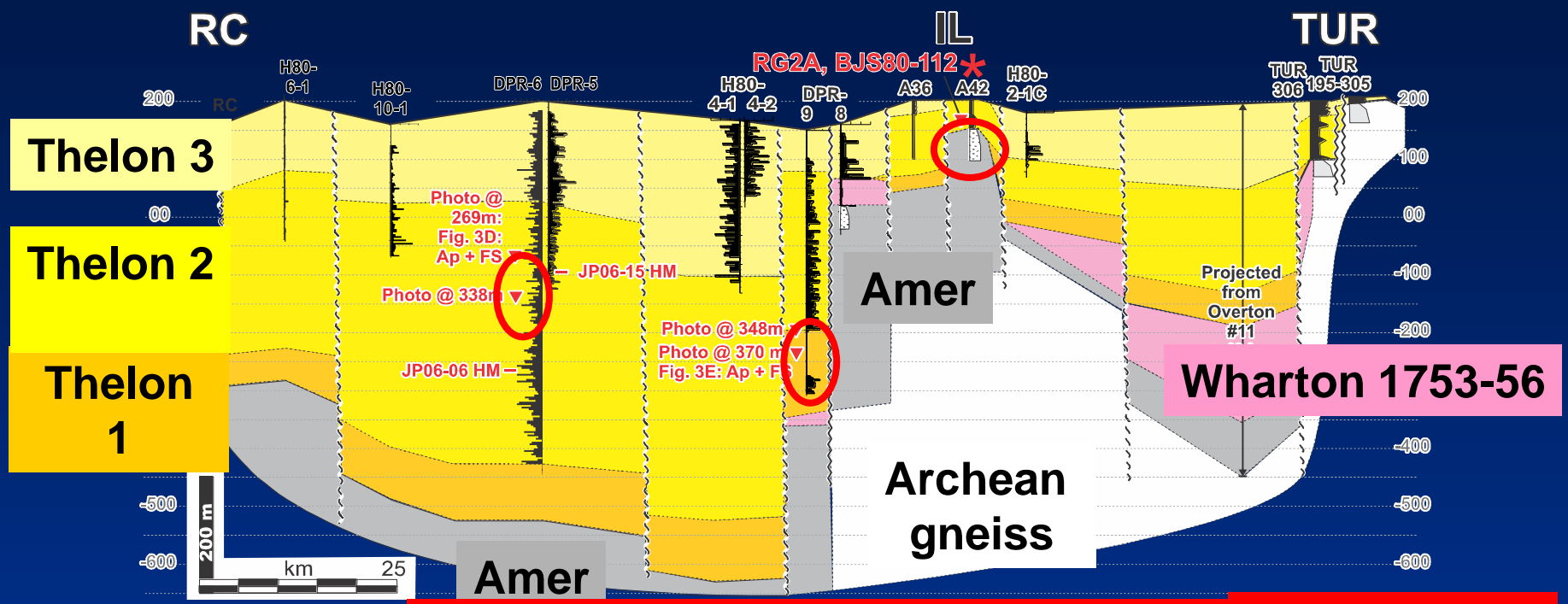
**Thanks to
so many!!!**



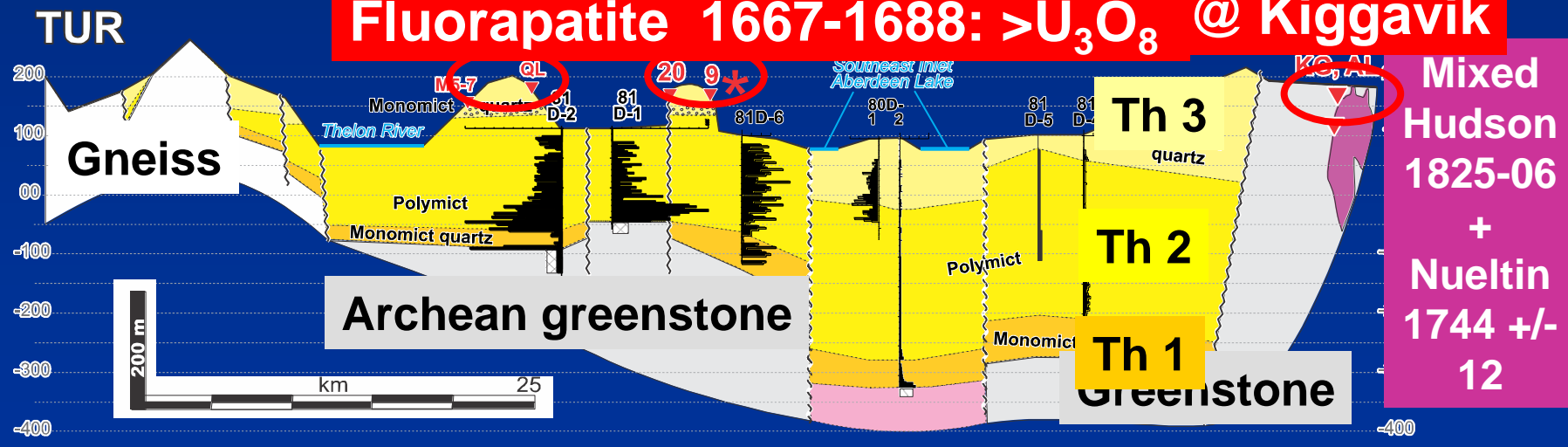


- In the following five panels

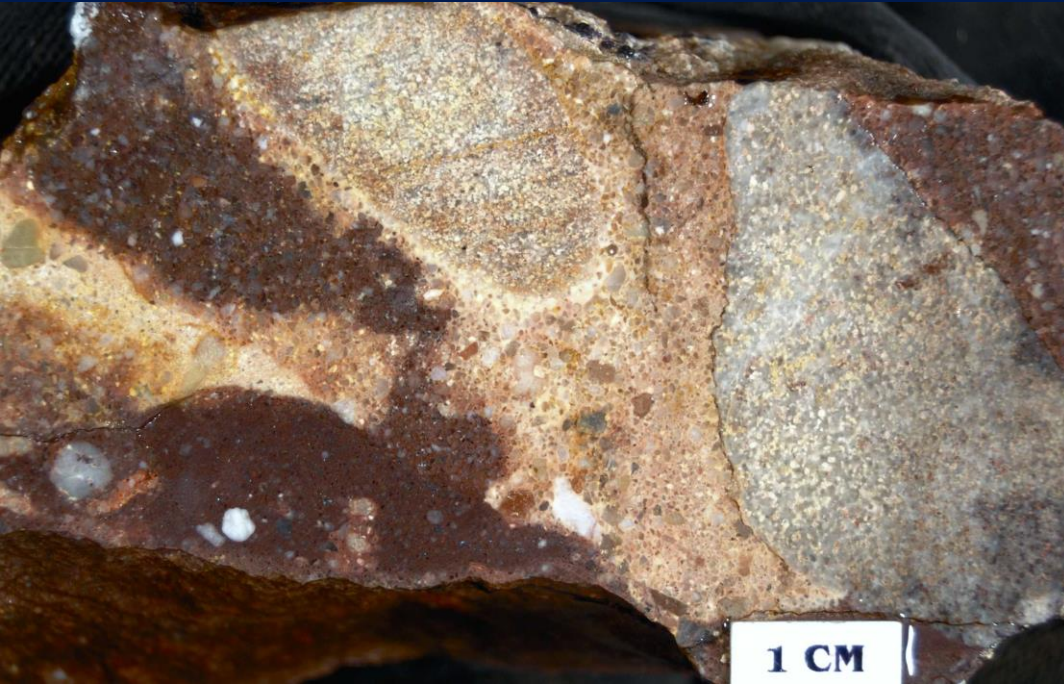
Sedimentary conglomerate review and context for apatite breccias cutting Thelon Formation



Fluorapatite 1667-1688: $>U_3O_8$ @ Kiggavik



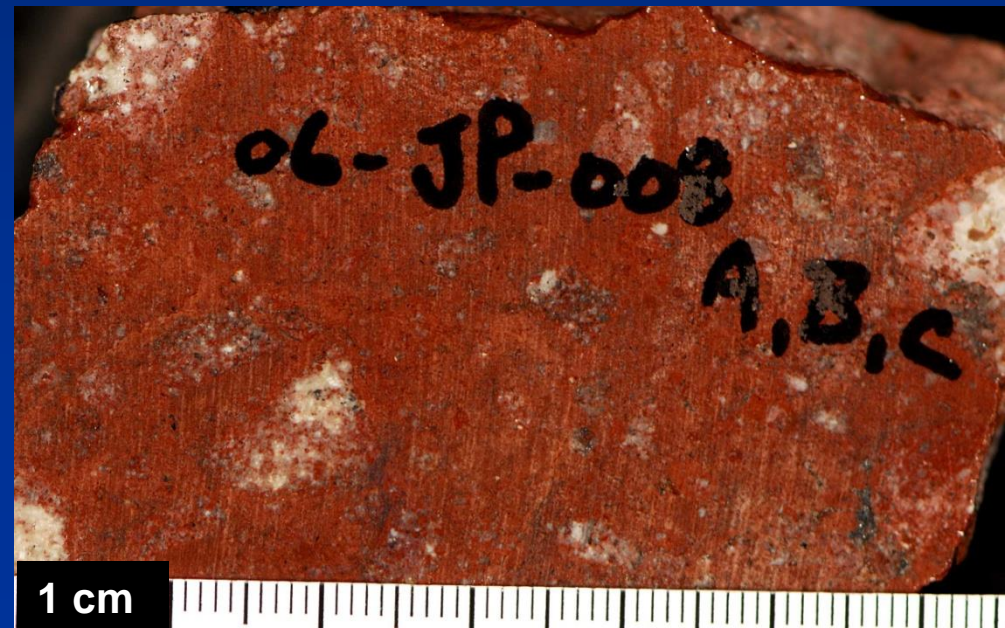
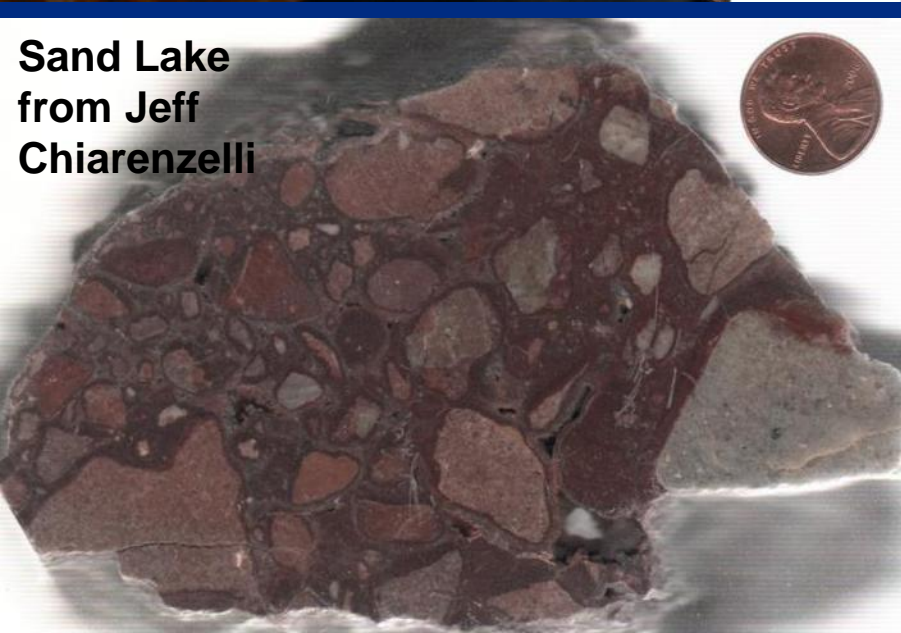
Fluorapatite-cemented breccias cutting Thelon Formation

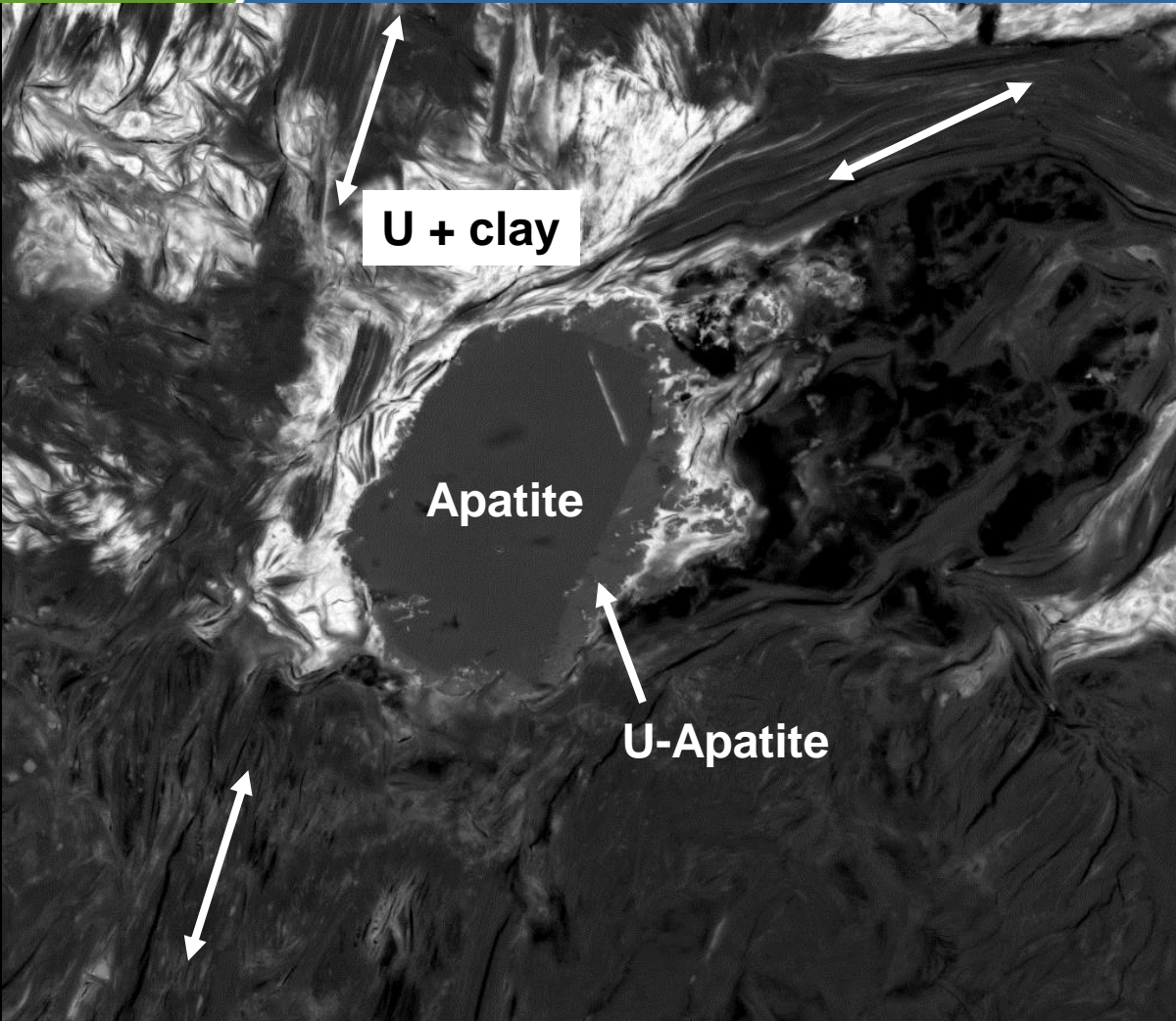


All in northeast Thelon
are 1667-1688 Ma.

See Davis et al. 2001 and
poster this conf.

See Scott et al. Tuesday
re apatite at Kiggavik





- Apatite abundant in altered & unaltered arkosic meta-greywacke, & various granitoid rocks
- Apatite with Pb only found in samples with alteration & U minerals
- Pb-rich apatite grains are too small for normal sand-size heavy mineral separations: trying silts
- Apatite in petrographic context with later U & clay minerals; tectonic fabric link to fault arrays & ages

det	mag	HV	WD	x: 53.2560 mm	50 µm
BSED	1 758 x	25.00 kV	10.9 mm	y: 1.1055 mm	BSED (Z contrast)
8/16/2011	det	WD	mag	HV	HFWD
10:40:38 PM	BSED	10.2 mm	2 817 x	20.00 kV	106 µm
					30 µm
					BSED (Z contrast)



Slave
indentor

Bathurst Ft.

Amer Mylonite Z.

North edge
Thelon Basin

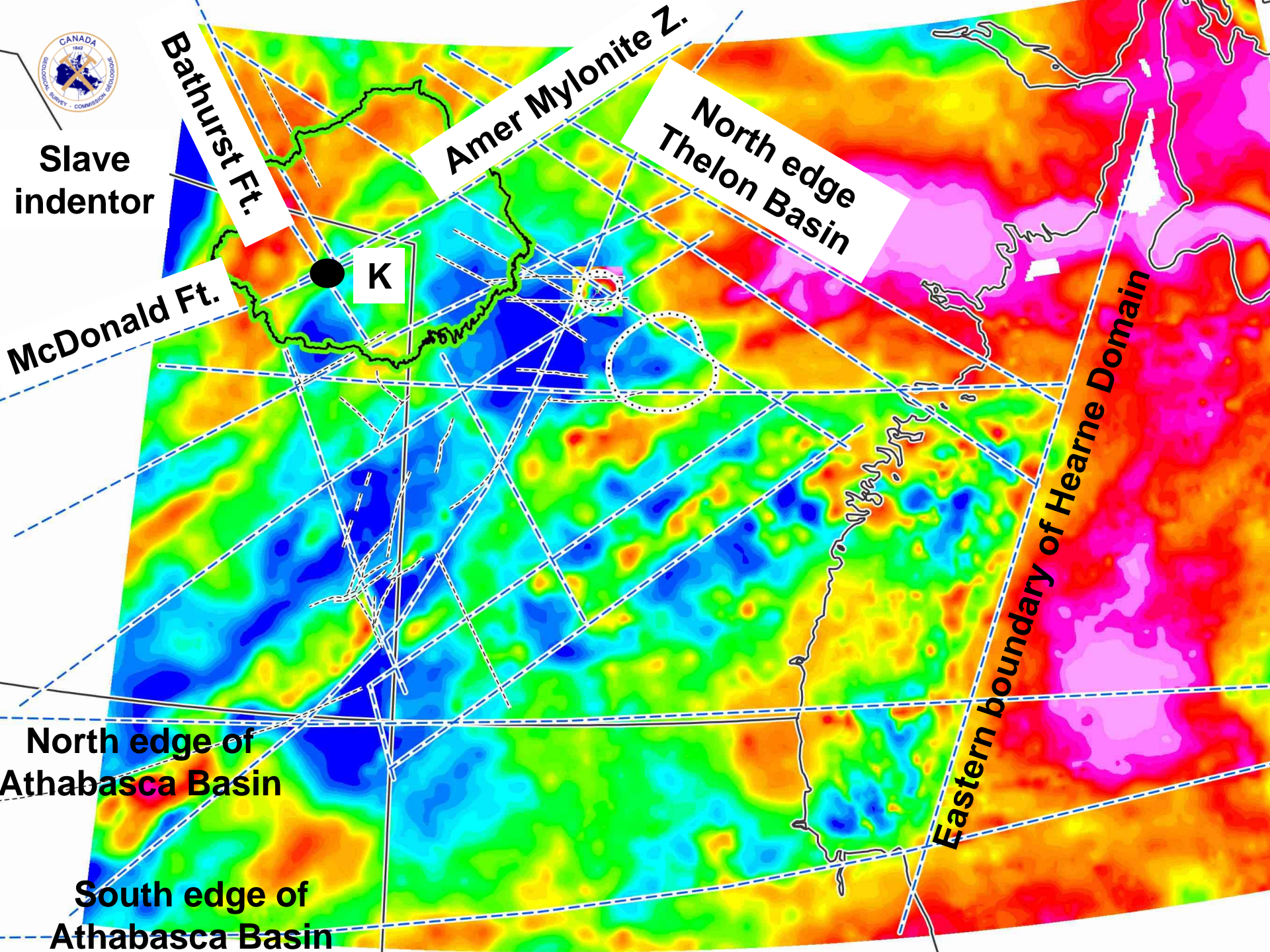
K

McDonald Ft.

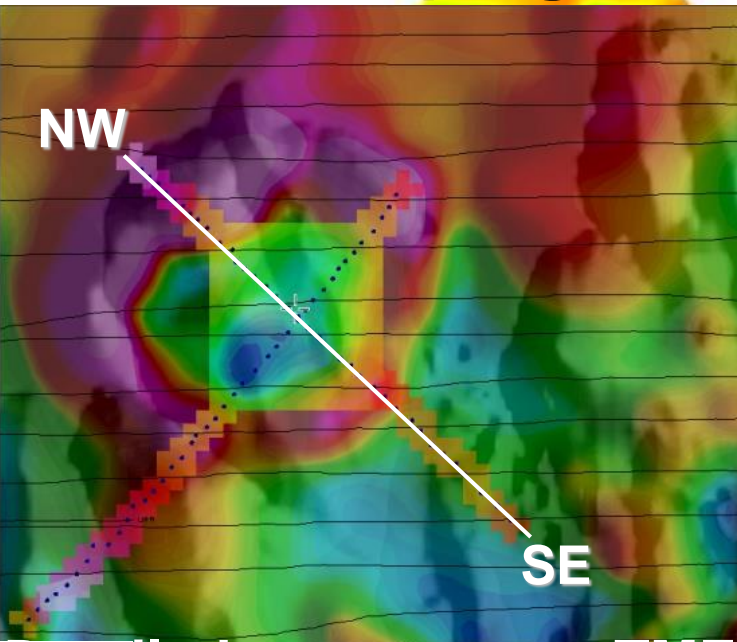
Eastern boundary of Hearne Domain

North edge of
Athabasca Basin

South edge of
Athabasca Basin



Developing & testing the gravity model



Mallery Lake

