

A photograph of layered grey rock with a white marker and a boot for scale. The rock shows distinct horizontal bedding planes and some reddish-brown staining. A white marker with a black cap lies horizontally across the rock. In the bottom right corner, a portion of a brown boot with white laces is visible.

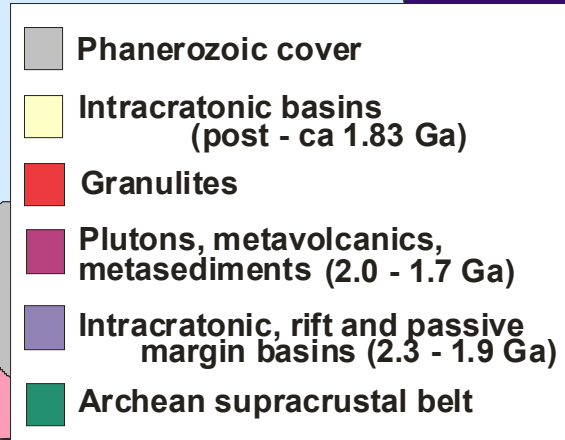
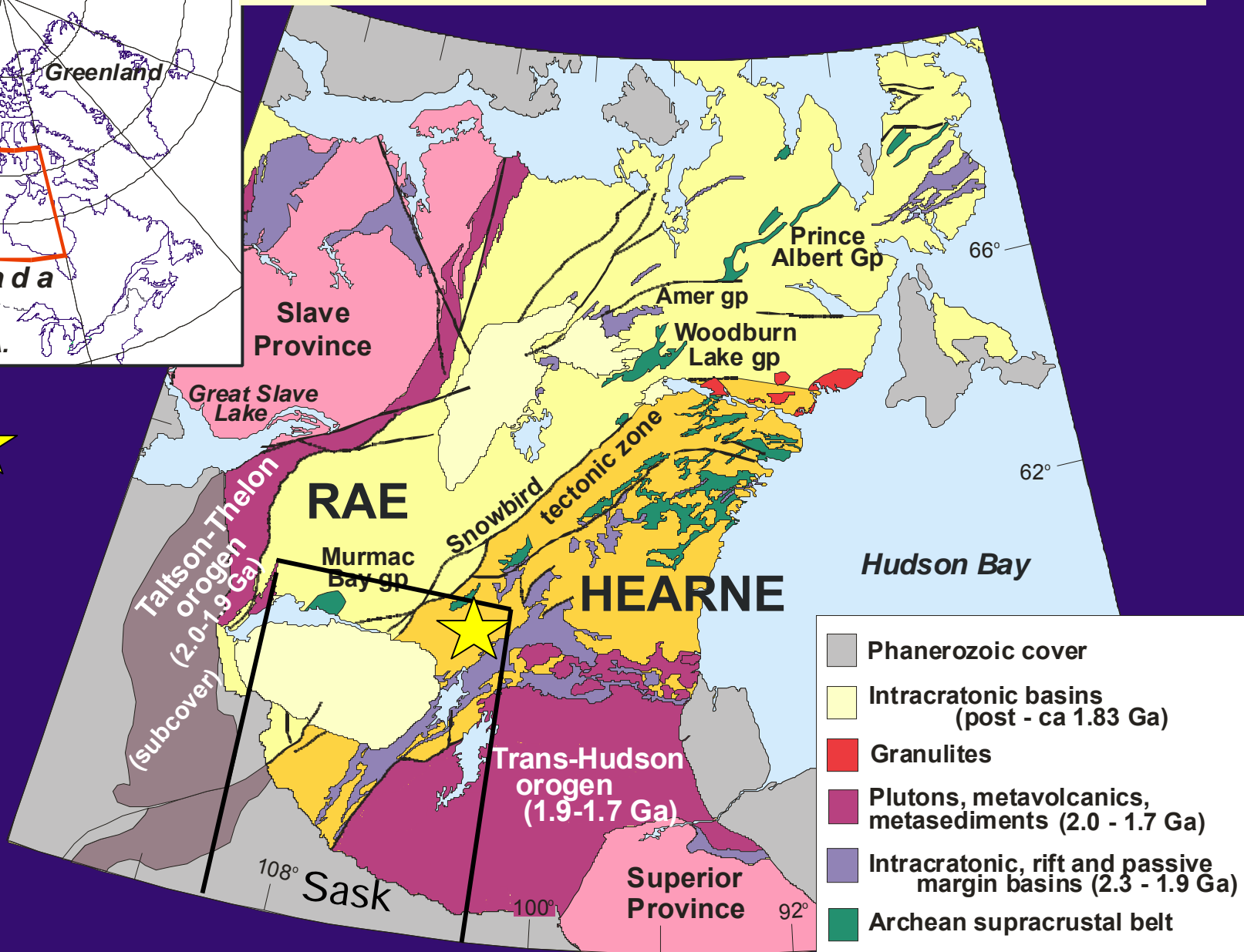
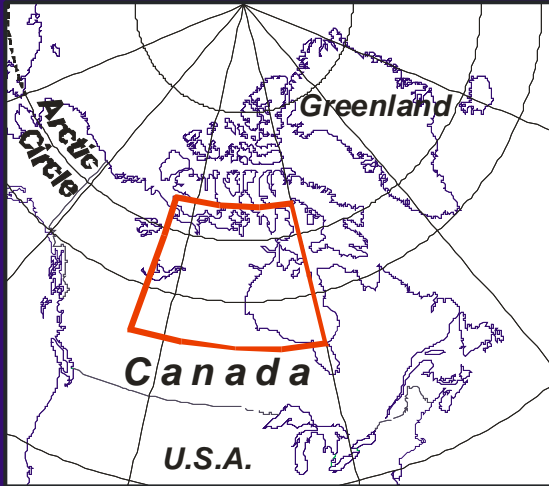
The Phelps Lake Project: Geochronology and Geochemical Update and Speculation on Archean History of the Hearne Province

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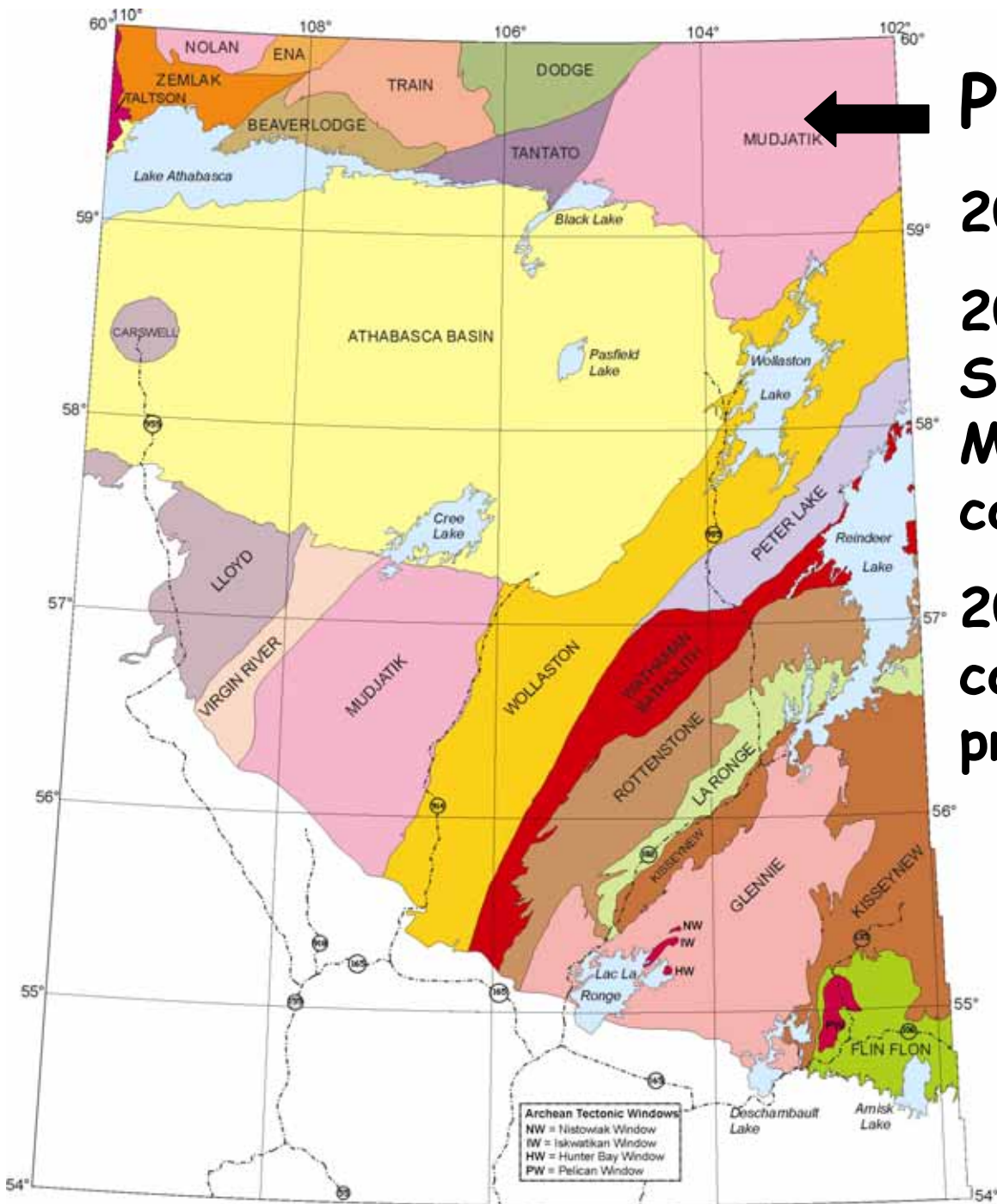
Outline

- Introduce Phelps Lake Project
- New 1:250 000 compilation map
- Geochronology highlights
- Geochemistry highlights
- Archean history of Hearne Province
- Summary

Western Churchill Metallogenic Project



Phelps Lake Project ★



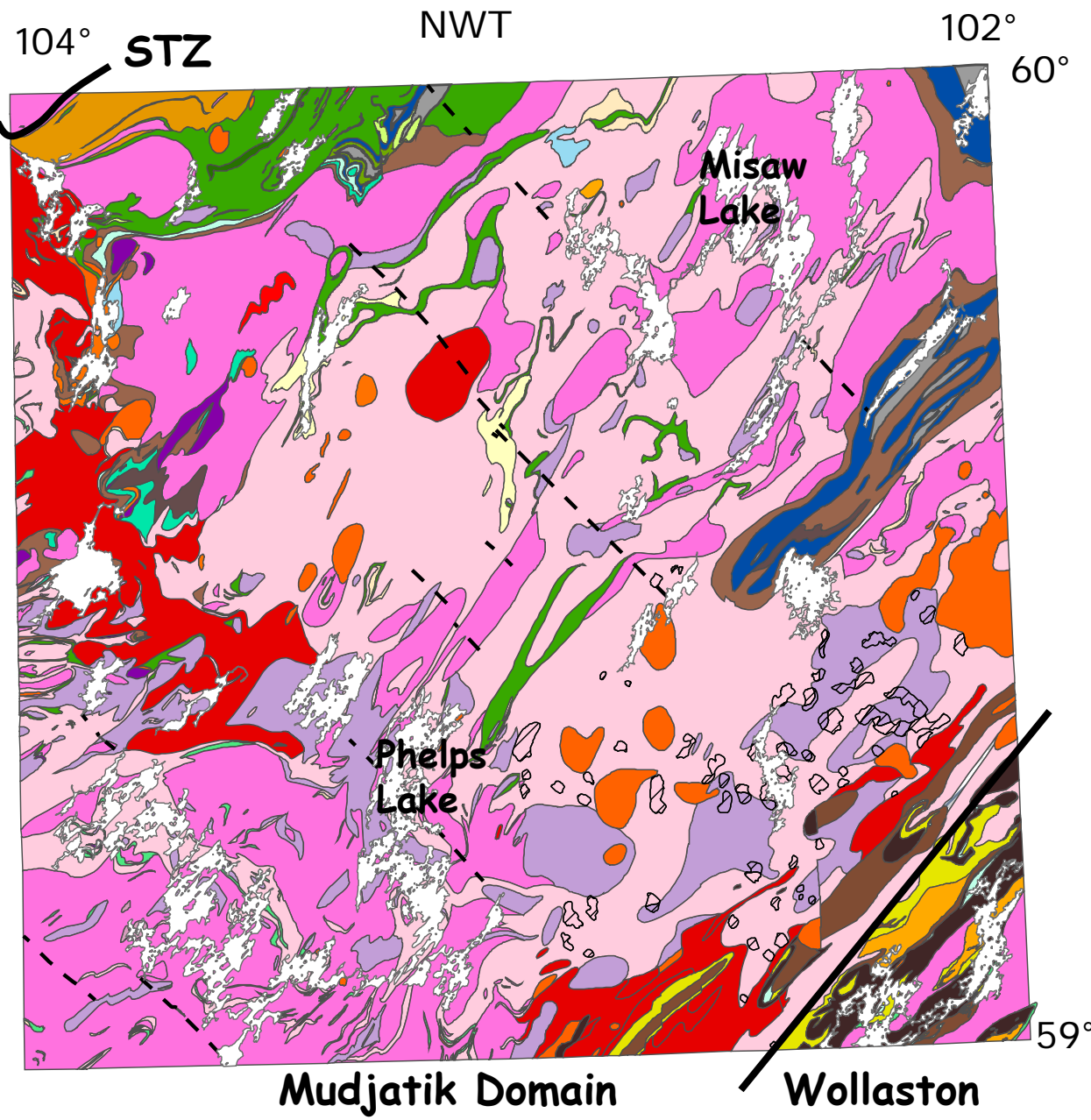
Phelps Area

2000 Airborne survey








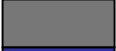











2001-2003 Geological, Surficial, & Metallogenic field components completed

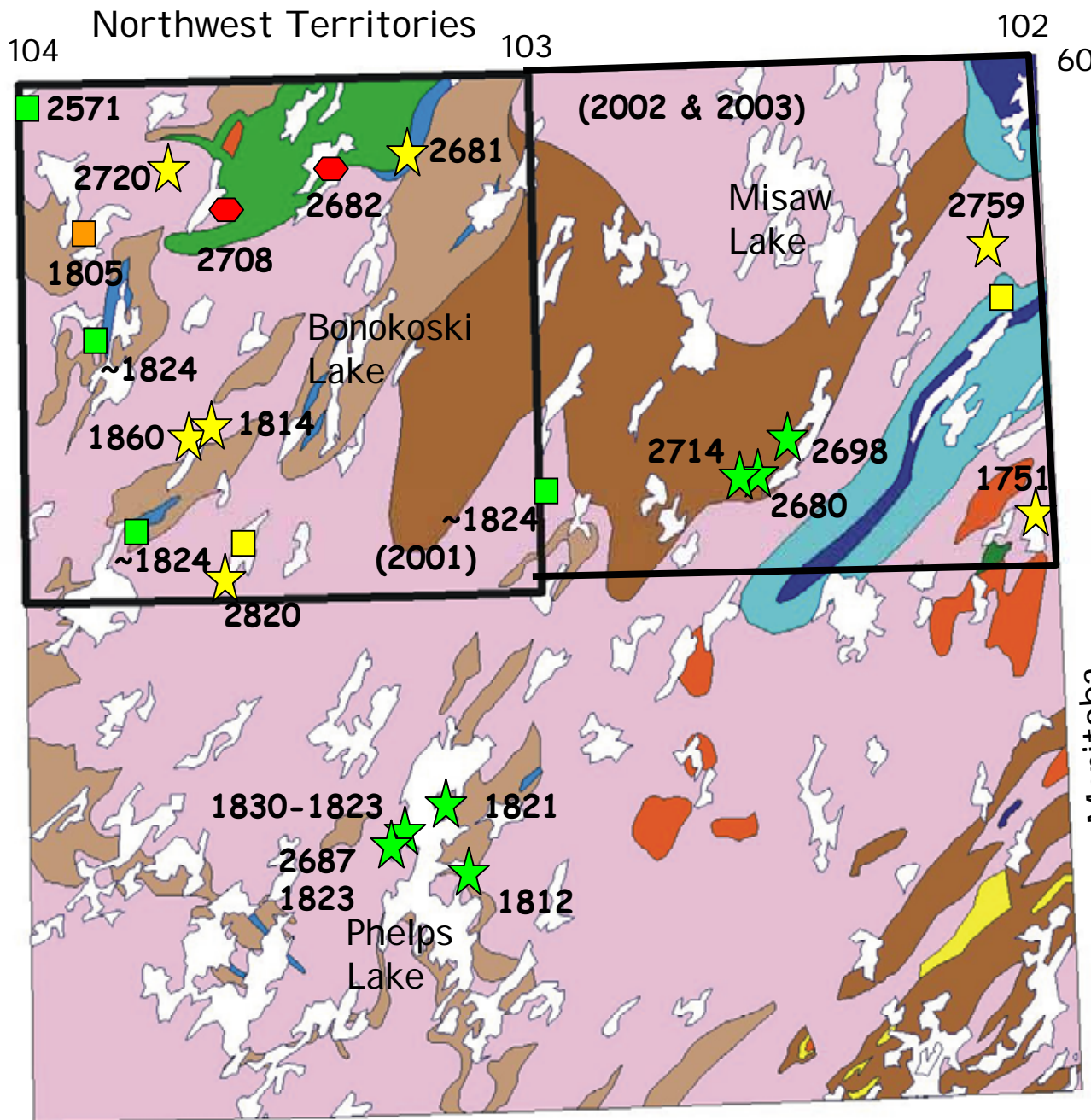
2004-05 Map compilation, and report preparation

New 1:250K Compilation Geology Phelps Lake (64M)



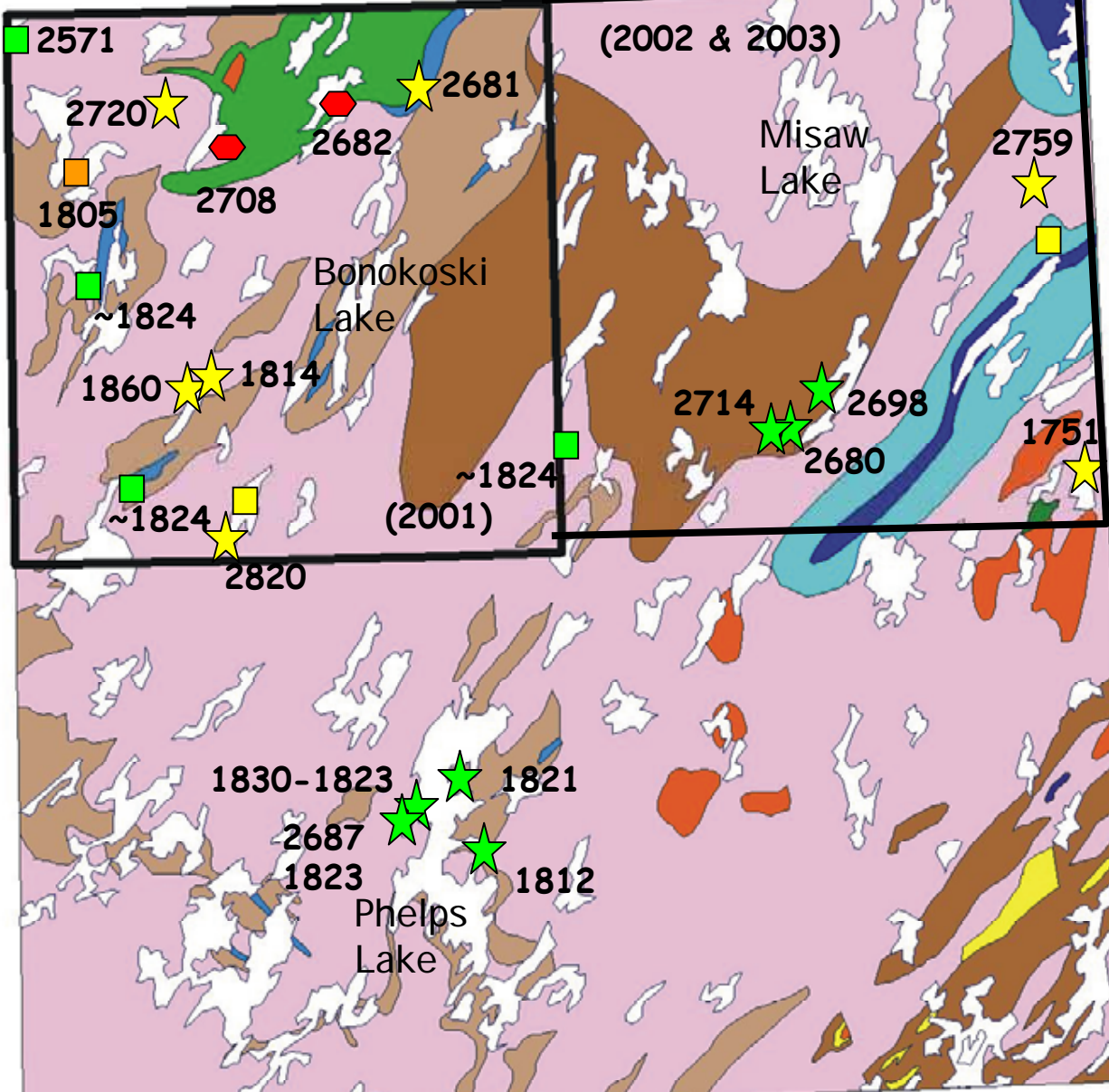
Legend

-  Diabase
-  Nueltin Granites
-  Leucotonalite
-  Intrusive contacts
-  Wollaston
-  Supergroup
-  Hurwitz Group
-  Hurwitz Group
-  Hurwitz Group
-  Hurwitz Group
-  Hurwitz Group
- ~~Unconformity~~
- Archean
-  Granite
-  Tonalite
-  Intrusive contacts
-  Ennadai Group
-  Ennadai Group
-  Ennadai Group
- ~~Unconformity?~~
-  Granitic migmatite
-  Tonalitic migmatite



Geochronology Sample Locations

- ◆ Existing dates
- ★ Dates from GSC & U of A
- Titanite (amphib)
- ★ GSC SHRIMP dating
- Monazite dating
- Still to be processed

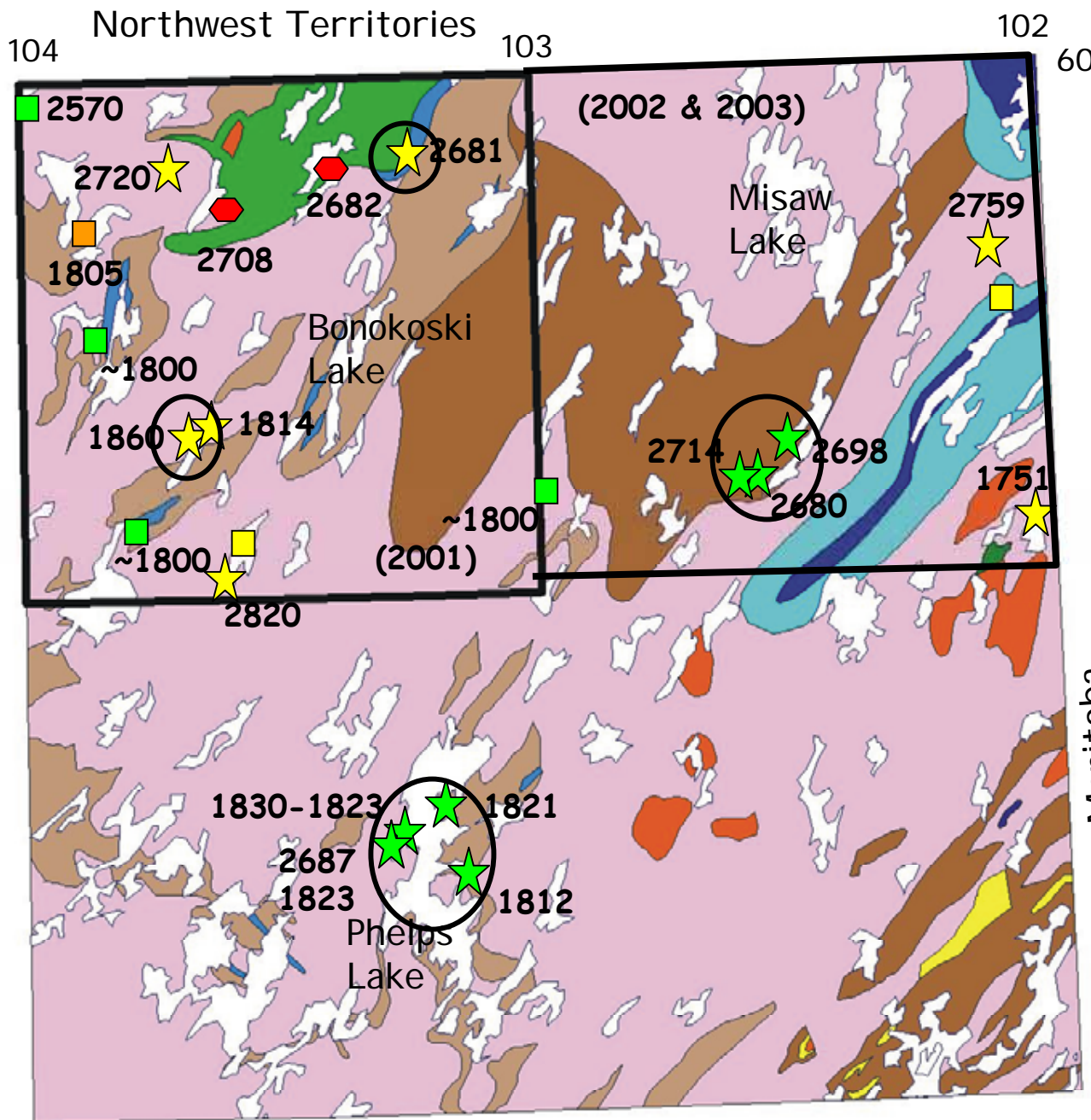


Phelps Archean Geochronology

Tonalite Migmatite	2820 Ma (Z)	Crystallization
Leucogranite gn	2759±18 Ma (Z)	?Crystallization
Leucogranite gn	2722 Ma (Z)	Crystallization
Tonalite orthogneiss	2712±6 Ma (ZS) (2736-2726 Ma)	Crystallization Inheritance
Leucotonalite	2708±3 Ma (Z) (1771 Ma (T))	Crystallization metamorphic overprint
Tonalite gneiss	2698±6 Ma (ZS)	Crystallization
Tonalite gneiss	2687±12 Ma (ZS) (1821±9 Ma (ZS))	Crystallization igneous overprint
Ennadai Rhyolite	2682±6 Ma (Z)	Volcanism
Ennadai Rhyolite	2681±2 Ma (Z) (1760-1750 Ma (T,R))	Volcanism metamorphic overprint
Granite gn	2681±7 Ma (ZS) (2701-2726 Ma) (2839-2943 Ma) (2960-2988 Ma)	Crystallization Inheritance Inheritance Inheritance
Mylonitic Pelite	2571±4 Ma (M)	Metamorphism

Phelps Paleoproterozoic Geochronology

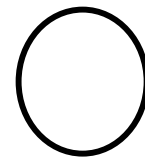
Jones L. Granite	~1860 Ma (Z) (3108 Ma UI)	Hudson granite Inheritance
Amphibolite	(1821-1812 Ma (M))	Metamorphism
	1830±12 Ma (ZS)	Metamorphism
	1823±2 Ma (Z)	Metamorphism
	(1778±5 Ma (T))	metamorphic overprint
Archean Pelitic gn	1824±8 Ma (M)	Metamorphism
Archean Pelitic gn	1824±8 Ma (M)	Metamorphism
Hurwitz pelitic gn	1824±8 Ma (M)	Metamorphism
Porph granite	1821±5 Ma (ZS)	Hudson granite
	(1915 Ma (ZS))	Inheritance
	(2685-2695 Ma)	Inheritance
Jones L. tonalite	1814±3 Ma (Z)	Crystallization
Anatectic gd	1812±4 Ma (ZS)	Crystallization
	(2565-2761 Ma)	Inheritance
Amphibolite	1806±4 Ma (T)	Metamorphism
Spratt L. fl granite	1751±2 Ma (Z)	Nueltin granite



Geochronology Sample Locations

- ⬠ Existing dates
- ★ Dates from GSC & U of A
- Titanite (amphib)
- ★ GSC SHRIMP dating
- Monazite dating
- Still to be processed

Nd Isotope Data



Geology from 1:1 000 000 Compilation

Sm-Nd Isotopic Results

Sample #	Rock	Age	ϵNd	TDM
	Type	GA		GA
0311-5006	Amphib	2.720	2.90 ± 0.44	3.20
0311-5002	Ton mig	2.716	2.05 ± 0.42	2.85
0311-5003	Tonalite	2.700	1.41 ± 0.43	2.88
0311-5007	Tonalite	2.687	na	
0111-3003	Rhyolite	2.681	2.85	2.77
0311-5001	Granite	2.680	-0.48 ± 0.45	3.02
0111-3002	Granite	1.860	-13.37	2.98
0311-5005	Granite	1.821	na	
0311-5008	Anatec Gd	1.812	-10.74 ± 0.45	3.09

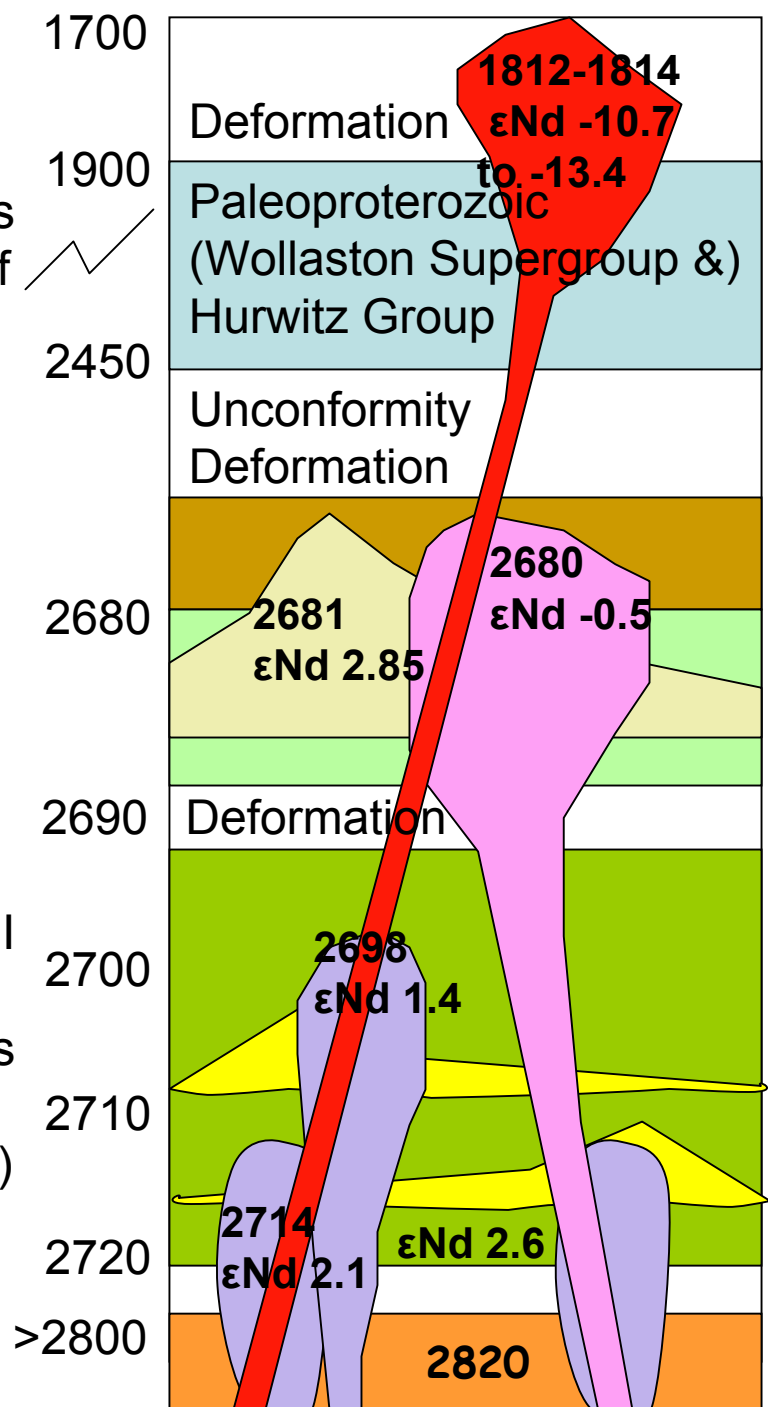
NE Saskatchewan

Nueltin (1.751) & Hudson (1.86, 1.821, 1.814, 1.812) granites
Strong deformation of Hurwitz (1.83 – 1.8)

Archean
Psammopelite to pelite, IF
Equiv. to Volc Assem II (2.68), synvolcanic intrusions

Equiv to Volc Assem I with minor seds, IF, synvolcanic intrusions (2.708) (2.723; Martel (2004))

Older crust (2.8-3.1) present & being melted by 2.68



Central Hearne, Nunavut

Nueltin Granites (1.76-1.75)
Mild deformation of Hurwitz

Late Archean intrusions
Turbidites, IF, cong, arkose

Volcanic Assemblage II
Felsic, intermediate & mafic flows & volcanoclastic rocks, synvolcanic intrusions

Volcanic Assemblage I
Mafic massive & pillowed flows, minor felsic volcanics, synvolcanic intrusions

No evidence for older basement

(Davis et al., 2004; Hanmer et al., 2004; Sandeman et al., 2004)

Geochemical Highlights

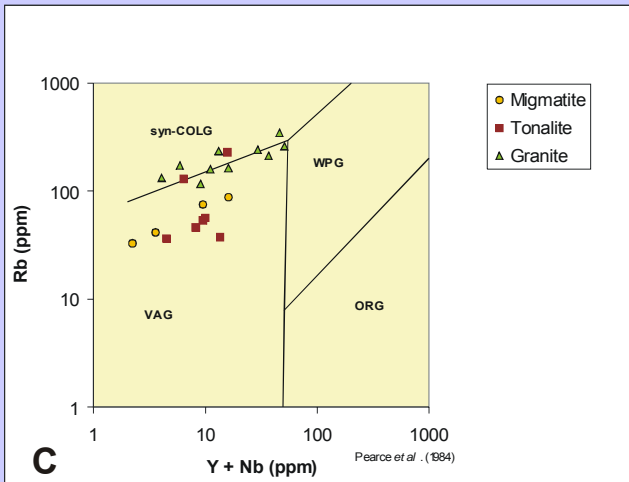
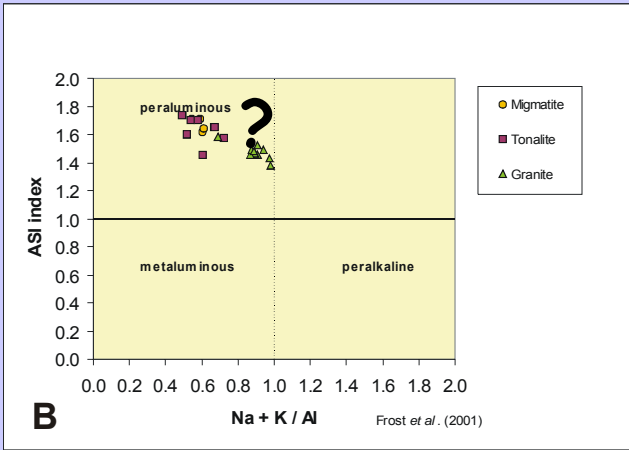
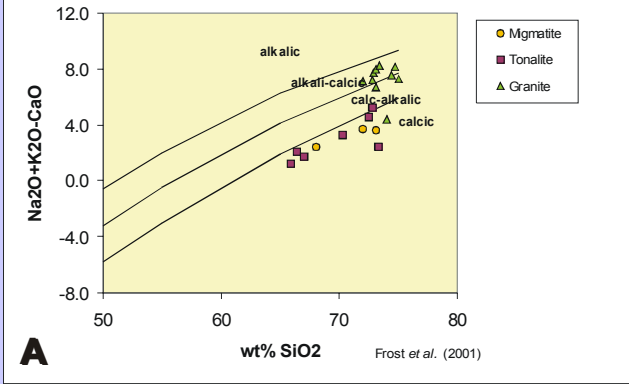
- ~ 120 samples collected
- Whole rock and trace element suite (+REE)
- Analyses at Act Labs, Ontario
- Archean & Proterozoic intrusions, Ennadai volcanics & iron fm, Hurwitz Group, mineralized rocks

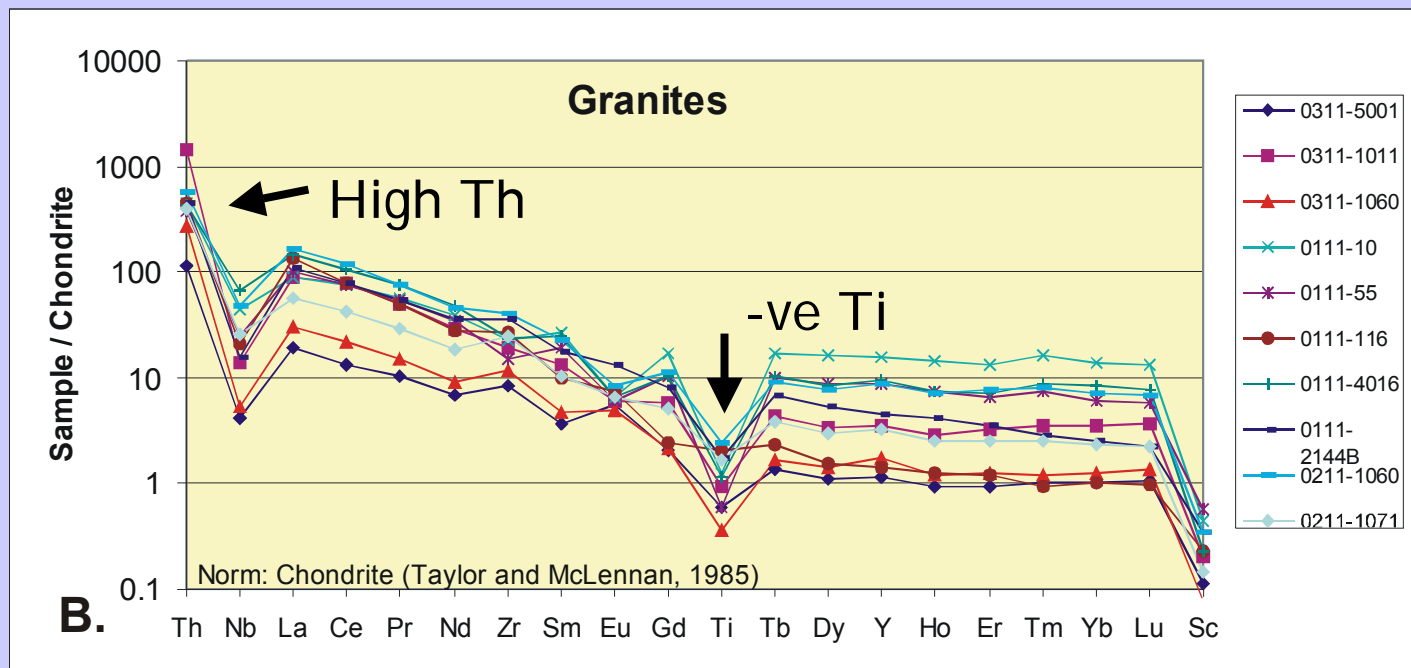
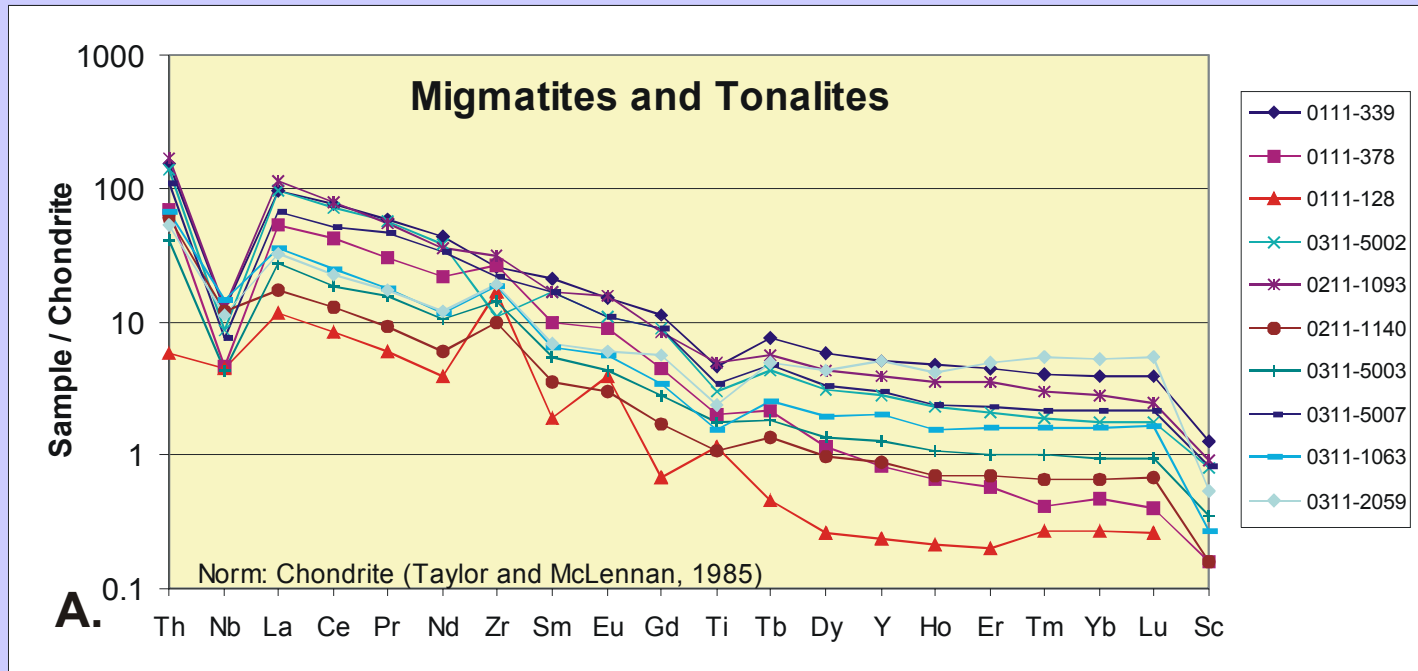
Archean Granitoids

Tonalite migmatites and tonalite intrusions are alkalic, (peraluminous?) & have VAG affinity.

Have TTG (adakite) chemical signature; high Sr/Y, La/Yb, +Eu

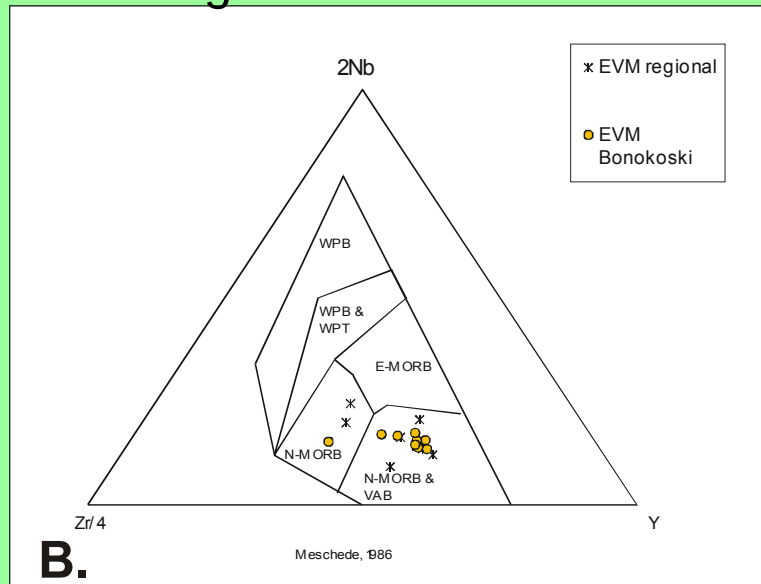
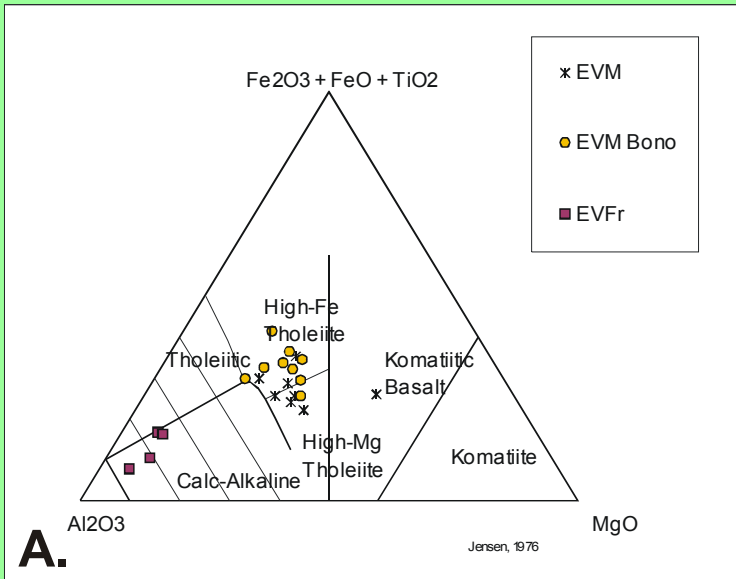
Granites are calc-alkalic to alkali-calcic, (peraluminous?), & have syn-COLG affinity, higher Th content & stronger -ve Ti



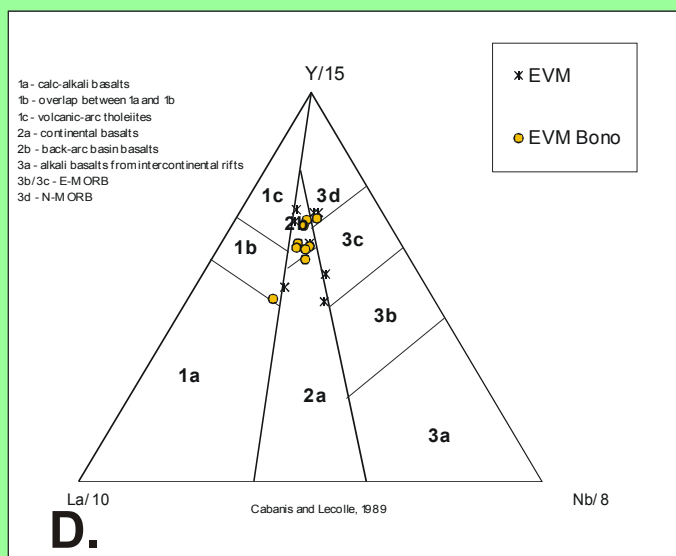
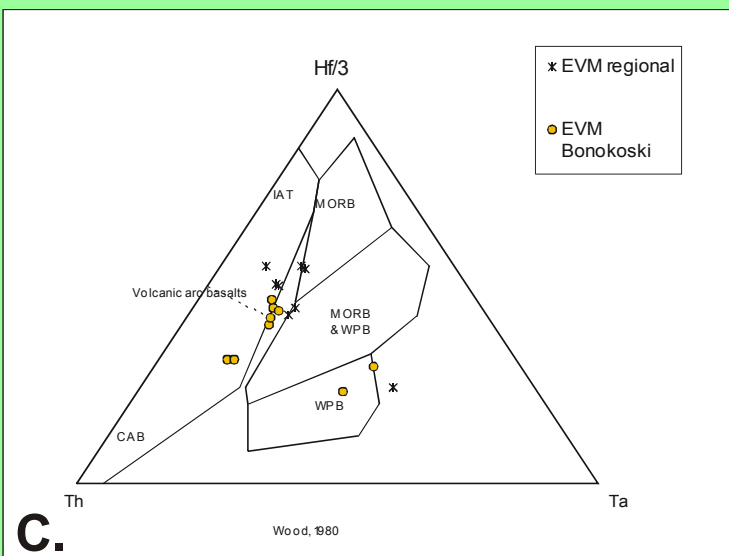


Ennadai Group

Mafic volcanics are subalkaline, high Fe to high Mg tholeiites; transitional MORB to VAB character, typical of arc to back-arc setting.

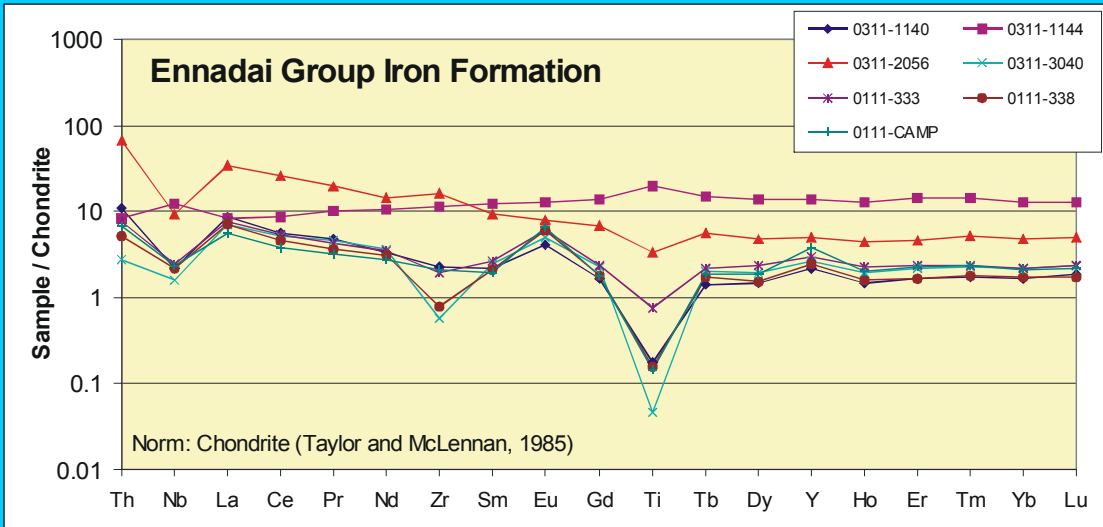


Possible komatiitic basalts in older volcanic sequence.

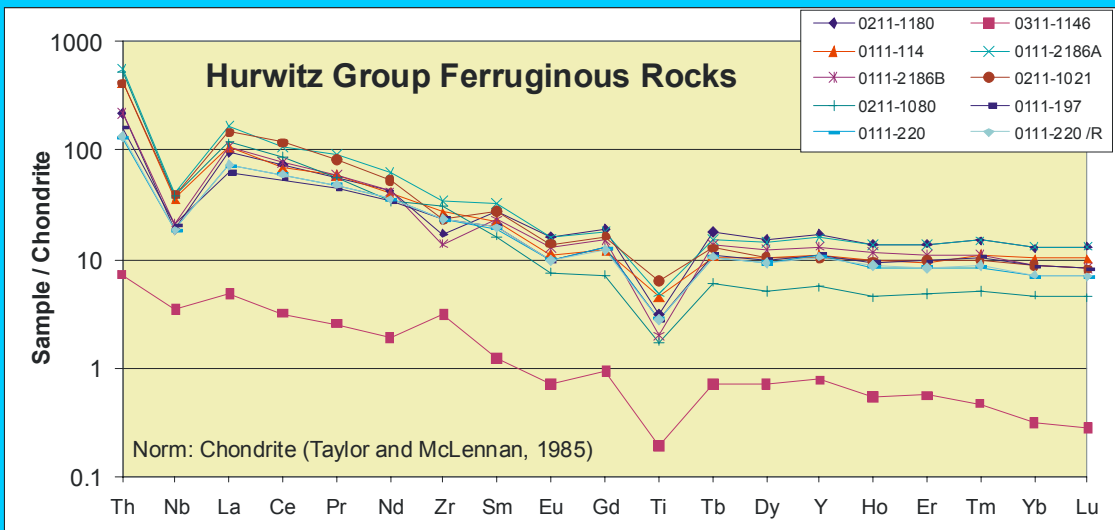


Felsic & intermediate volcanics are calc-alkaline and typical of arc setting.

Iron formations

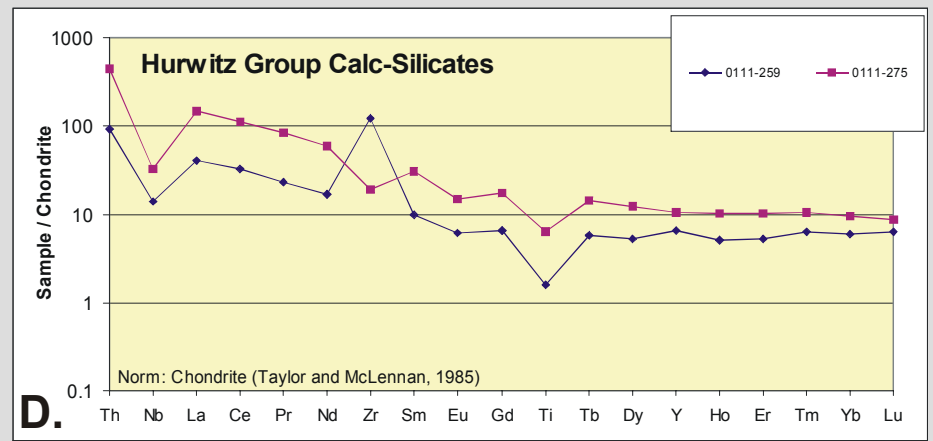
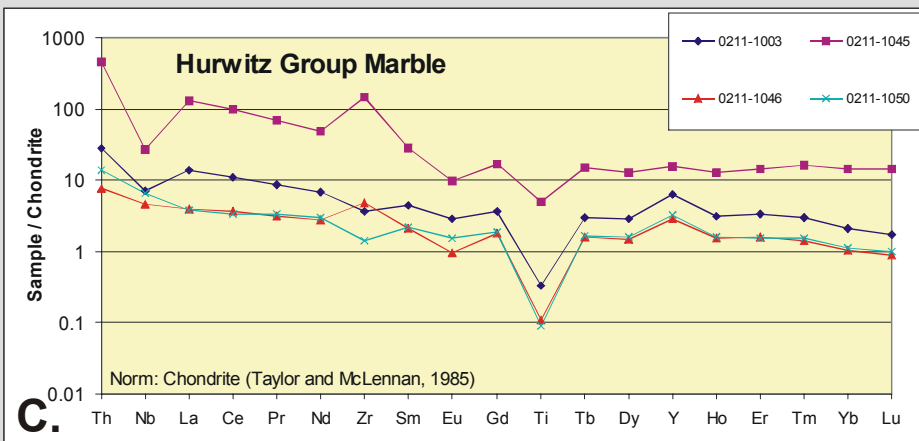
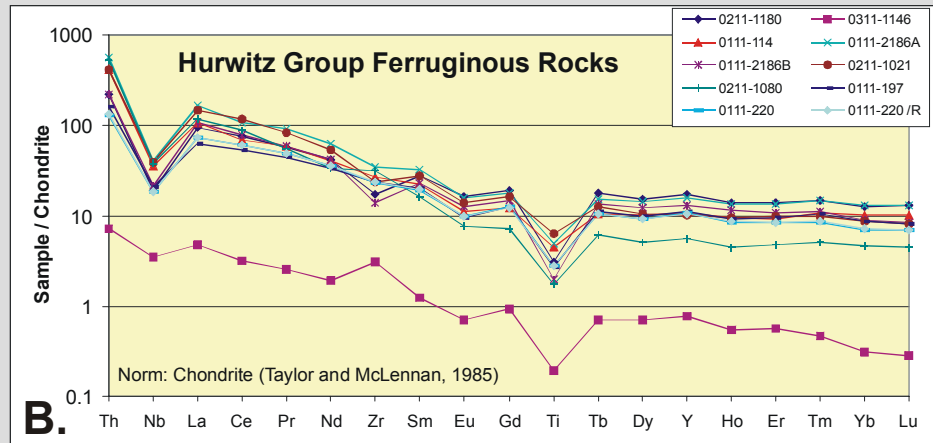
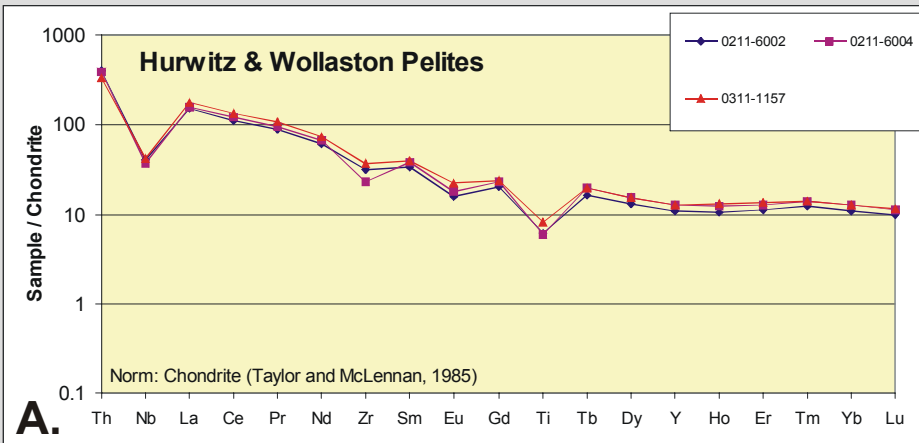


Ennadai Group IF have relatively flat REE profile, +ve Eu anomaly, -ve Nb, Zr, & Ti; indicative of hydrothermal fluids associated with VMS deposits.

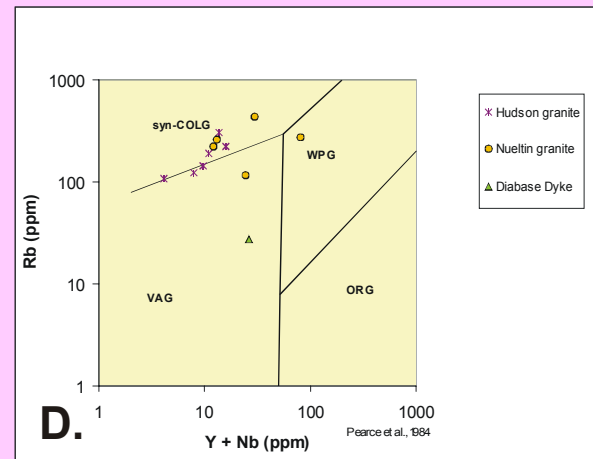
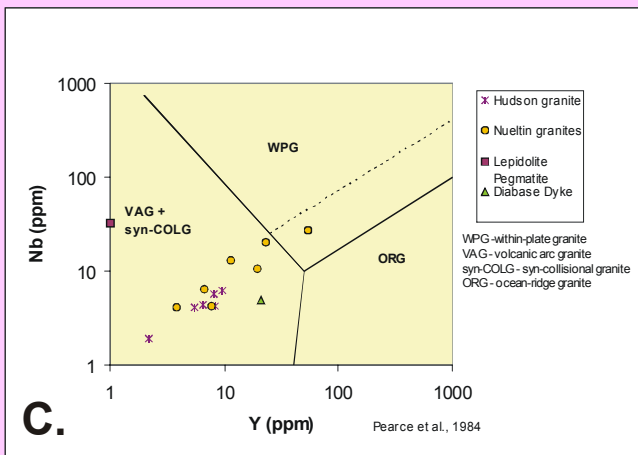
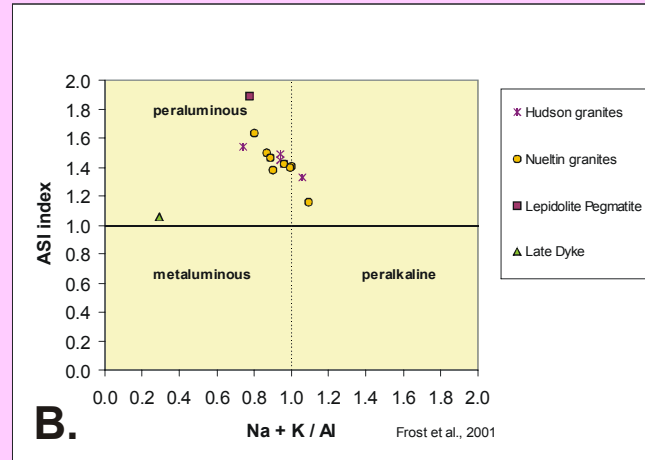
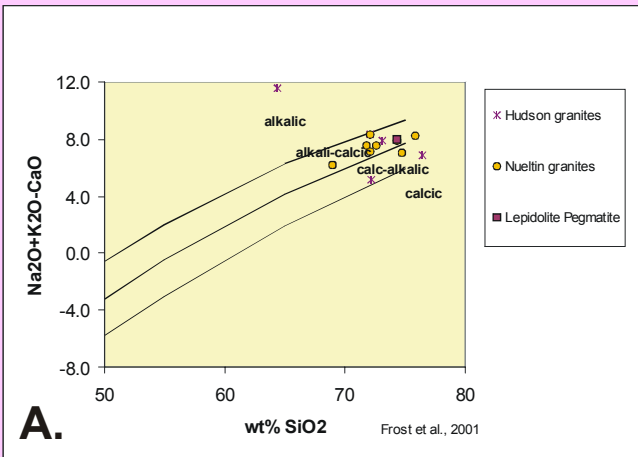


Hurwitz Group ferruginous pelites & IF are >10X the concentration of elements, have steeper REE profile, weak -ve Eu anomaly, & prominent -ve Nb & Ti; characteristic of shale-hosted IF

Hurwitz Group Sediments

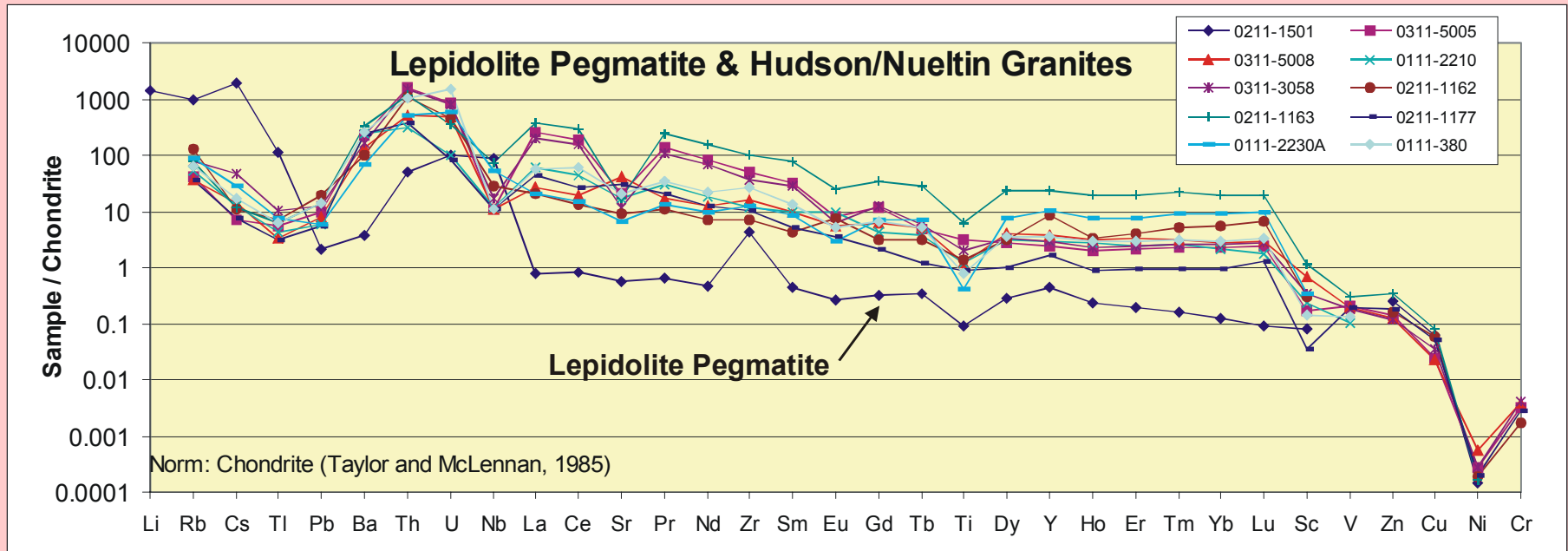


Paleoproterozoic Intrusions



The **Hudson & Nueltin granite suites** are silicic, potassic, calc-alkaline, & peraluminous with syn-COLG affinity. The Nueltins tend to be porphyritic, fluorite bearing & can be REE enriched.

Lepidolite Pegmatite Boulder



Undeformed **lepidolite pegmatite** has very high **Li, Rb, Cs, Nb, Ta, Sn, Be, Tl, Ga, & Ge** (with low REE, Ba, & Ti) which is similar to complex rare element pegmatites like Bernic Lake. Likely formed from volatile-rich magma associated with post-tectonic granitic intrusions. Nueltn granites are likely candidates from which rare element pegmatites could have originated.

Archean History in the Hearne

Look at distribution of Archean ages

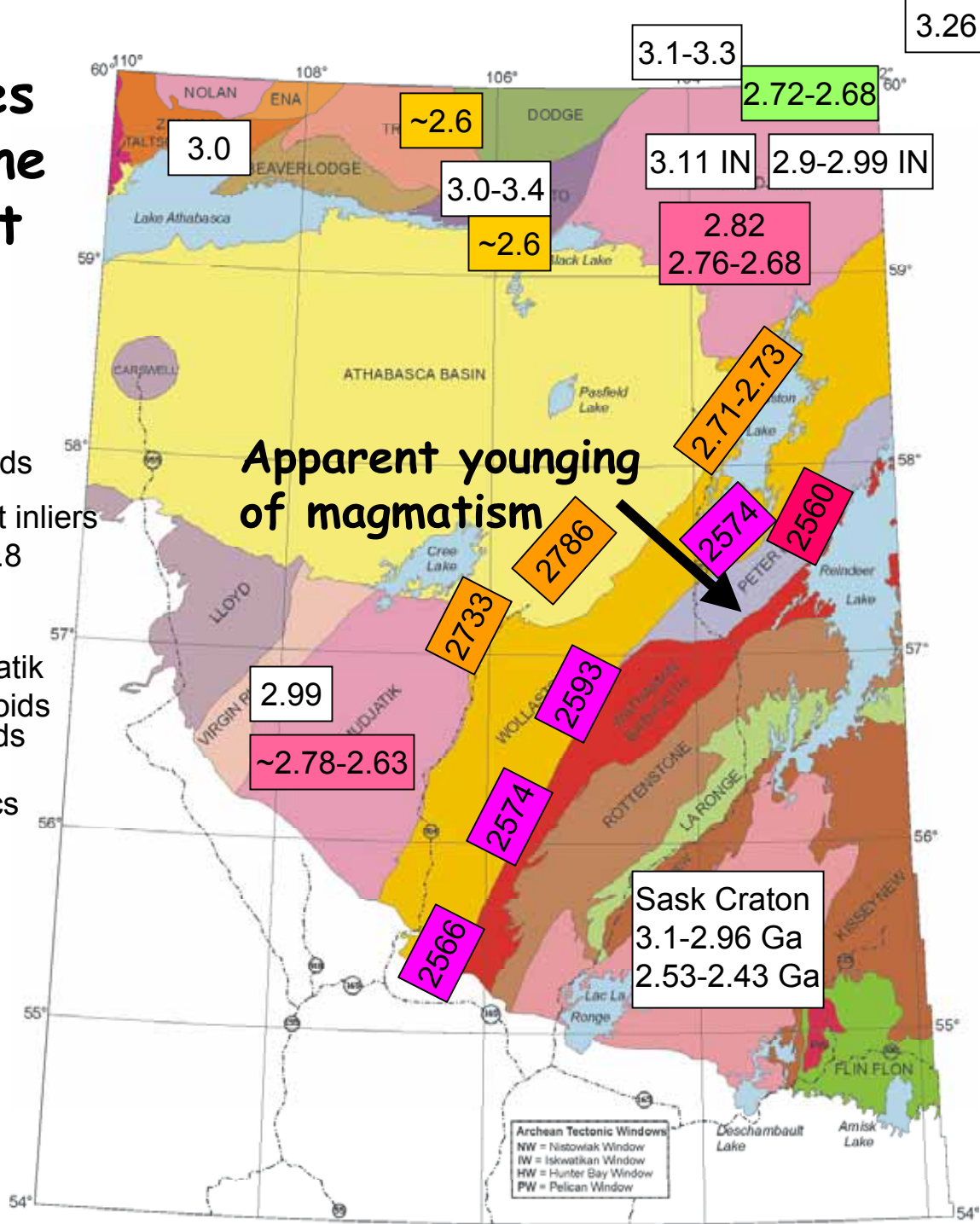
Look at Ennadai - basement story from geochronology and isotope data

Speculation and Arm waving... a possible tectonic model



Archean ages in the Hearne and adjacent areas

- Peter L. granitoids
- Wollaston bsmt inliers
 $\epsilon Nd +0.1$ to $+0.8$
- Rae granitoids
- Wollaston-Mudjatik transition granitoids
- Hearne granitoids
- Hearne volcanics
- Meso-Archean

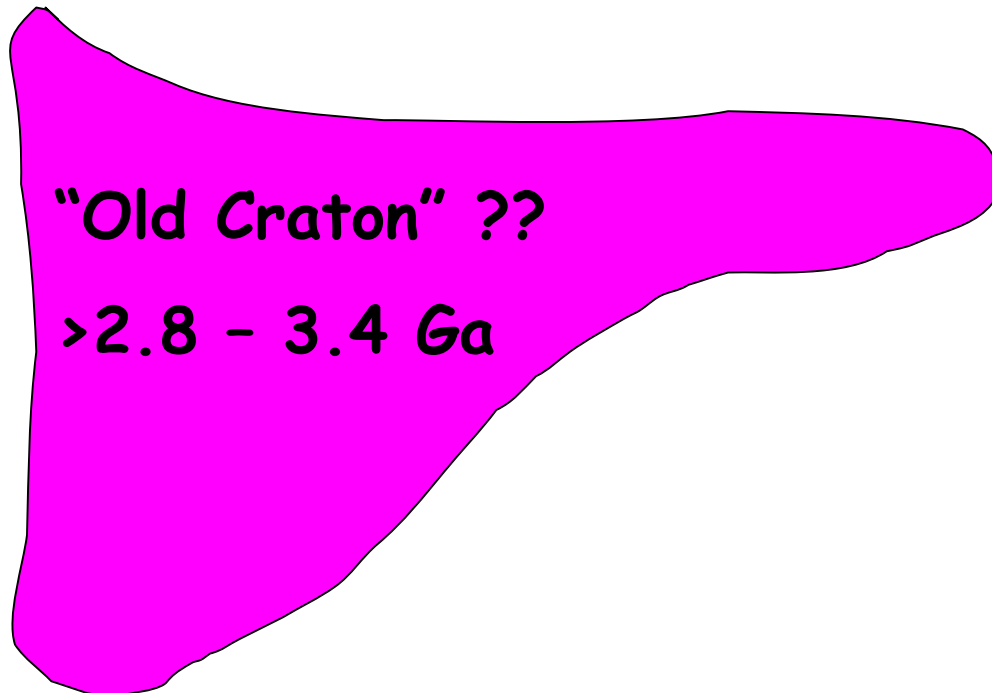
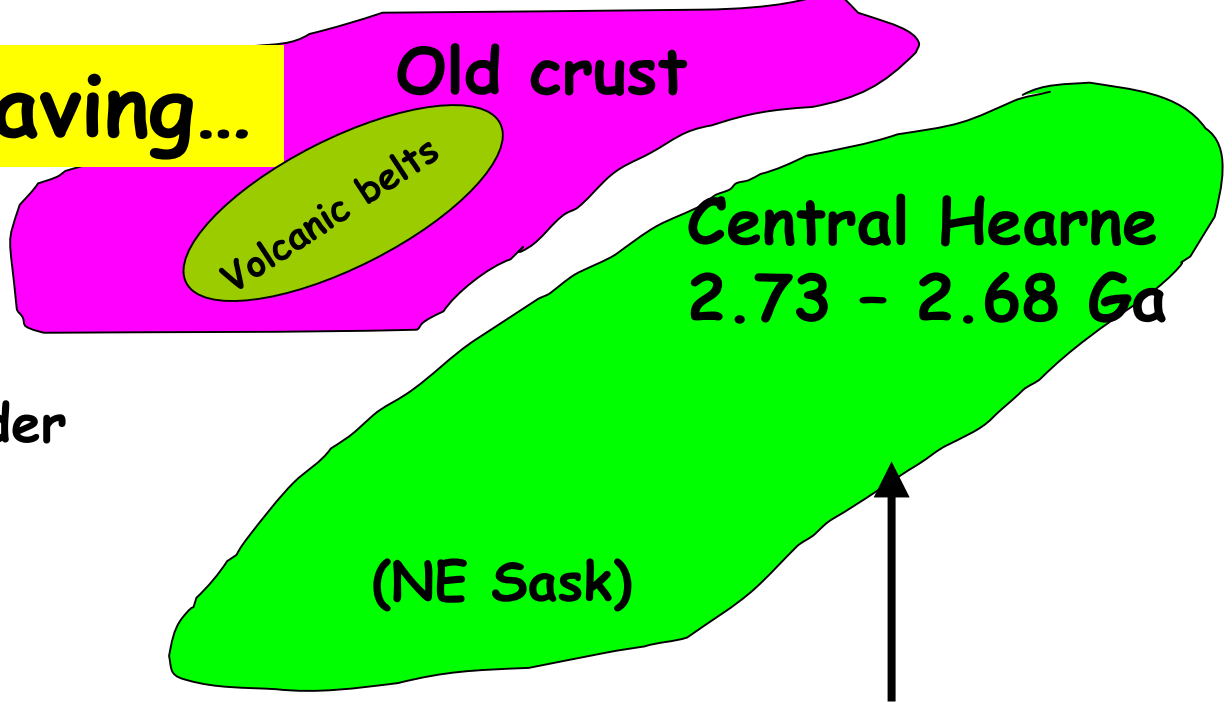


Ennadai - Basement Story

- ~2.73 Ga Volcanism; $+\epsilon\text{Nd}$ = juvenile, no evidence for older crustal contamination
- ~2.714-2.69 Plutonism; $+\epsilon\text{Nd}$ = juvenile, no evidence for older crustal contamination
- ~2.68 Volcanism; $+\epsilon\text{Nd}$ = juvenile, no evidence for older crustal contamination
BUT
- ~2.68 Plutonism; $-\epsilon\text{Nd}$ = crustal contamination, + 2.8 - 3.0 inherited zircons
- COLLISION WITH/SUBDUCTION OF OLD ARCHEAN CRUST?
 - Is this Rae-Hearne collision or something else?

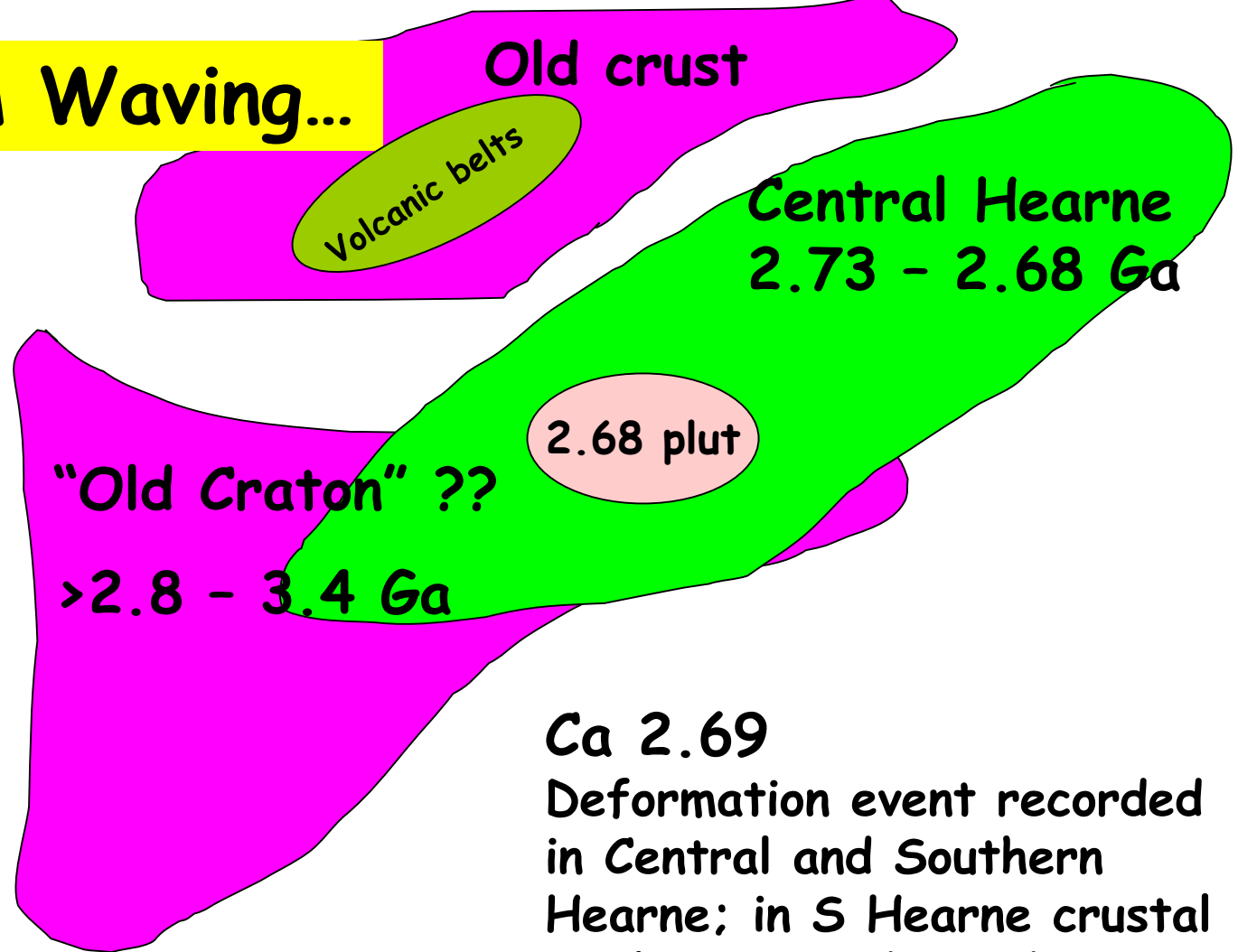
The Arm Waving...

Pre 2.69 Ga
Volcanic arcs & older
crustal plates



Ennadai-Rankin greenstone
belt developing with no
apparent basement present;
rocks are all juvenile,
mantle derivatives

The Arm Waving...

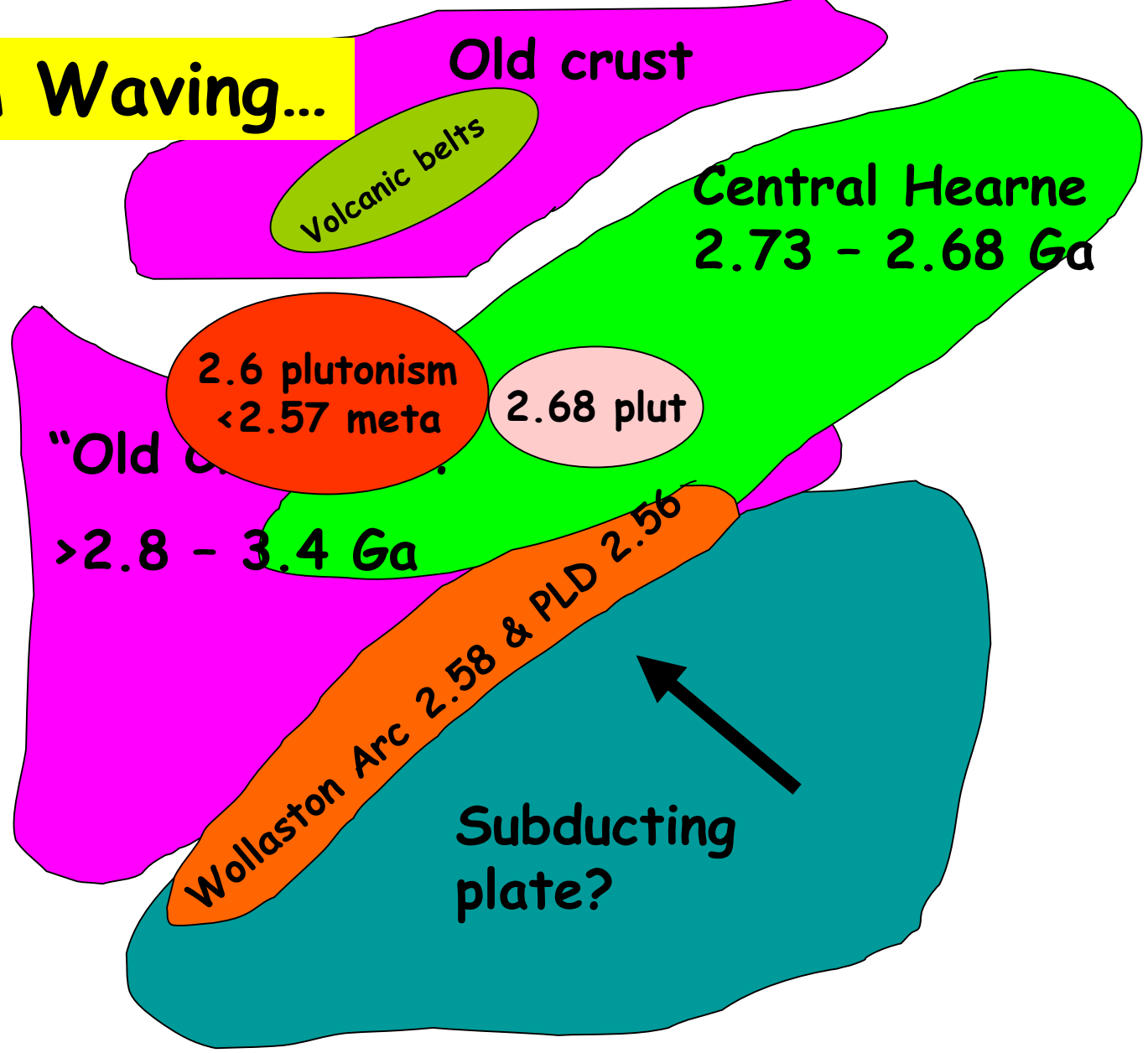


Ca 2.69

Deformation event recorded in Central and Southern Hearne; in S Hearne crustal involvement indicated in 2.68 Ga granite (abundant Mesoarchean zircons, $-\epsilon\text{Nd}$ value, & syn-COLG chemistry)

The Arm Waving...

Ca. 2.6 Ga
? Subduction
along SE margin
of Hearne to
produce
magmatic arc
of <2.6 Ga age
(now underlies
much of
Wollaston
Domain) &
slightly younger
(2.56 Ga) in
Peter Lake
Domain. ?Far
field affect to
produce 2.6 Ga
plutonism and
<2.57 Ga
metamorphism
elsewhere in
Hearne.

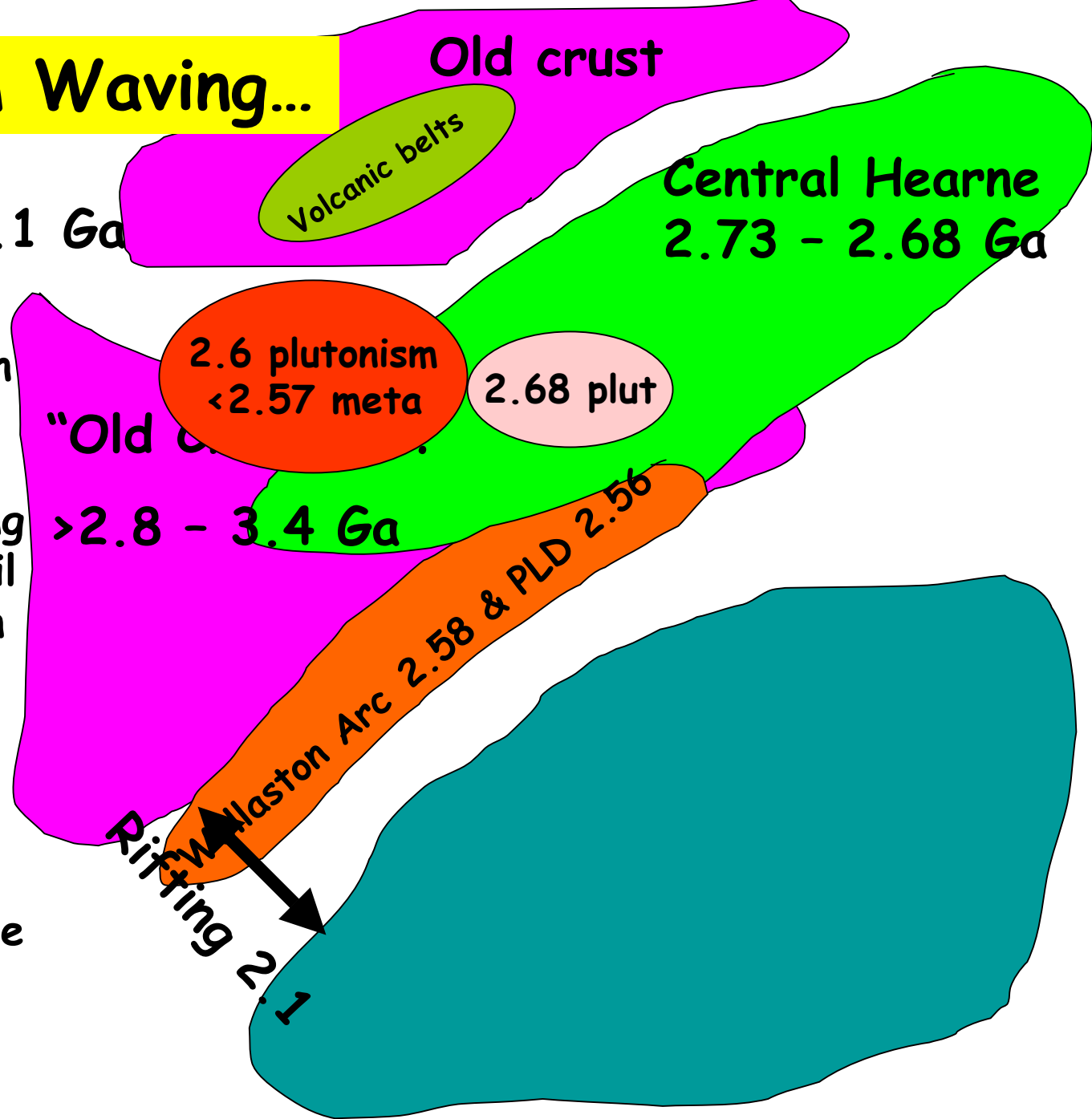


produce 2.6 Ga plutonism and <2.57 Ga metamorphism elsewhere in Hearne.

The Arm Waving...

Ca 2.45 to 2.1 Ga

Deposition of Lower Hurwitz in Central Hearne, but apparently nothing happening in S Hearne until ca. 2.1 Ga when rifting occurs and Wollaston Supergroup starts forming along a new SE margin of Hearne province.



Summary

1. Evidence for Meso-Archean rocks - >2.8 Ga & 3.0-3.1 Ga inheritance (?were they present before Ennadai GB started)
 - may have implications for diamond exploration
2. Assemblage I tholeiitic volcanism (MORB-VAB in arc-BAB setting) and tonalitic plutonism 2.72-2.695 Ga with ϵNd values of +2.6 - +1.4 indicating juvenile, mantle derivation
 - Gold & base metal potential
3. Deformation ca. 2.69-2.68 Ga - was this a collisional event?
4. Assemblage II calc-alk felsic volcanism at 2.68 Ga with ϵNd values of +2.6 indicating juvenile, mantle derivation, but granitic plutonism at 2.68 Ga, & ϵNd values of -0.5 & abundant inherited zircons, & chemical affinity to syn-COLG indicate derivation from older crustal material; -Gold & base metal potential

Summary (cont.)

5. Late Archean thermotectonism (monazite 2.57 Ga) - What is this related to? Collision/subduction of various Archean cratons...
Southeastward younging of Archean granitoids across Mudjatik-Wollaston-Peter Lake domains - magmatic arcs related to subduction along SE margin of Hearne
6. Deposition of Hurwitz Gp & Wollaston Supergroup (~2.2-1.9 Ga)
- Gold & base metal potential
7. Trans-Hudson Orogeny - emplacement of Hudson granites 1.86-1.8 Ga with high-grade metamorphic events between 1825-1810 Ma & cooling through 1.77 Ga
8. Emplacement of Nuelin granites 1.76-1.75 Ga
- REE, rare metal pegmatites, gold skarns?