GRANITE PROSPECTIVITY OF EASTERN AUSTRALIA

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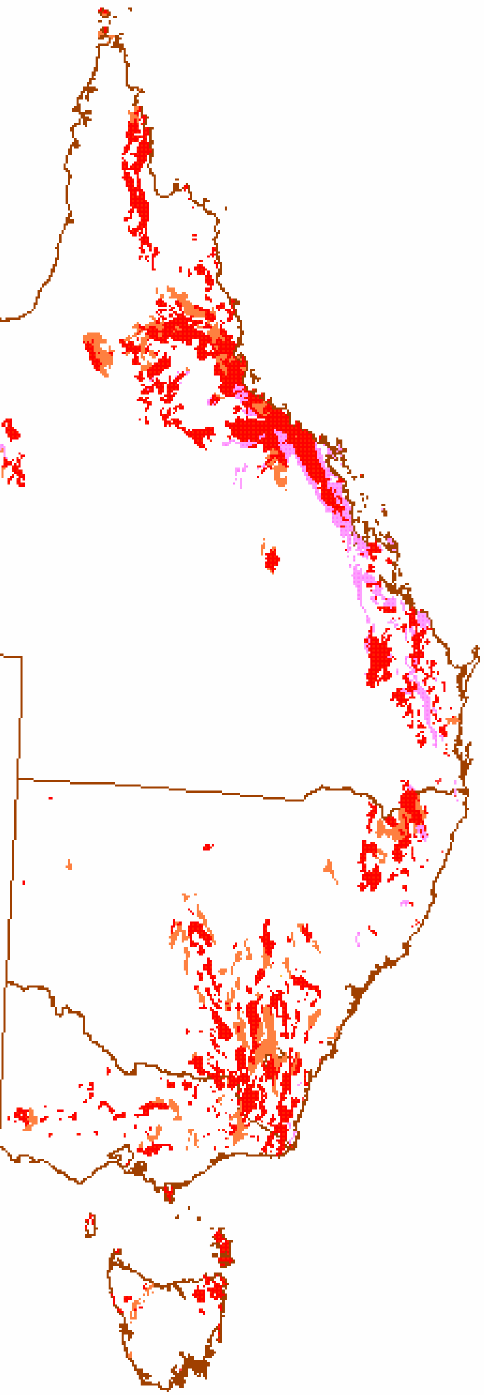
NSW DEPARTMENT OF PRIMARY INDUSTRIES

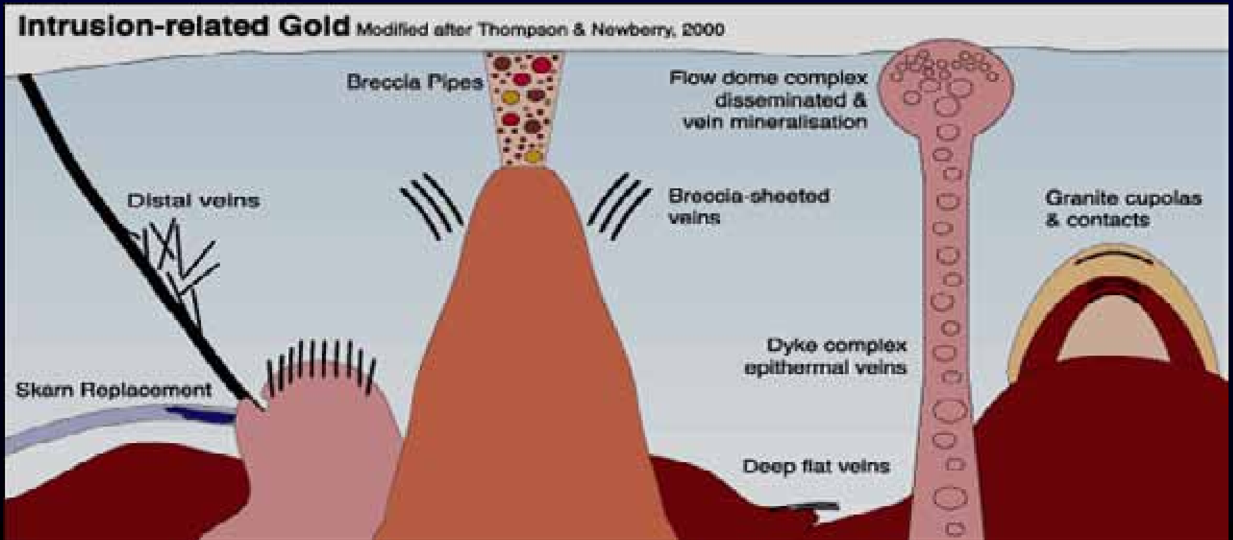


Granites

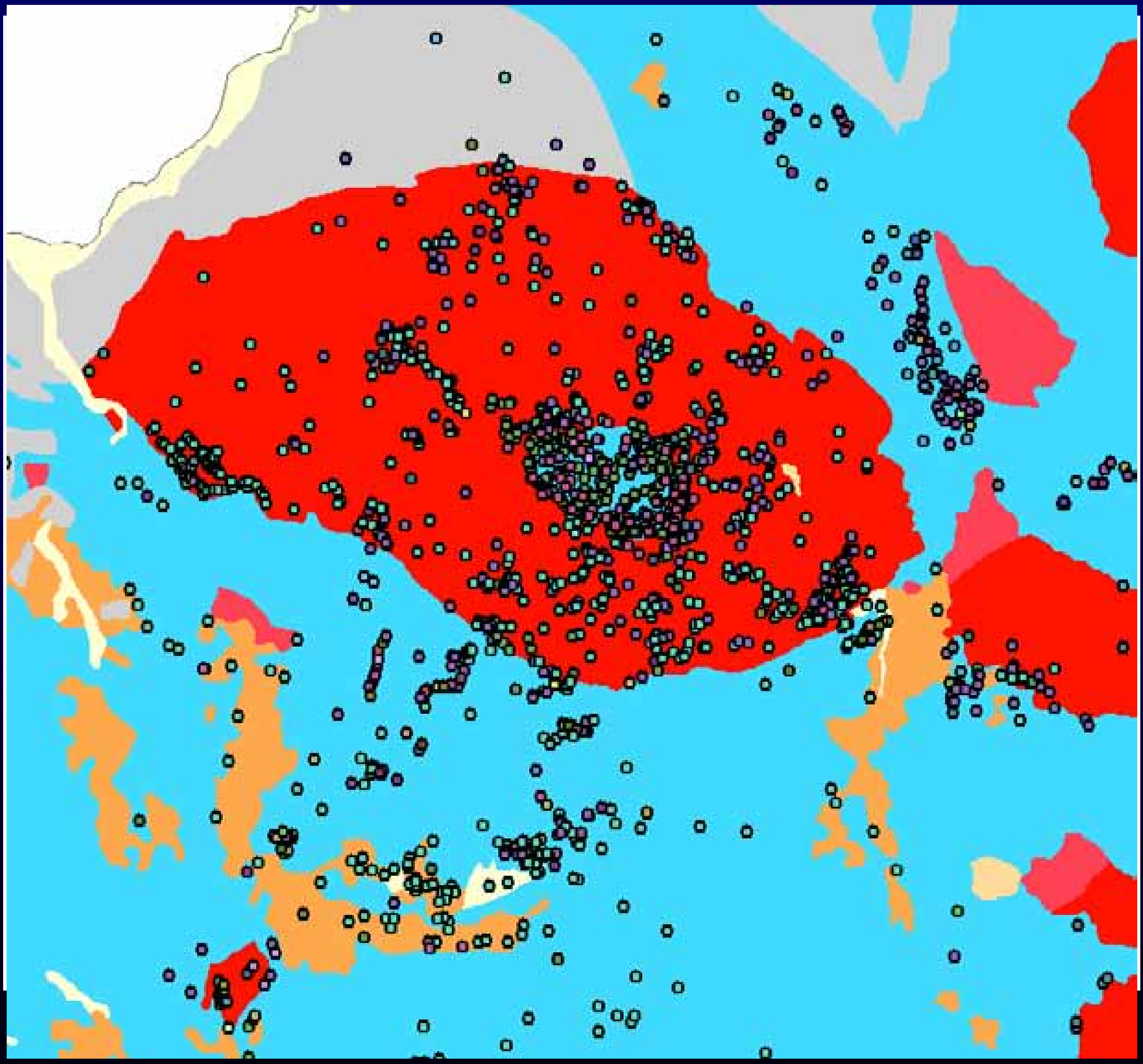
- Granites (or granitoids) loosely refer to a wide range of felsic plutonic rocks . They comprise a major proportion of the continental crust.
- Granites redistribute significant amounts of material vertically within the crust.
- Most occur in areas where the continental crust has been thickened by orogeny, including continental arc subduction or collision.
- The majority of granites are derived by crustal anatexis, but the mantle may also be involved. The mantle contribution may comprise heat and/or material.

Granite related mineral deposits

- Granites are related to many ore deposit types:
  - Cu-Au, Cu-Mo, Mo, Sn porphyries
  - Sn-W, W, W-Mo-Bi
  - Polymetallic Pb-Zn-Ag
  - Pegmatite Nb, Ta, F, Li, Be
  - IRGD
  - Iron oxide copper gold
  - Rare and/or strategic metals Re, In, REE
  - Heat
- Deposit types vary - veins, skarns, porphyries, greisens, replacement, disseminations, breccias.



Granite mineral system zonation

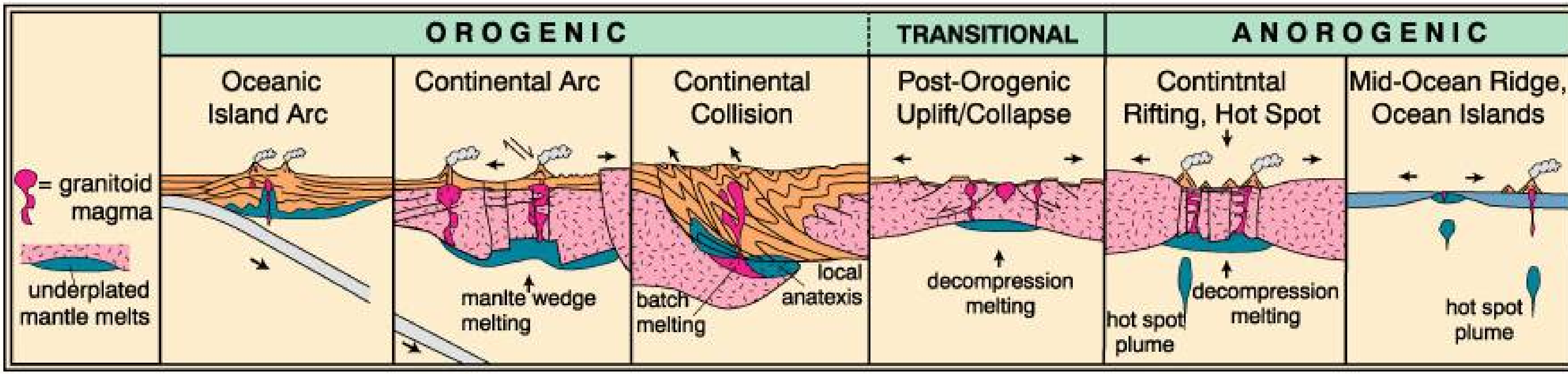


On Granite

Goethe - 1784

"*I do not fear the reproach that a spirit of contradiction draws me from the contemplation of the human heart - this most mobile, most mutable and fickle part of the creation - to the observation of (granite) the oldest, firmest, deepest, most immovable son of nature. For all natural things are in connection with each other*."

Table 18-4. A classification of granitoid rocks based on tectonic setting

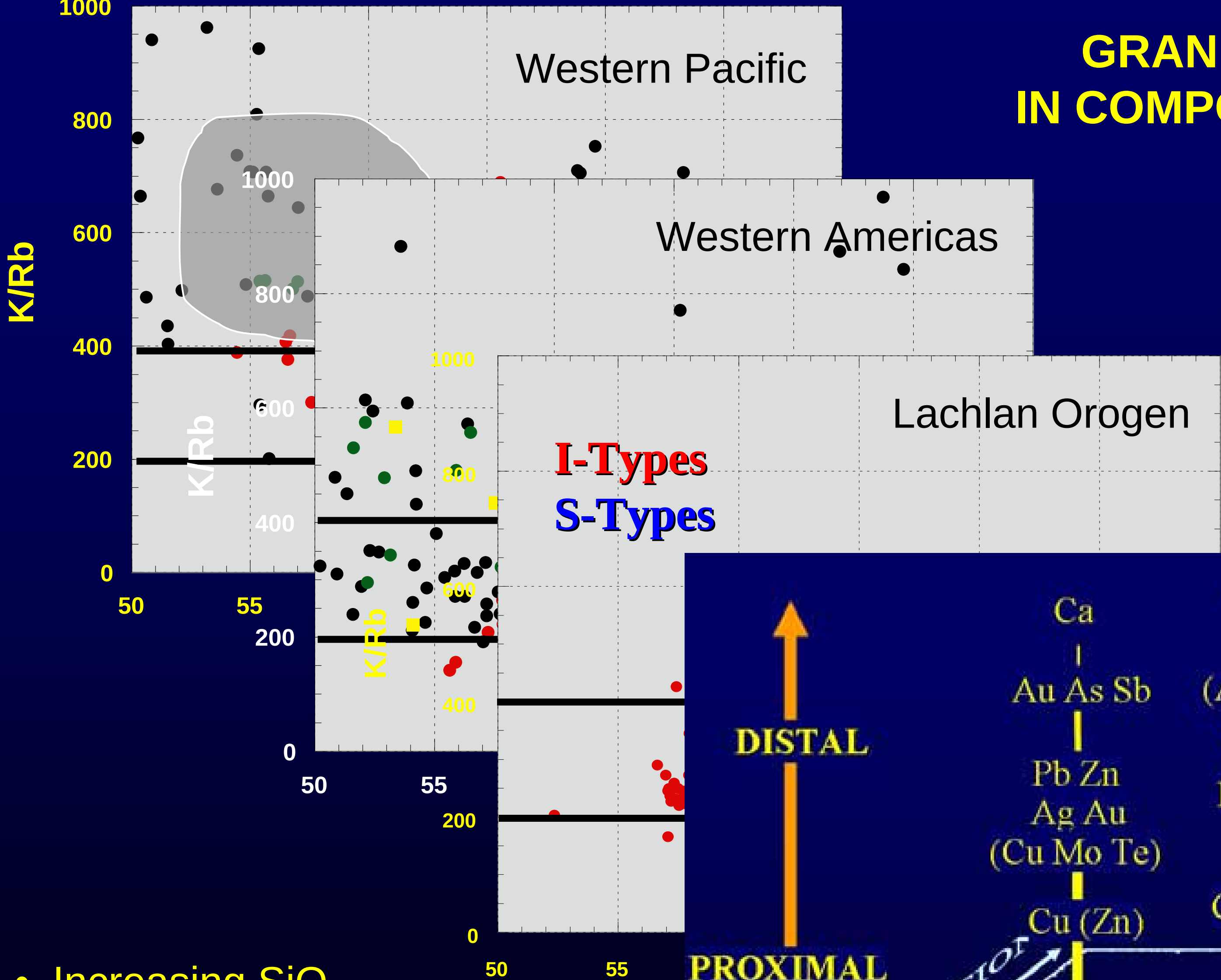


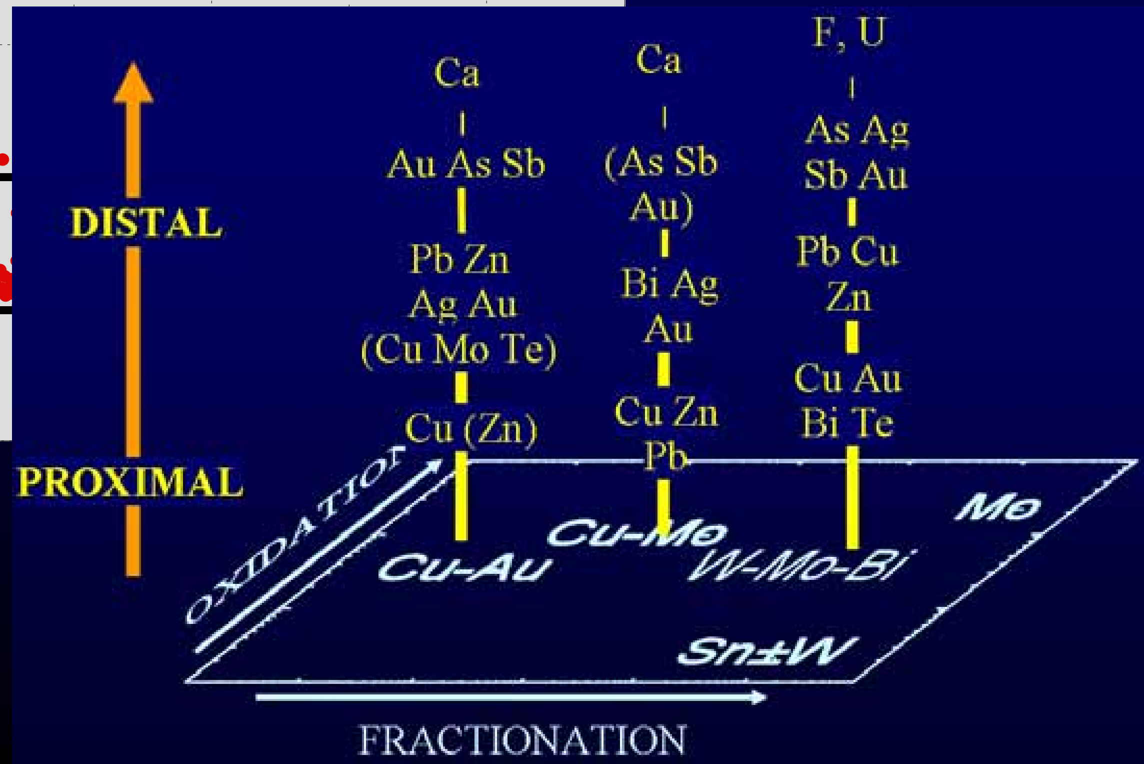
Geo-chemistry	Calc-alkaline > thol. M-type & I-M hybrid Metaluminous	Calc-alkaline I-type > S-type Met-Al to sl. Per-Al	Calc-alkaline S-type Peraluminous	Calc-alkaline I-type S-type (A-type) Metalum. to Peralum	Alkaline A-type Peralkaline	Tholeiitic M-type Metaluminous
Rock types	qtz-diorite in mature arcs	tonalite & granodior. > granite or gabbro	migmatites & leucogranite	bimodal granodiorite + diroite-gabbro	Granite, syenite + diorite-gabbro.	Plagiogranite
Associated Minerals	Hbl > Bt	Hbl, Bt	Bt, Ms, Hbl, Grt, Als, Crd	Hbl > Bt	Hbl, Bt, aegirine fayalite, Rbk, arfved.	Hbl
Associated Volcanism	Island-arc basalt to andesite	Andesite and dacite in great volume	often lacking	basalt and rhyolite	alkali lavas, tuffs, and caldera infill	MORB and ocean island basalt
Classification Barbarin (1990)	T_{IA} tholeiite island arc	H_{CA} hybrid calc-alkaline	C_{ST} C_{CA} C_{CI} continental types	H_{LO} hybrid late orogenic	A alkaline	T_{OR} tholeiite ocean ridge
Pearce *et al.* (1984)	VAG (volcanic arc granites)		COLG (collision granites)		WPG and ORG (within plate and ocean ridge granites)	
Maniar & Piccoli (1989)	IAG island arc granite	CAG contin. arc granite	CCG cont. collision gran.	POG post-orogenic gran.	RRG CEUG rift & aborted/hotspot	OP ocean plagiogranite
Origin	Partial melting of mantle-derived mafic underplate	PM of mantle-derived mafic underplate + crustal contribution	Partial melting of recycled crustal material	Partial melting of lower crust+ mantle and mid-crust contrib	Partial melting of mantle and/or lower crust (anhydrous)	Partial melting of mantle and frac-tional crystallization
Melting Mechanism	Subduction energy: transfer of fluids and dissolved species from slab to wedge. Melting of wedge, transfer of heat upward		Tectonic thickening plus radiogenic crustal hea	Crustal heat plus mantle heat (rising asthen. + magmas)	Hot spot and/or adiabatic mantle rise	

After Pitcher (1983, 1993), Barbarin (1990)

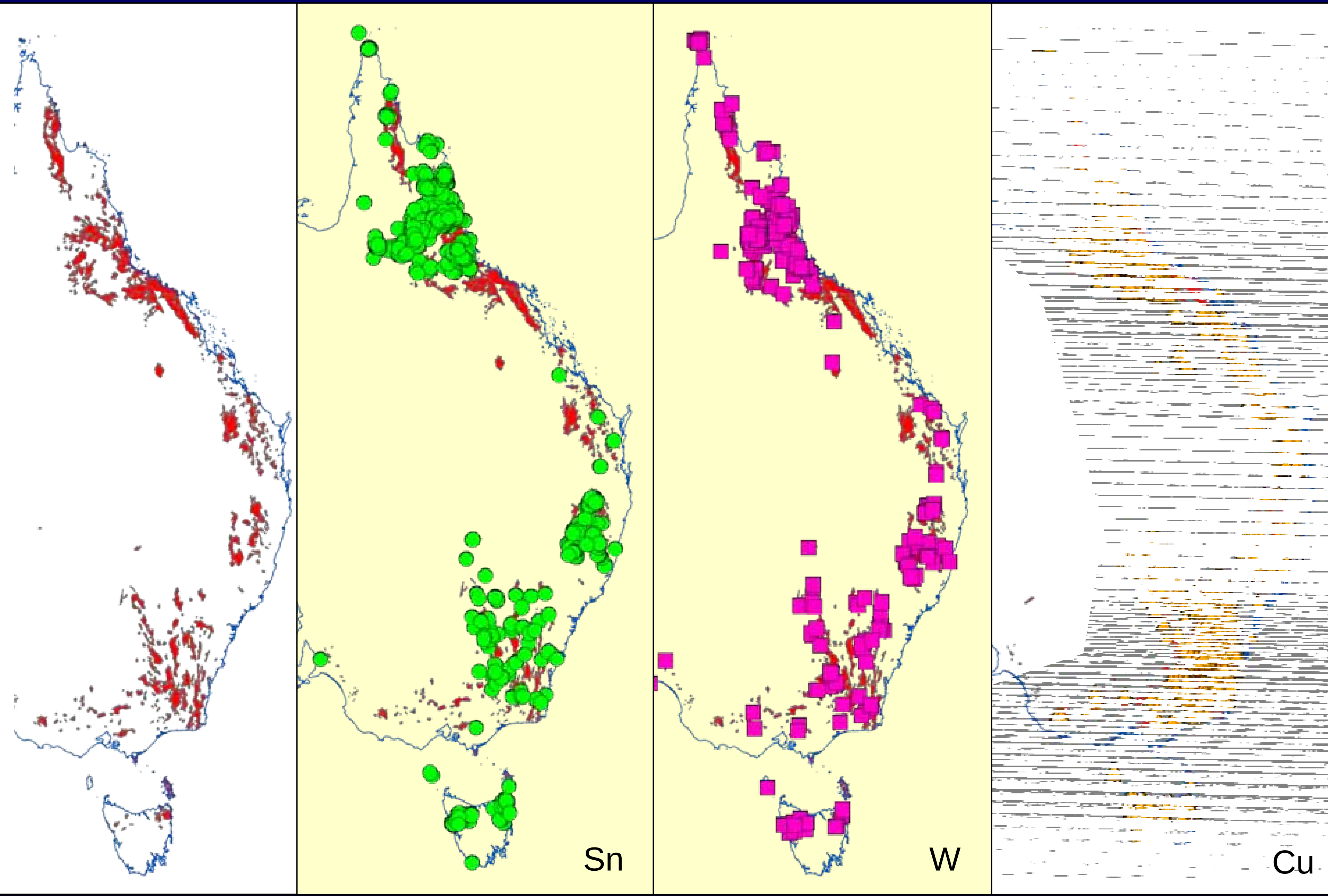
Mountain Building Processes, Academic Press, London; Pitcher (1993), *The Nature and Origin of Granite*, Blackie, London; and Barbarin (1990) *Geol. Journal*, 25, 227-238. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

GRANITE EVOLUTION IN COMPOSITIONAL SPACE

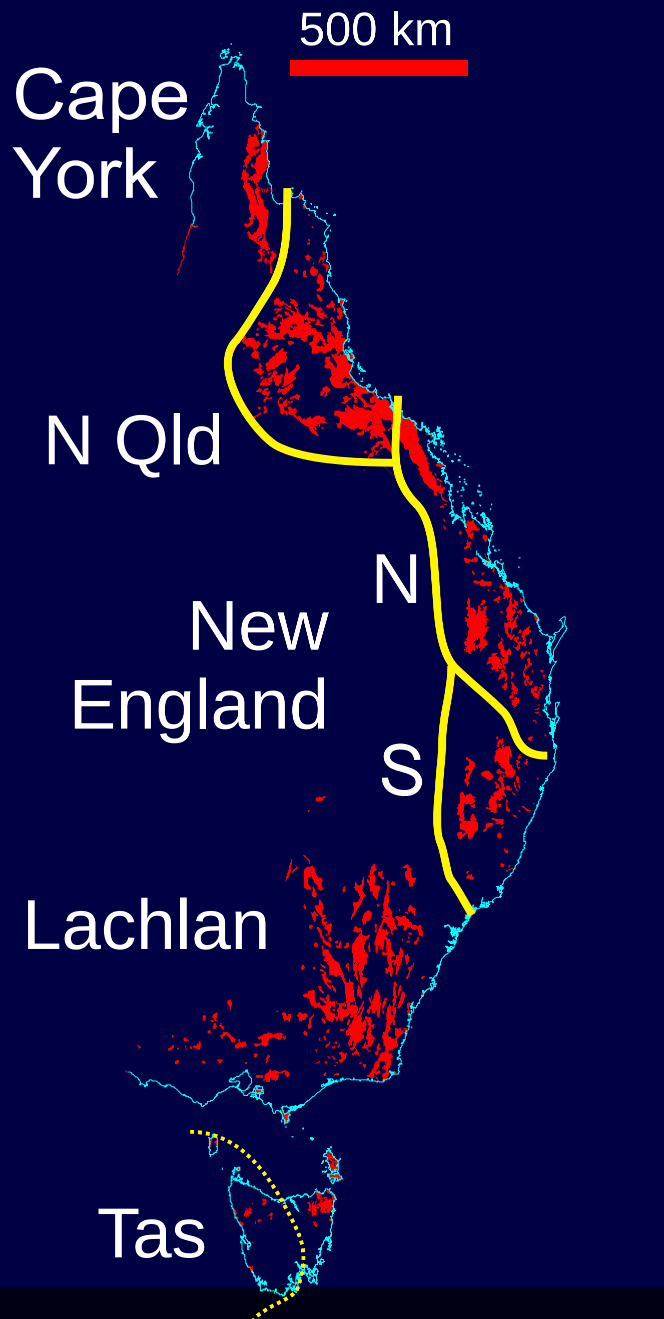


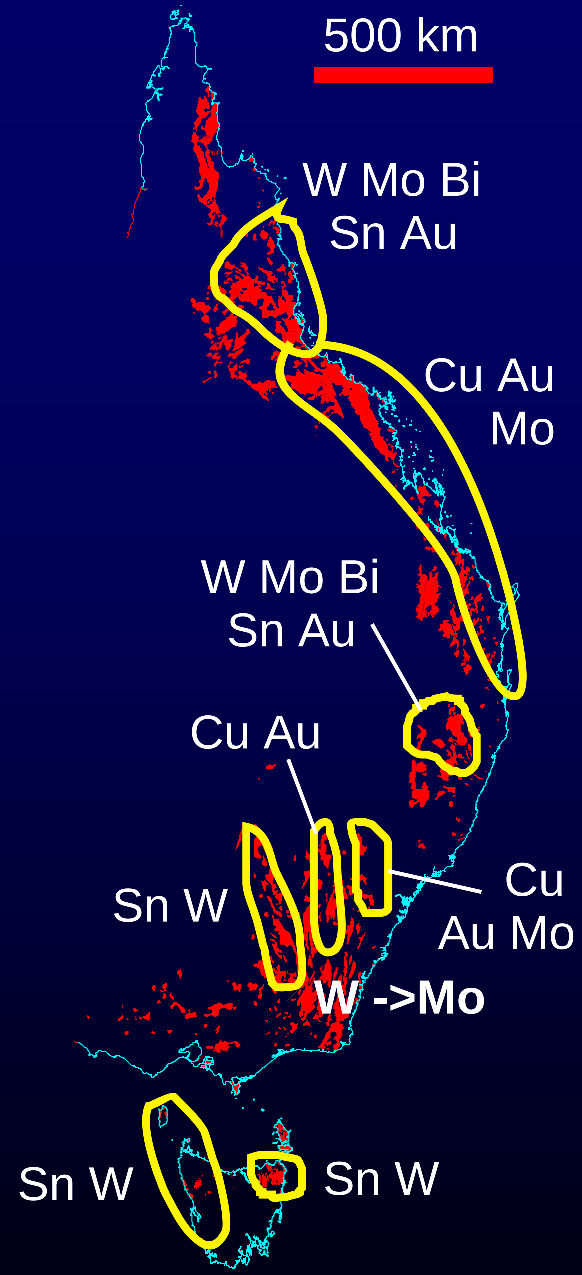


- Increasing SiO_2
- Decreasing K/Rb
- More “granitophile” metallogeny
- Redox & other controls

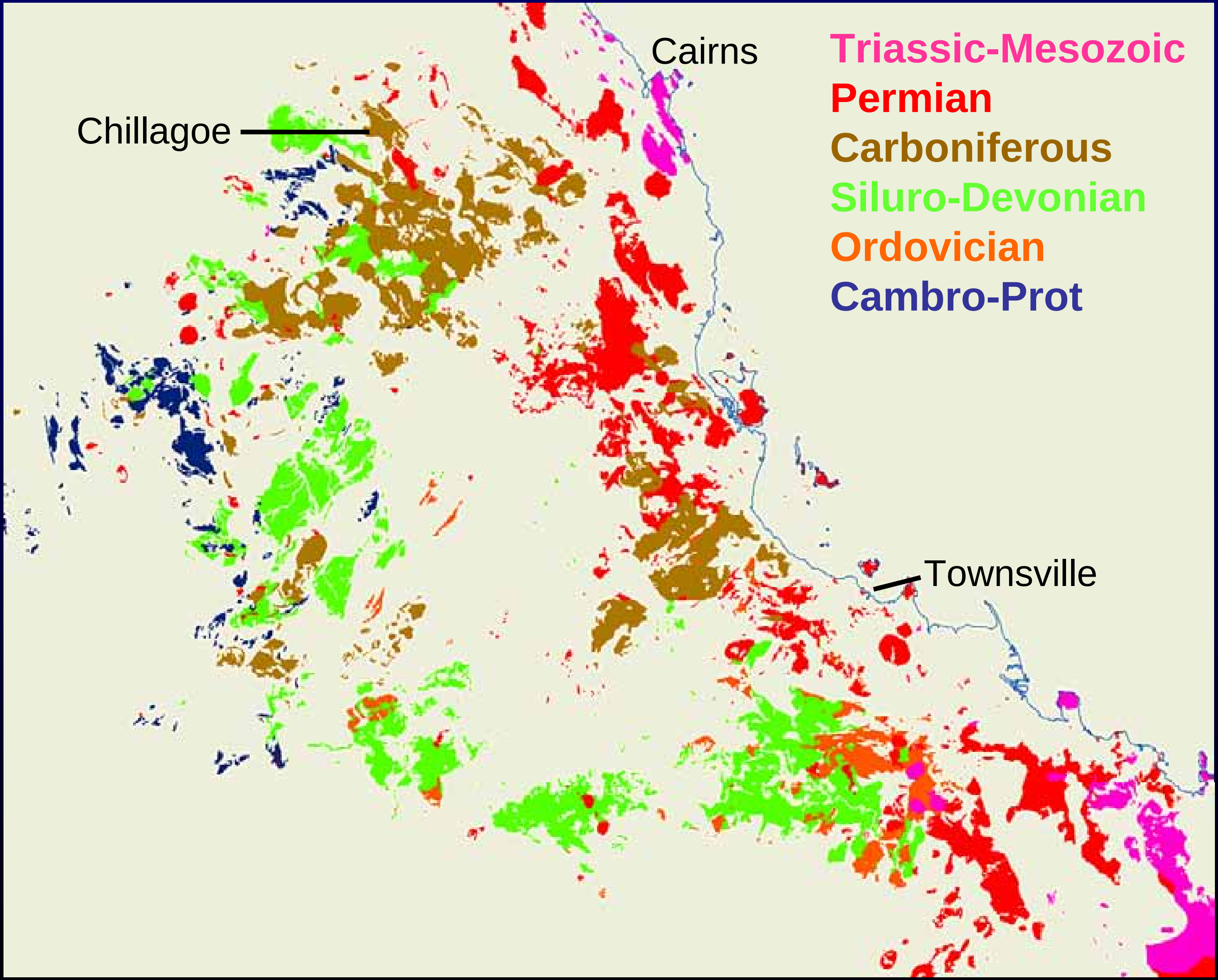


Granite related ore elements are not distributed evenly in the crust

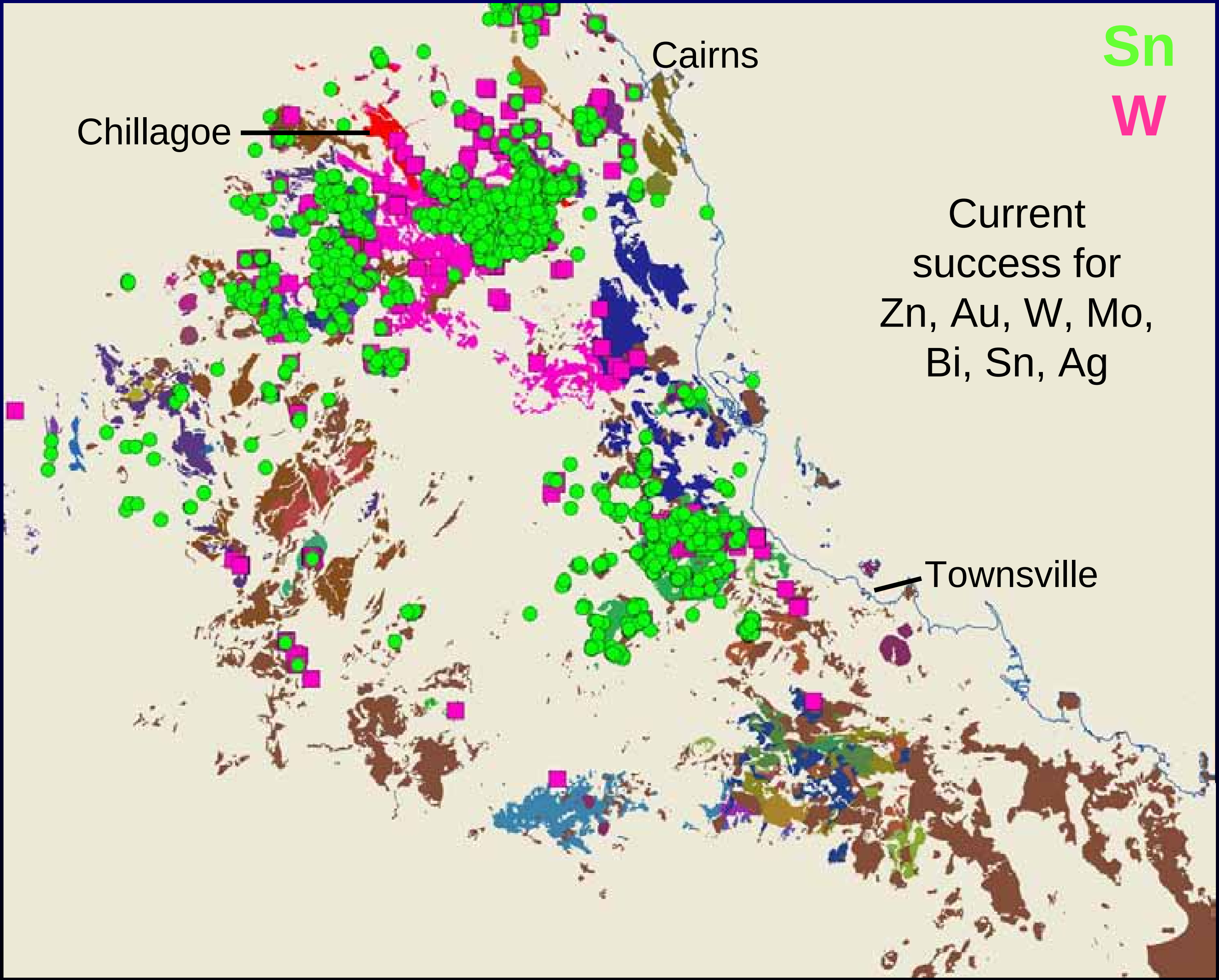

500 km
Cape York
N Qld
N
New England
S
Lachlan
Tas


500 km
W Mo Bi
Sn Au
Cu Au
Mo
W Mo Bi
Sn Au
Cu Au
Sn W
Cu
Au Mo
W ->Mo
Sn W
Sn W

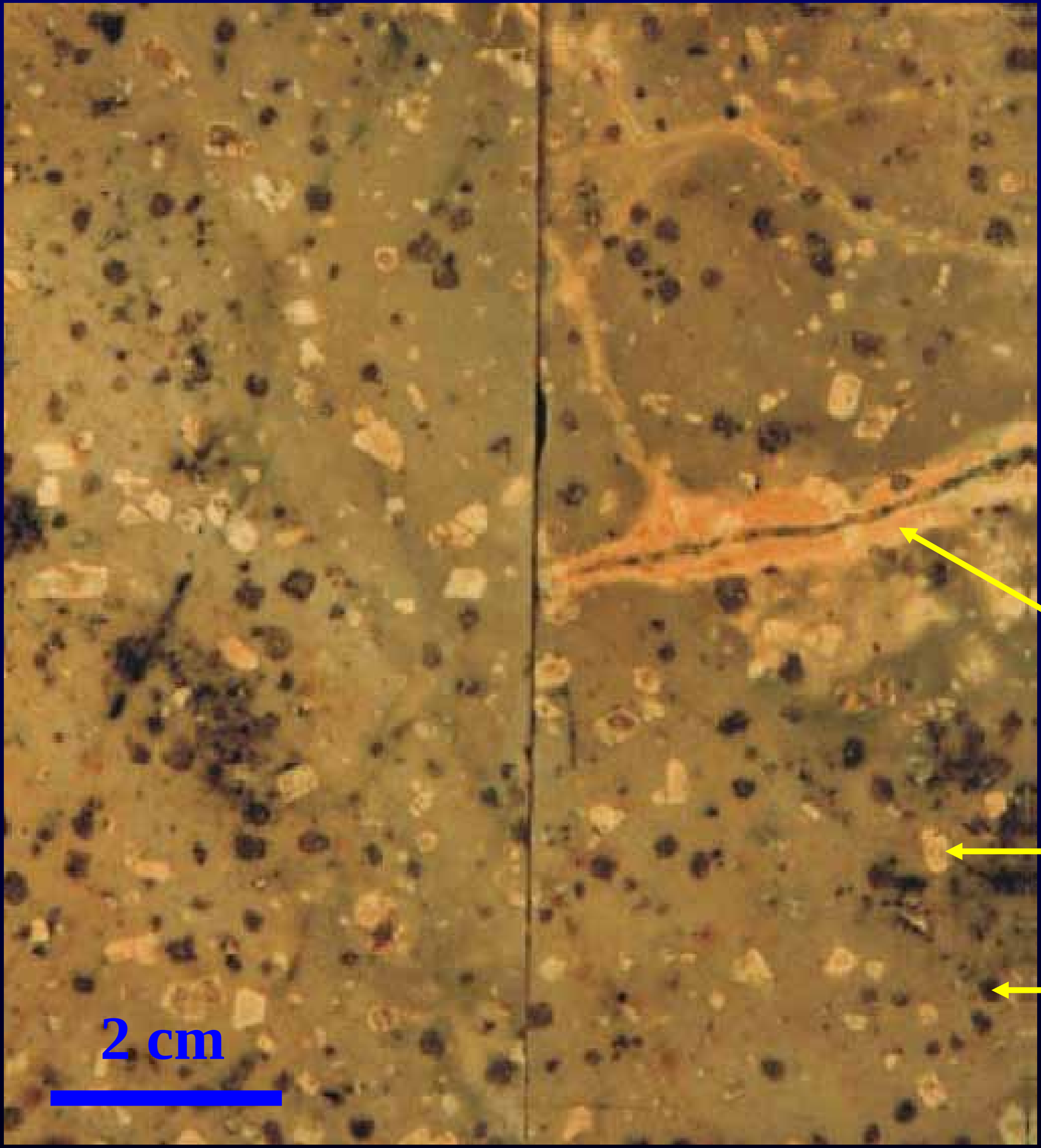
Coastal Range Granites and surrounds….



FNQ – Sn, W, Mo, Au, Bi, Ag, Zn, Pb, F, Cu.



Red Dome Porphyry



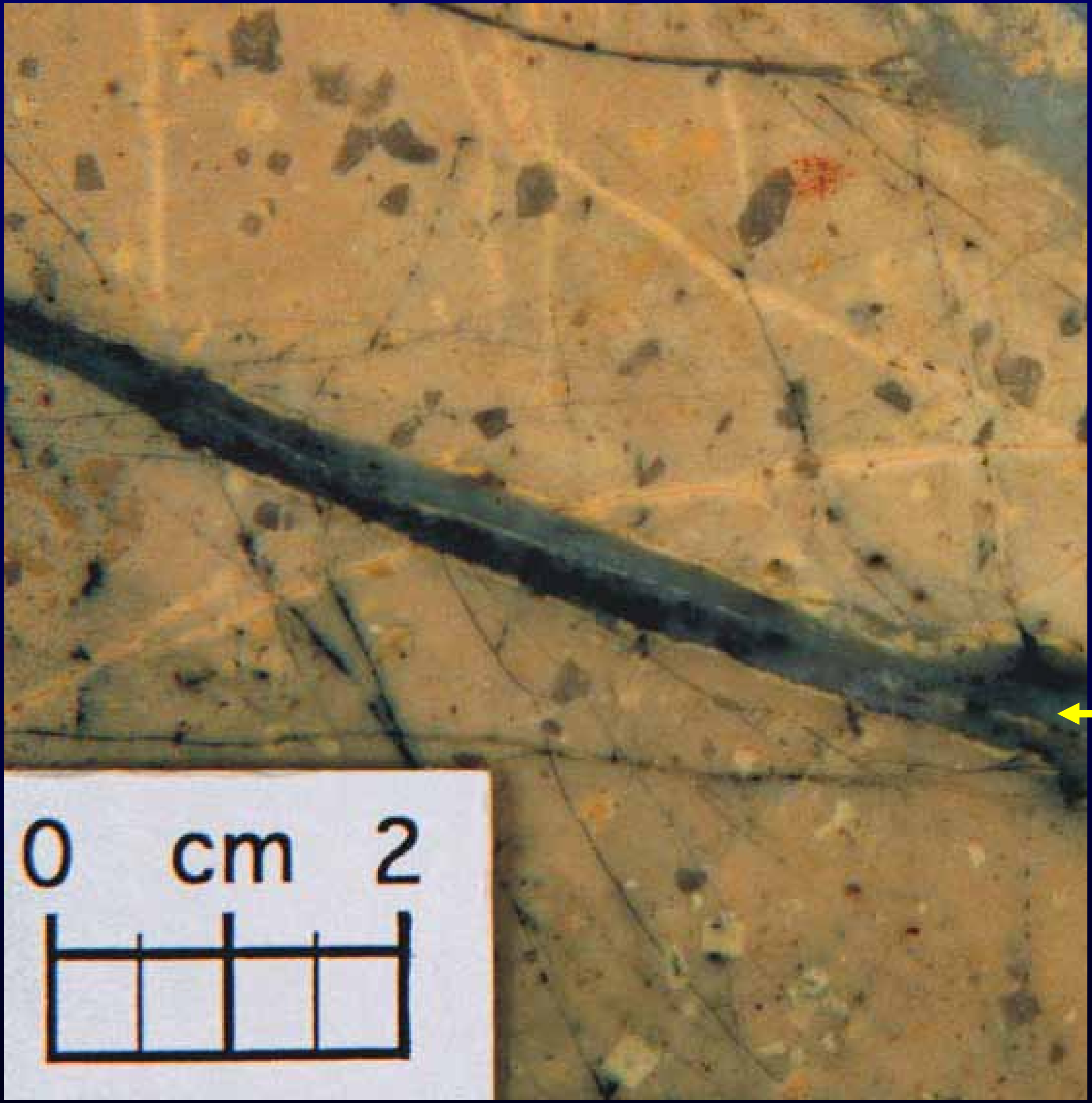
Endoskarn vein

Feld. Pheno

Quartz Pheno

Kidston

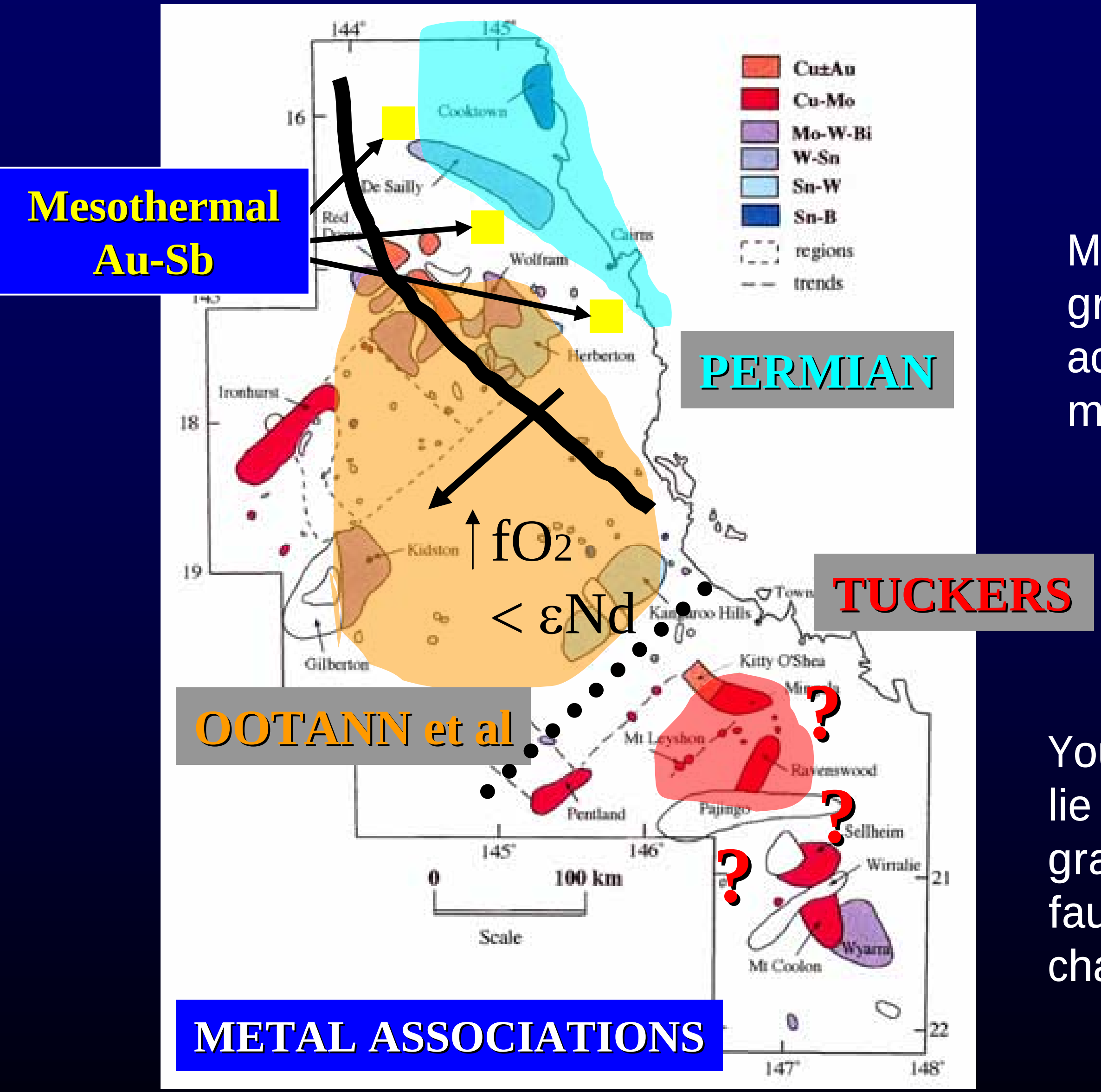
Porphyry with high T. mineralisation



$Qtz\text{-}MoS_2$ vein


Mount Leyshon 4/01

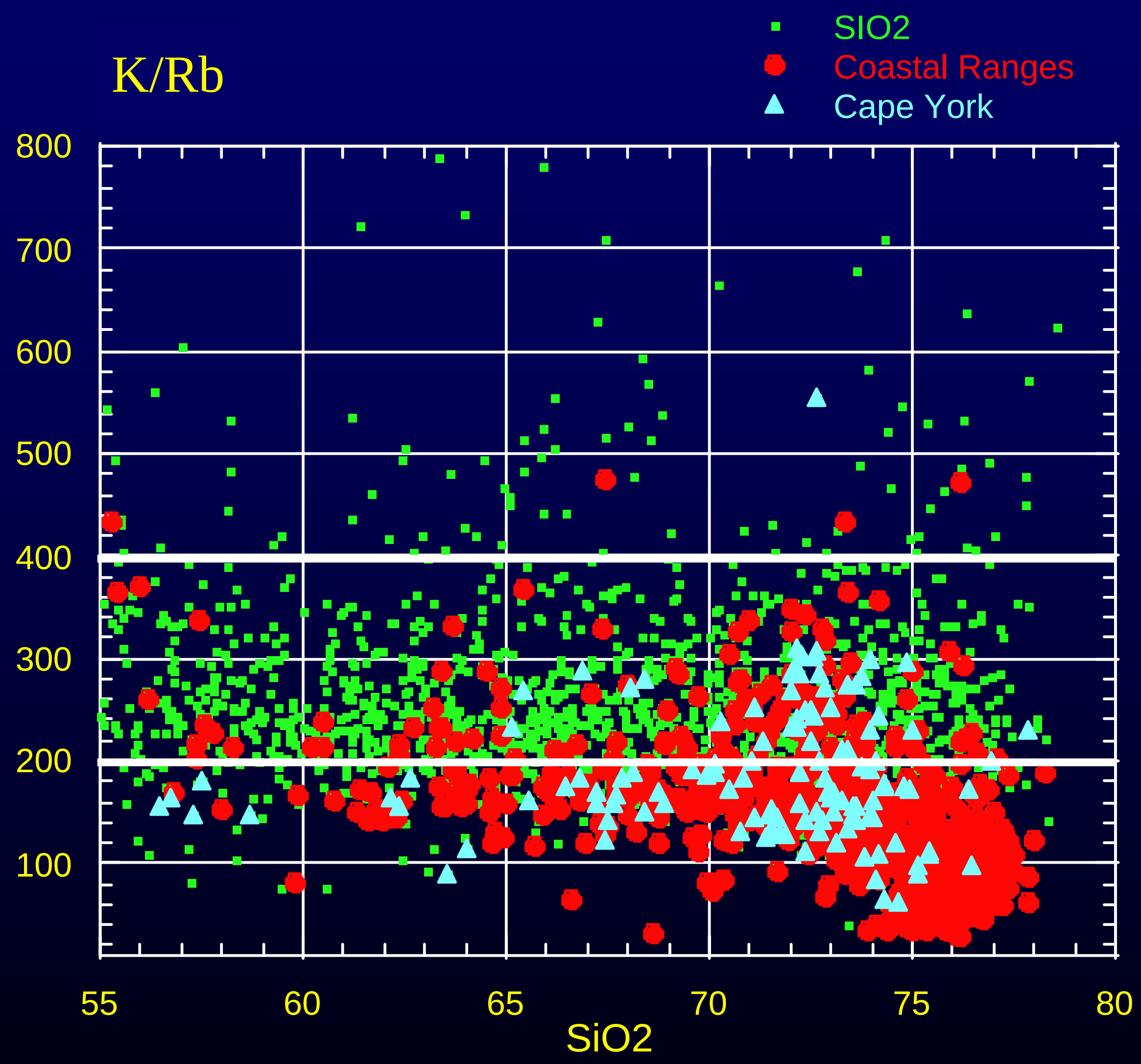
Igneous Metallogenic Relationships - NQ



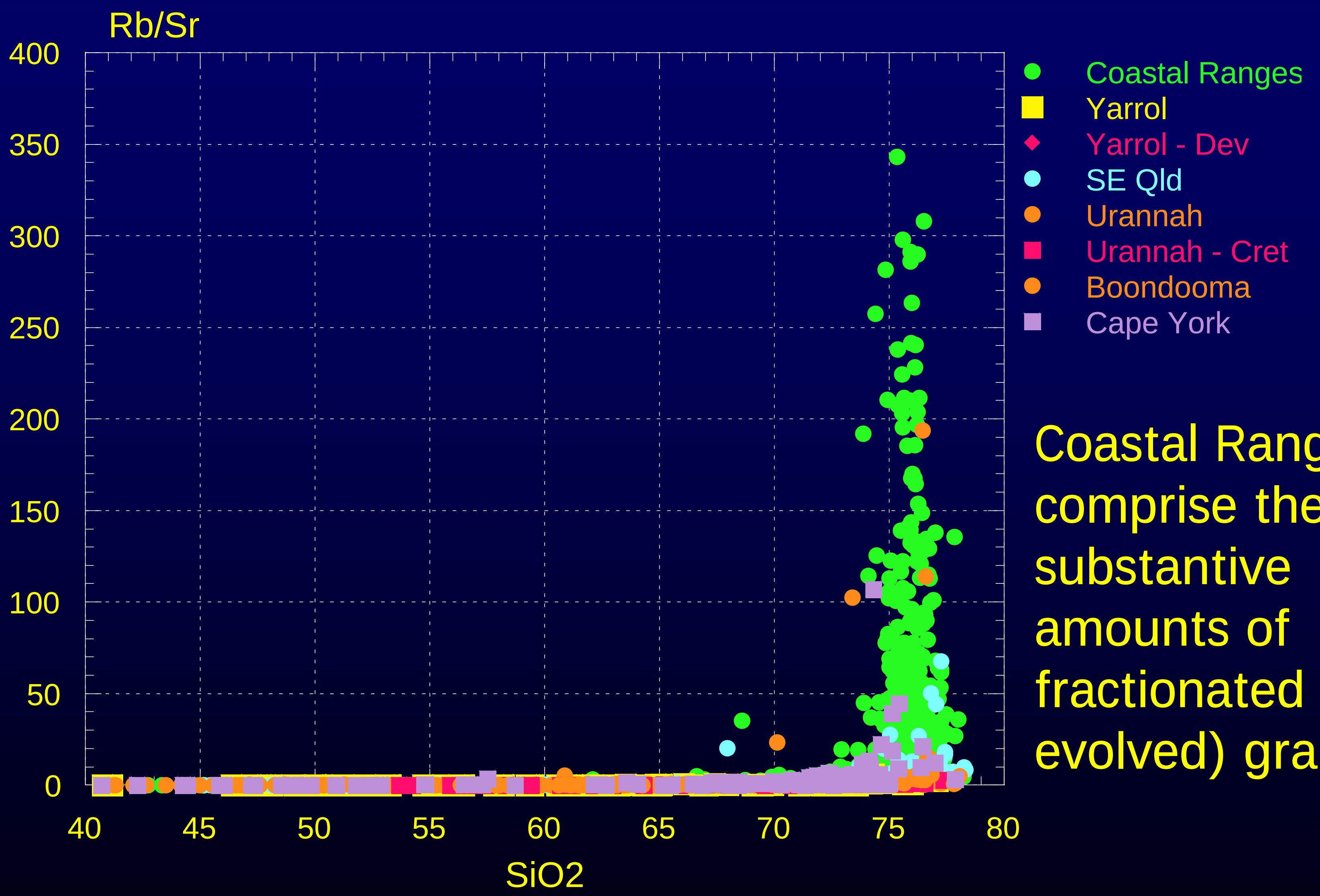
Major faults & lineaments: granites change composition across Clarke R. lineament, ignore major Palmerville Fault

Oxidation state increases inboard - continental effect.

Younger mesothermal Au deposits lie in “quiet” zone between granite supersuites, not along major faults - denotes location of major change in lower crust.

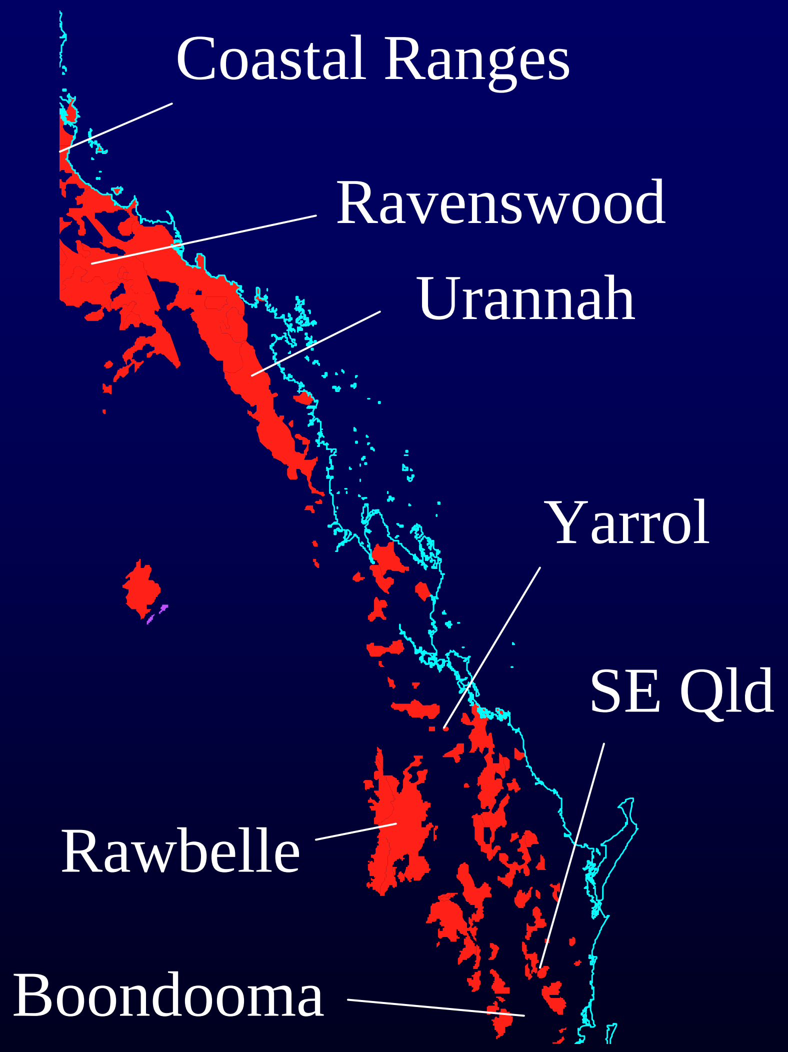


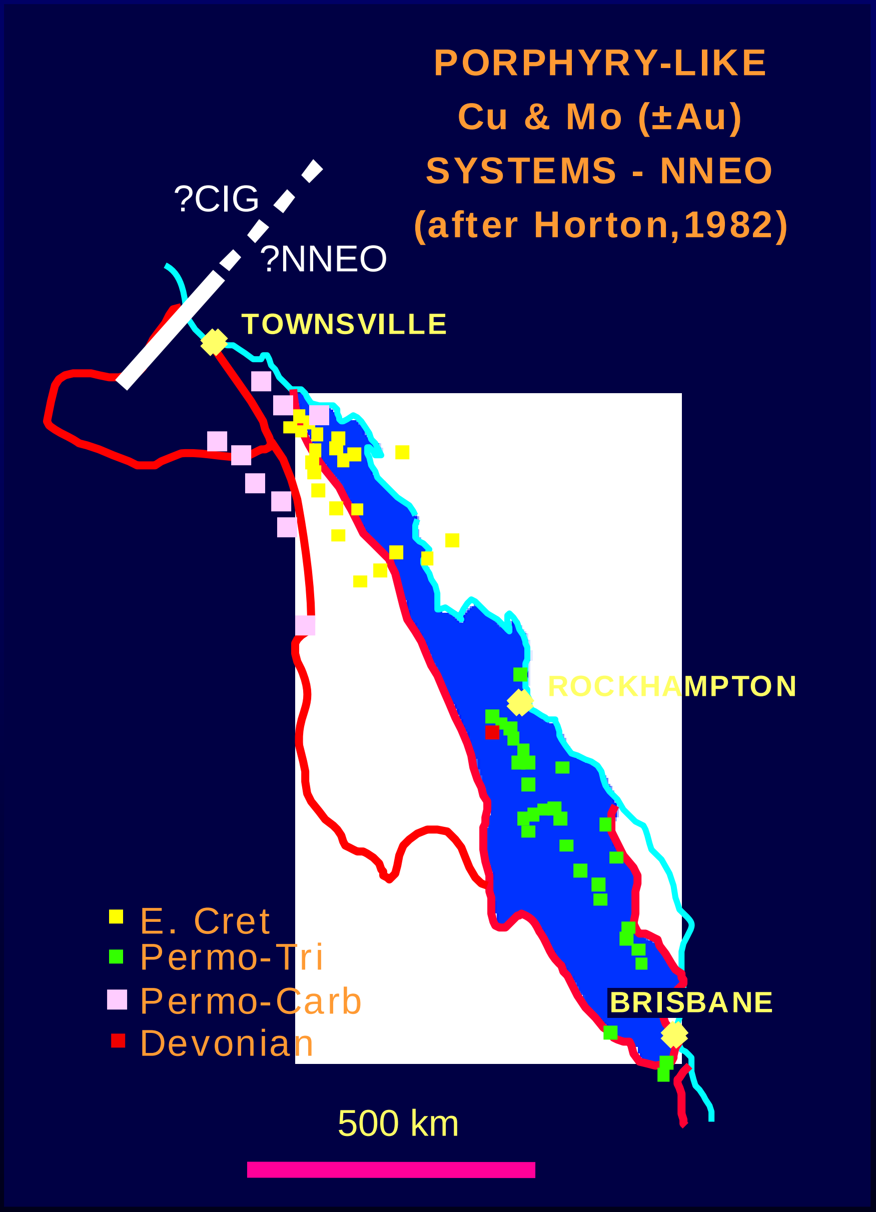
Cape York (CYG) and Coastal Ranges (CRG) Granites are compositionally evolved - CYG much like the LFB Sil-Dev while CRG are more fractionated.



Coastal Ranges comprise the only substantive amounts of fractionated (and evolved) granites.

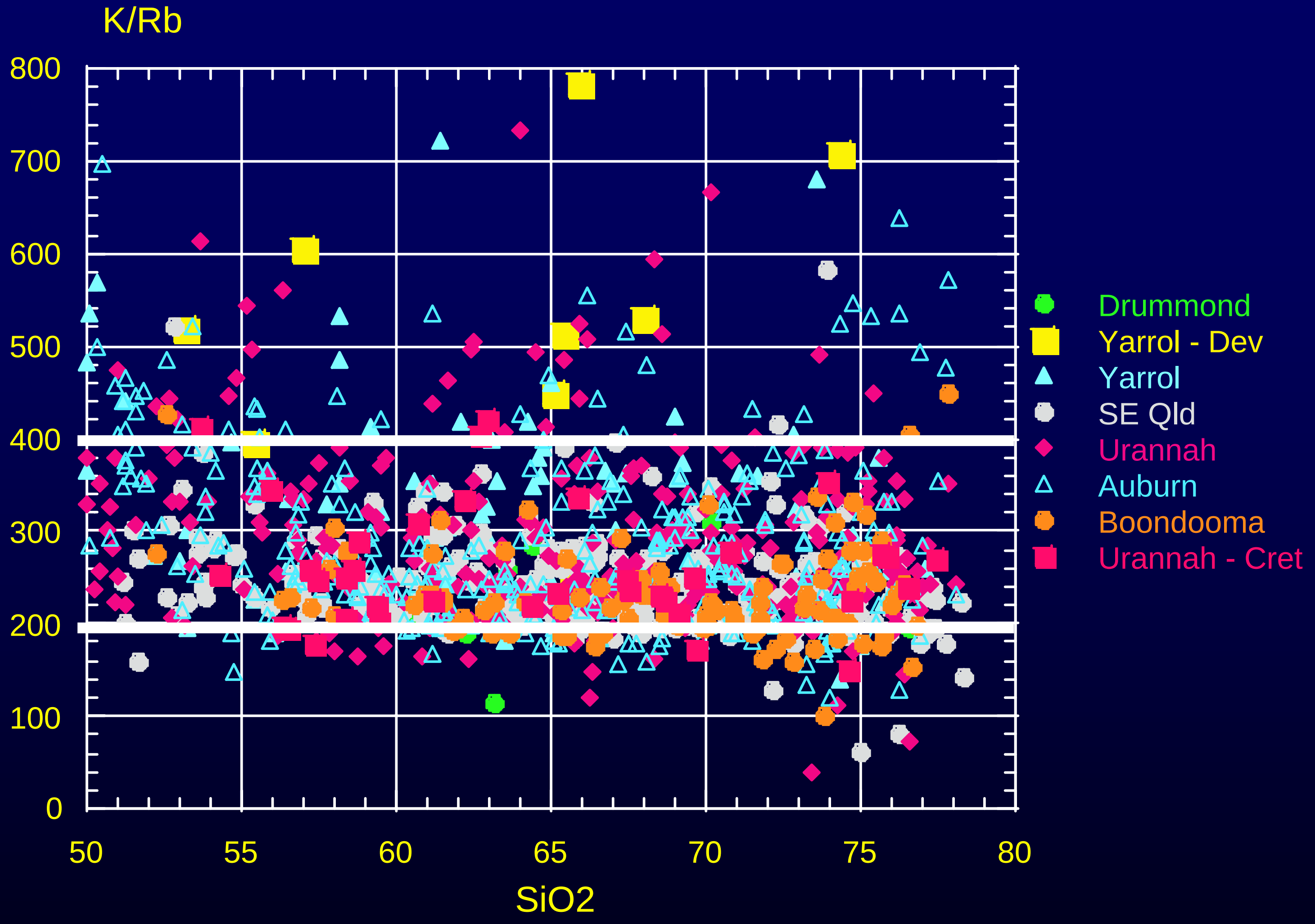
Northern NEO



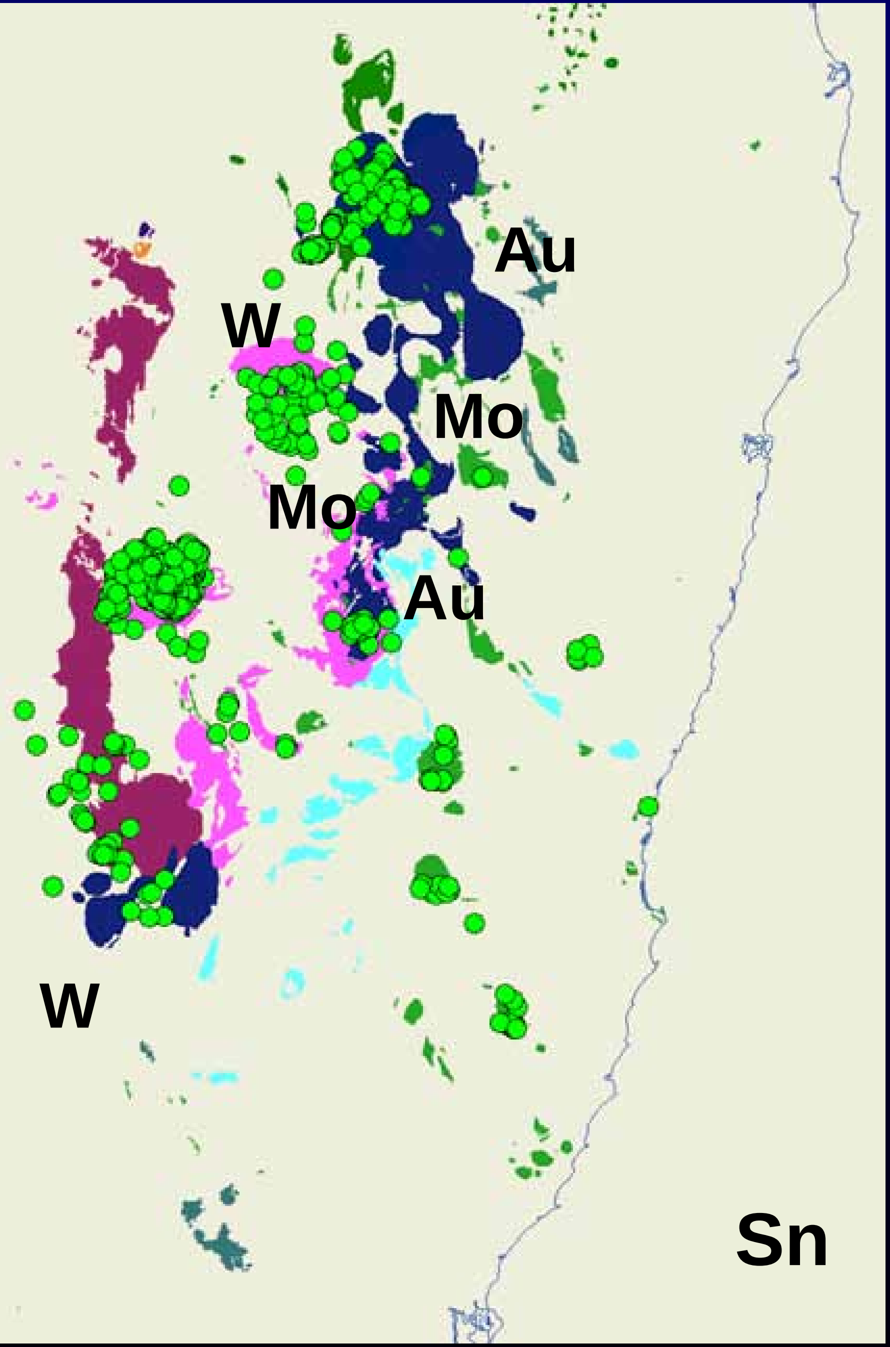


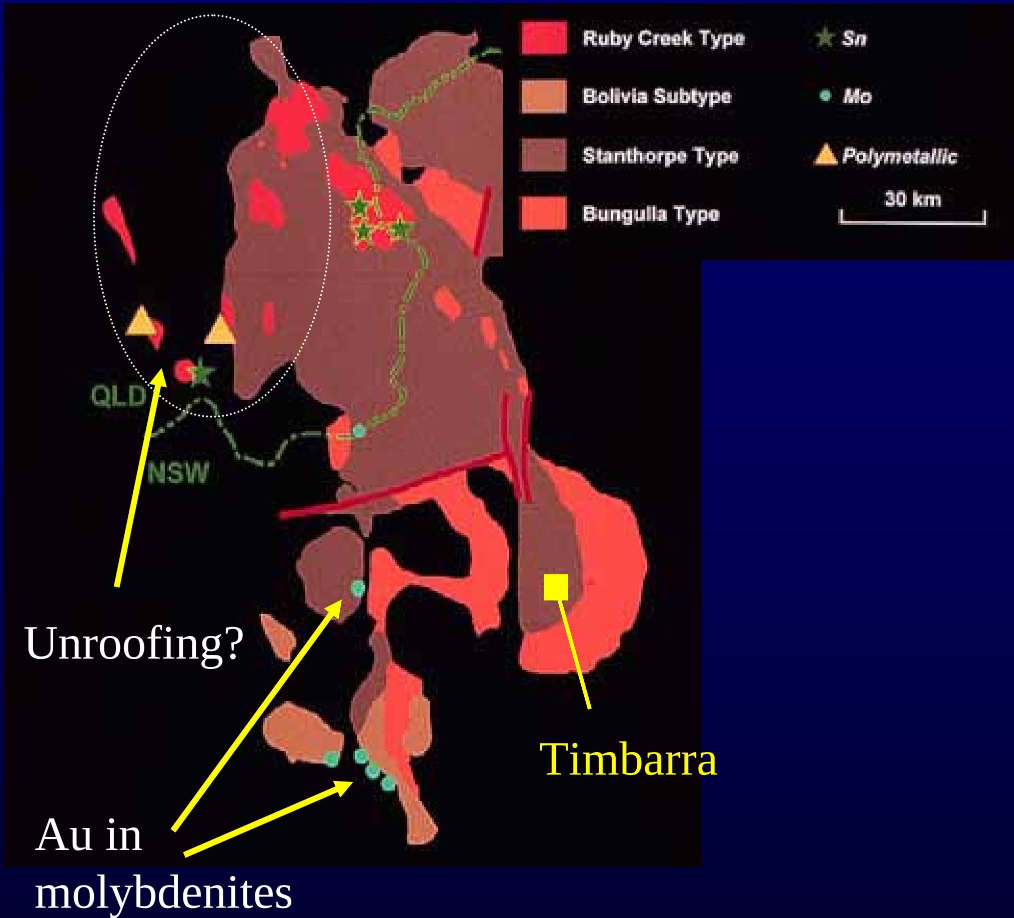
Current activity for Au, Cu and Mo

Northern New England Orogen



Compositional character of granites are typical of continental margins

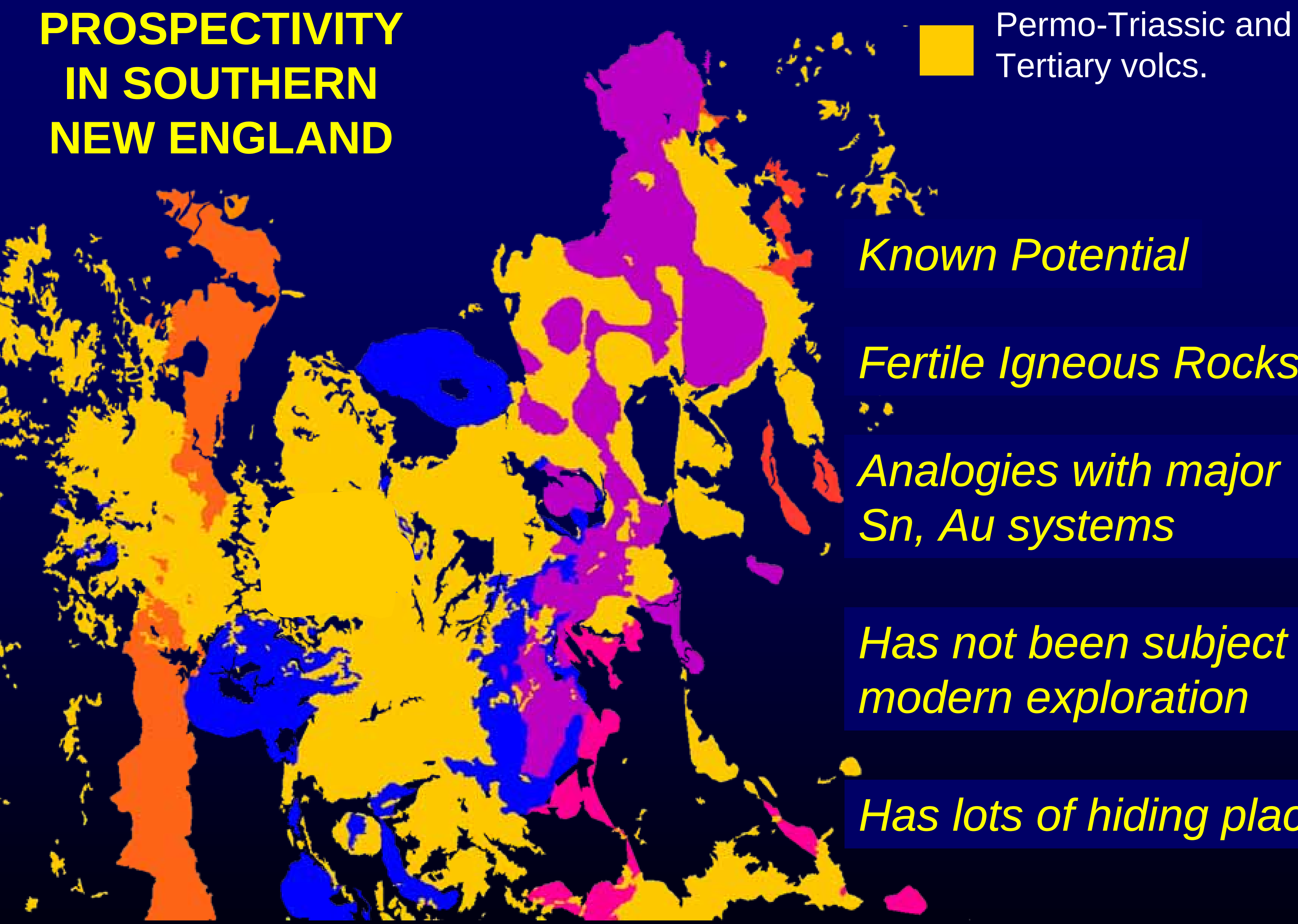




Marked contrast to the northern NEO

Exploration activity/success for Sn, Mo-Bi, Au, Ag-BM-In

PROSPECTIVITY IN SOUTHERN NEW ENGLAND



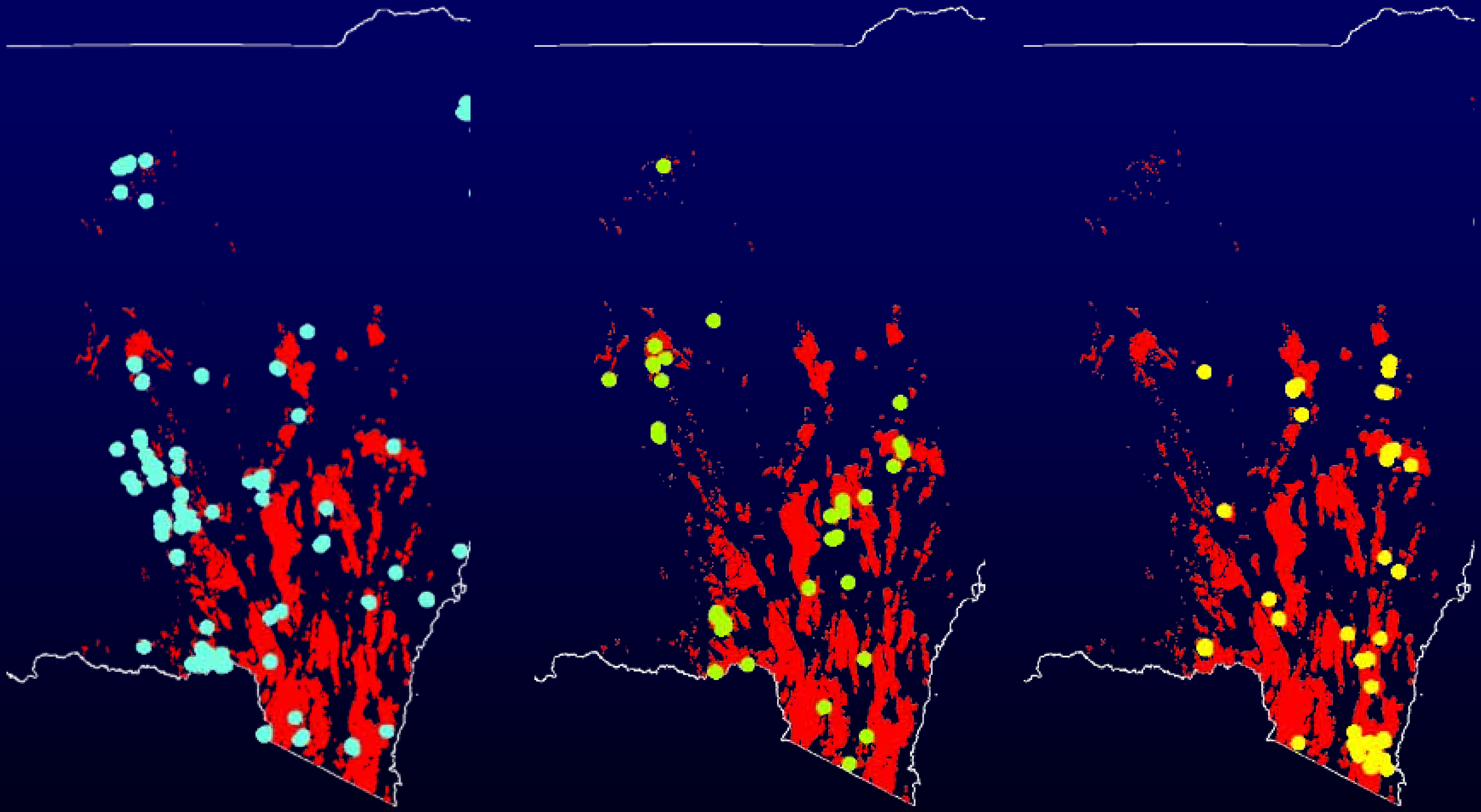
Known Potential

Fertile Igneous Rocks

Analogies with major Sn, Au systems

Has not been subject to modern exploration

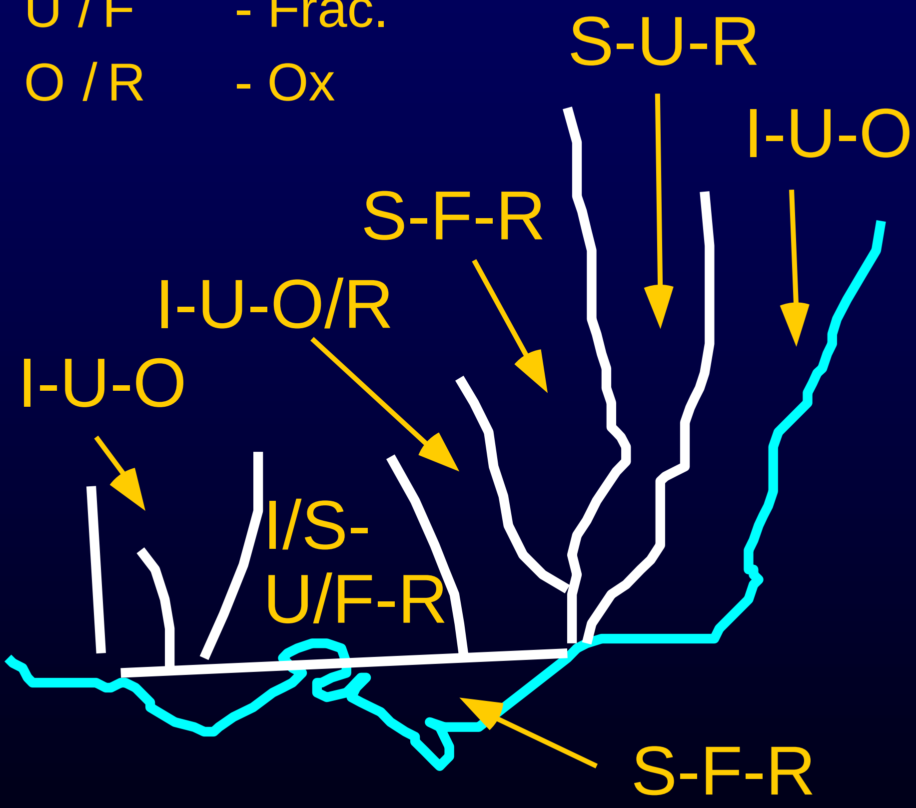
Has lots of hiding places

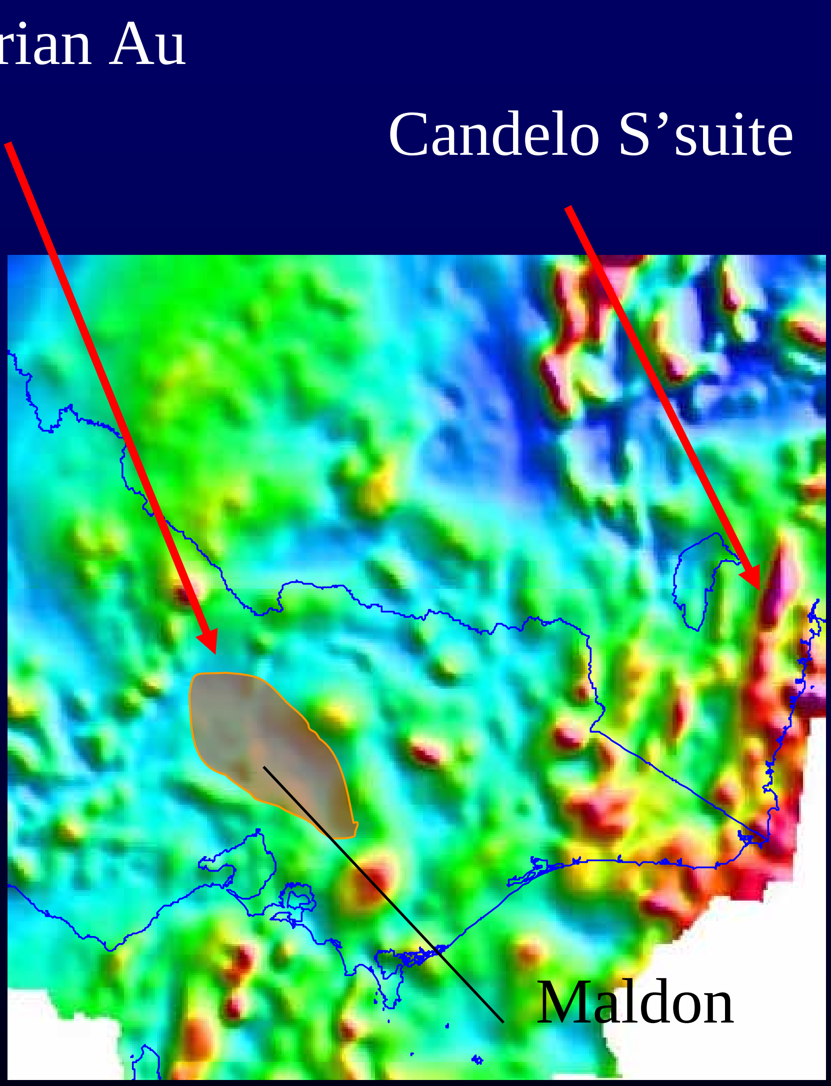


Sn W Mo

Granite Character by Province - LFB

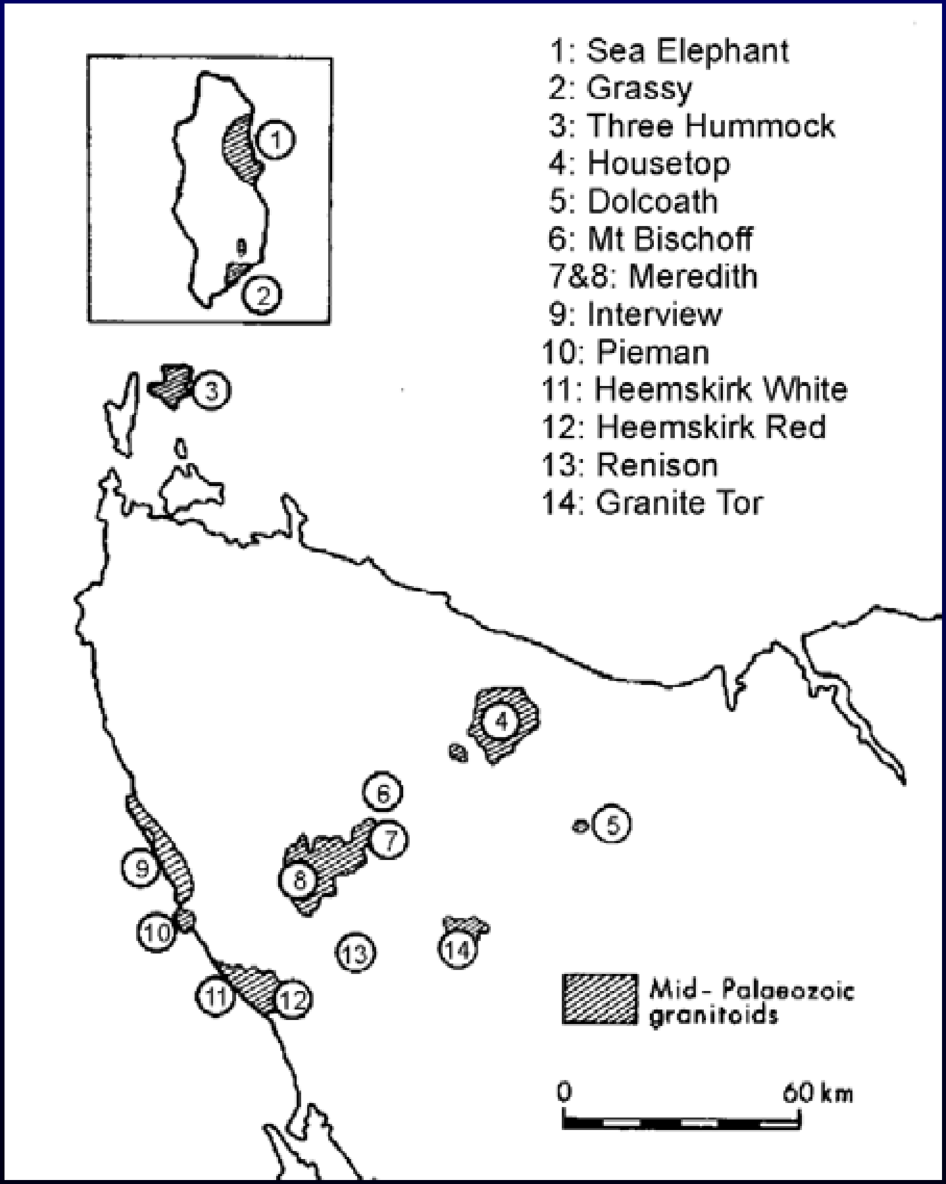
I / S - Type
U / F - Frac.
O / R - Ox

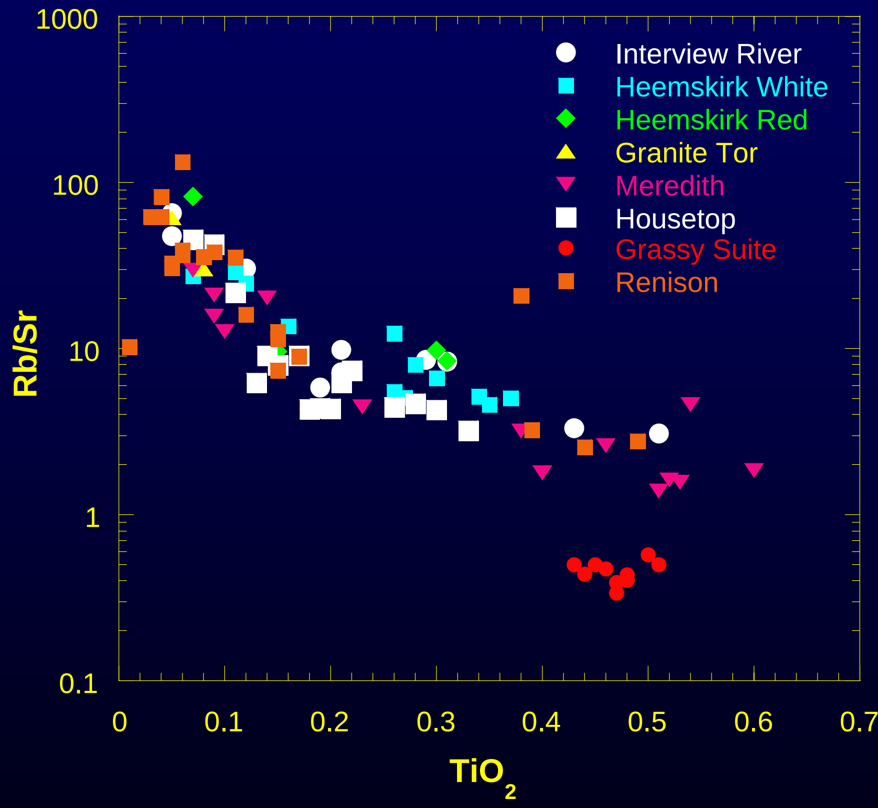


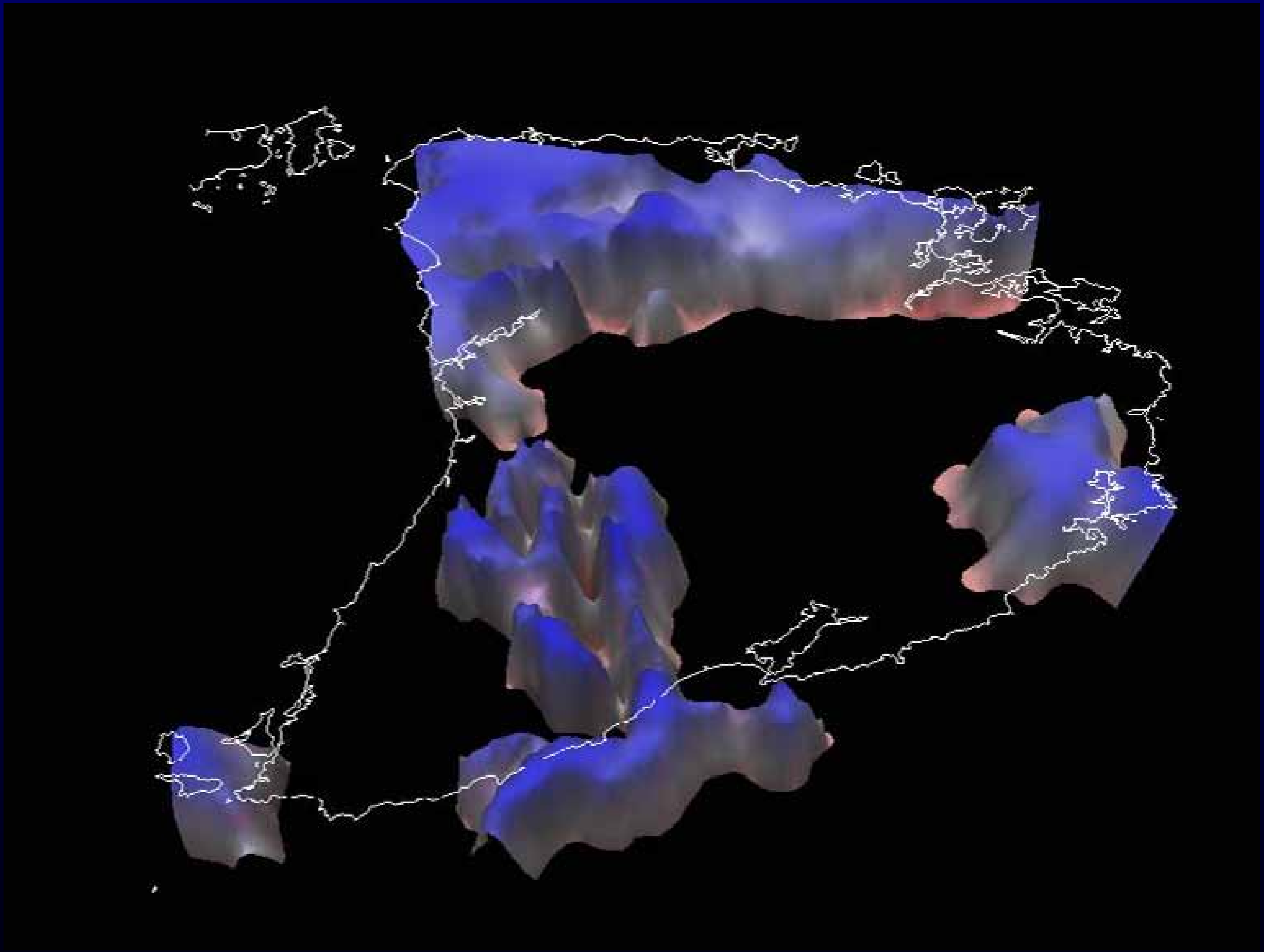


Western Tasmania

Sn, W, Au

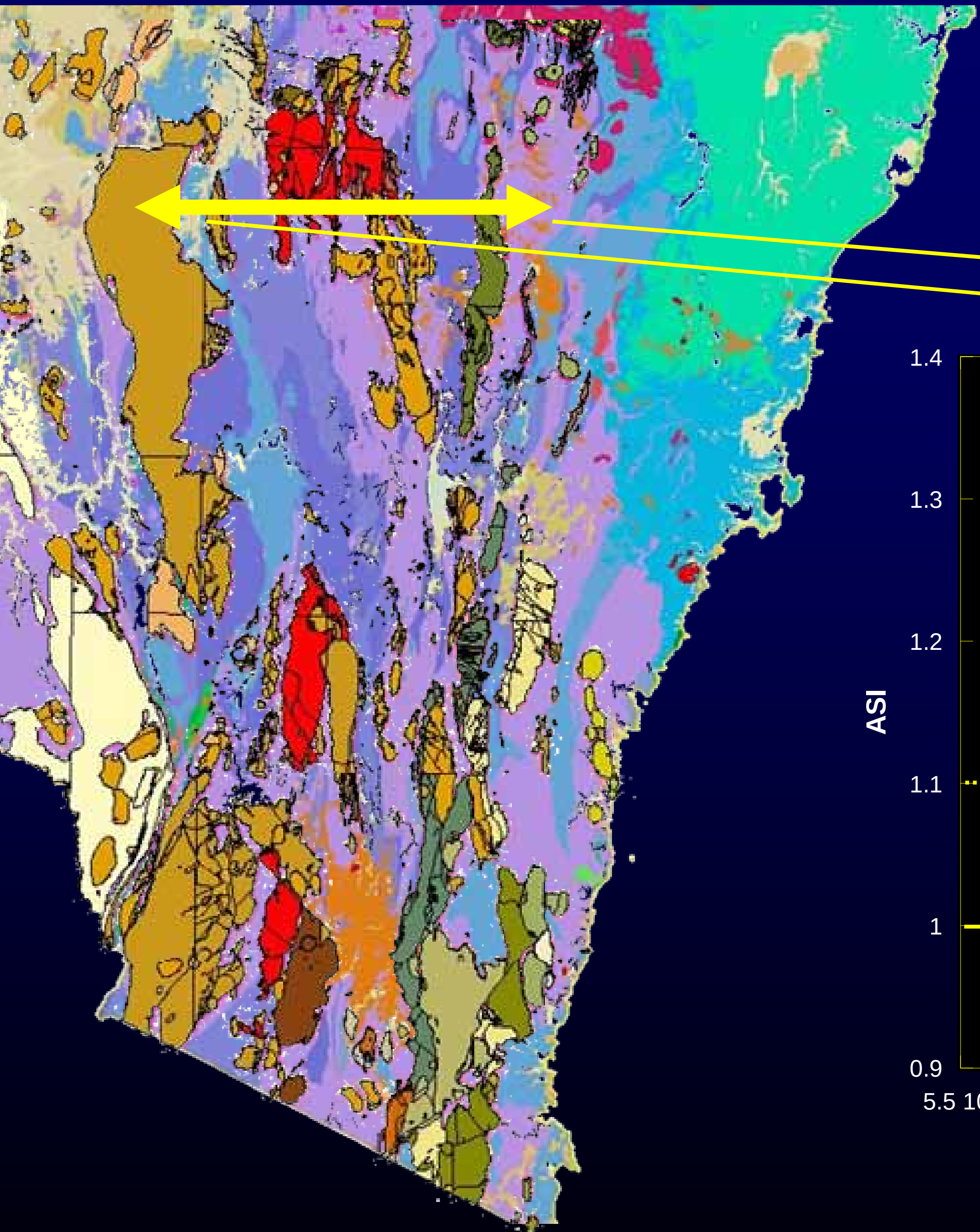


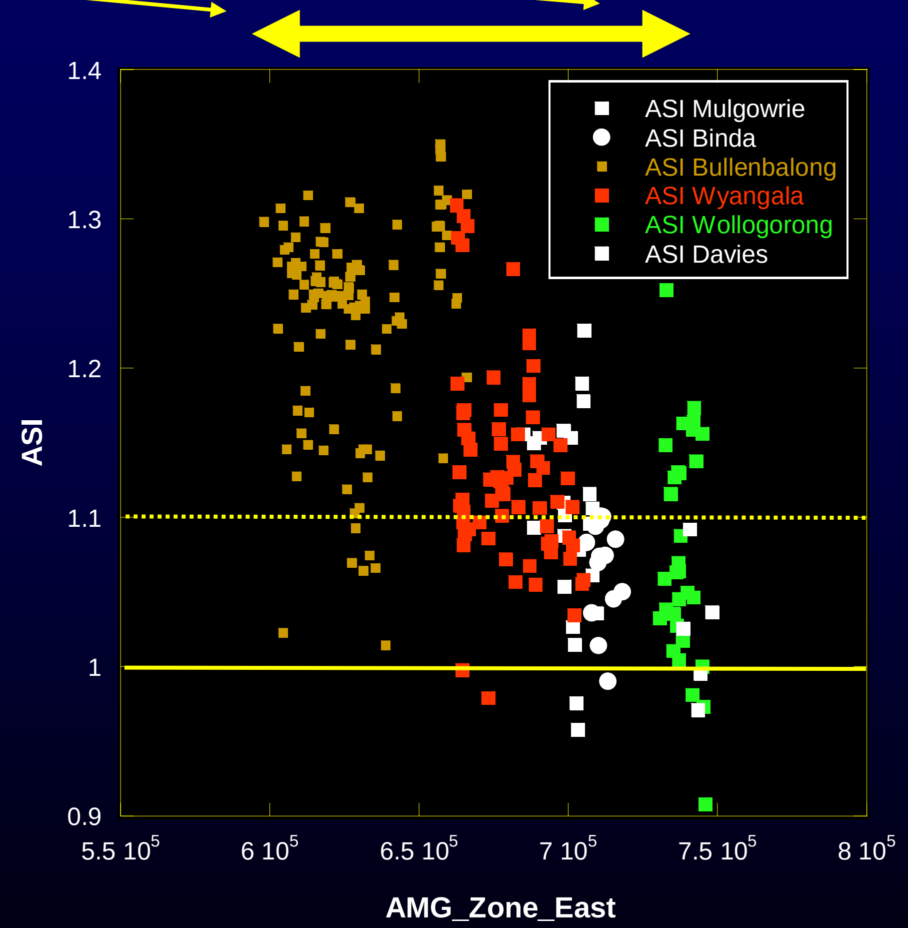




Tasmanian TASGO 3D VRML model

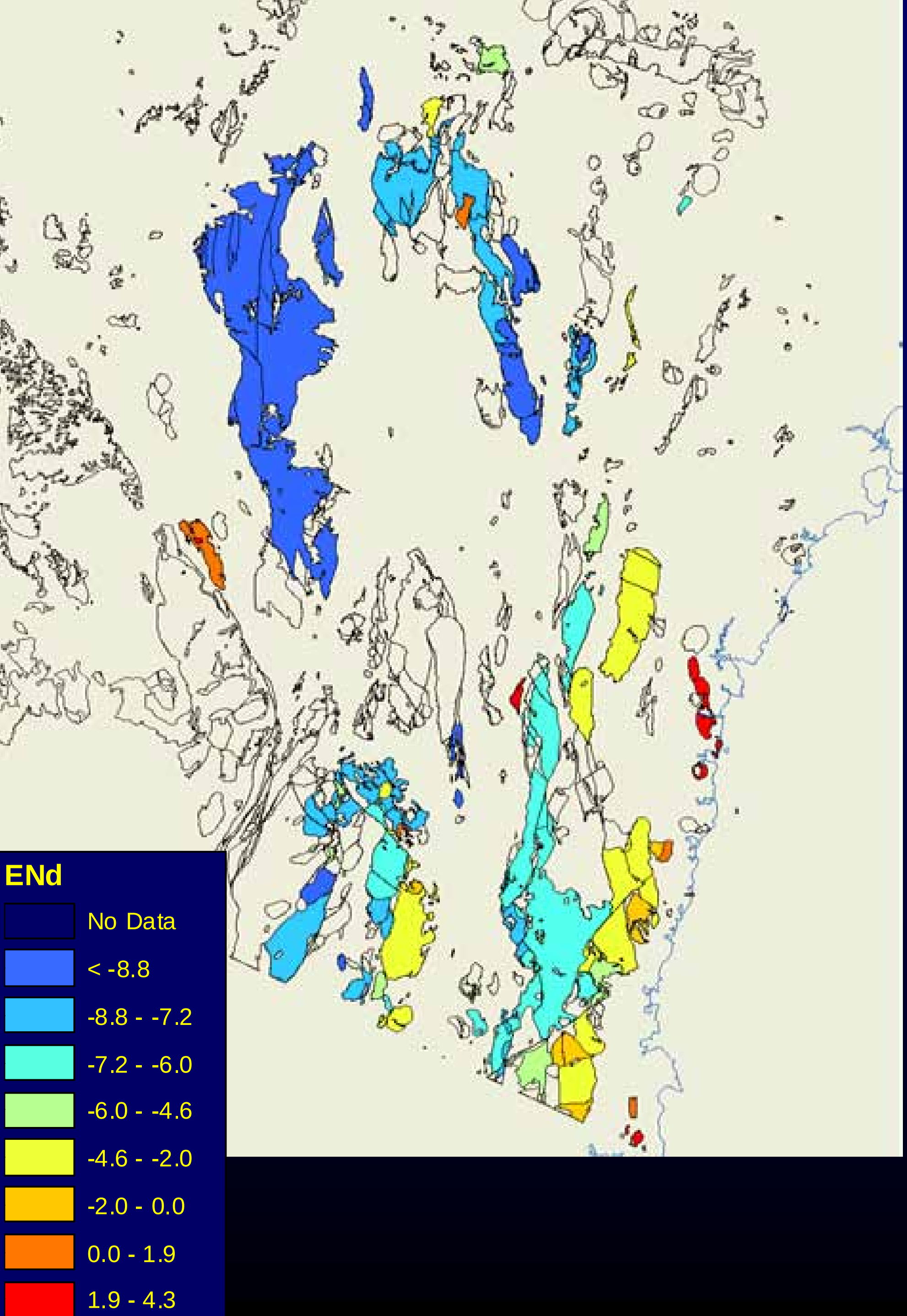
Granites become less "S-type" to the east

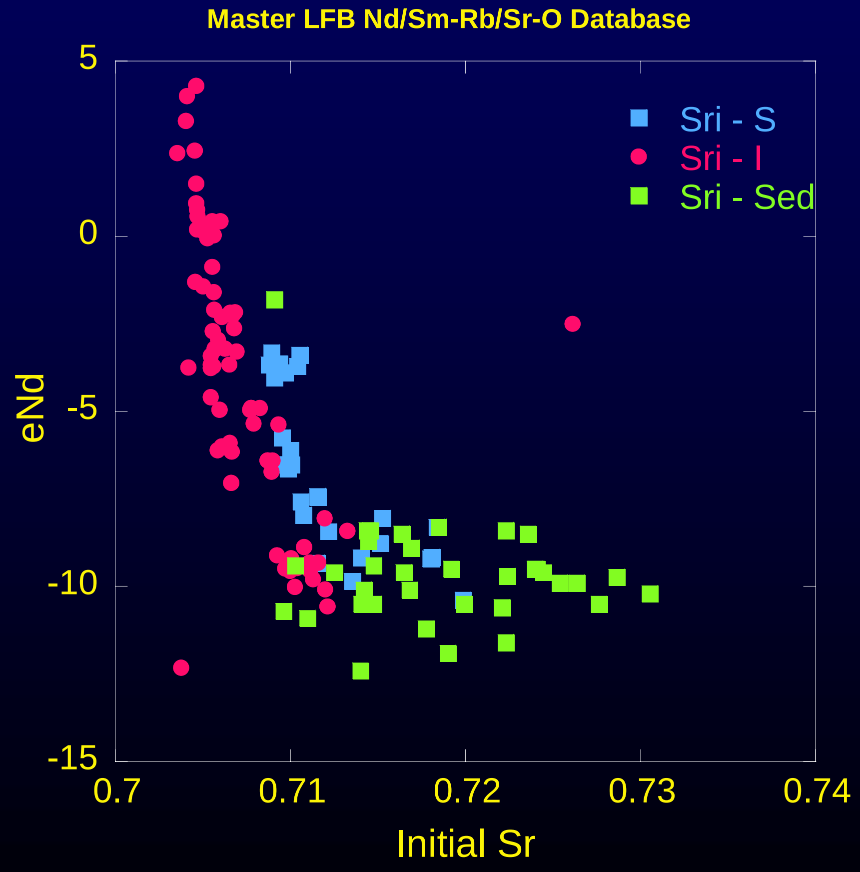


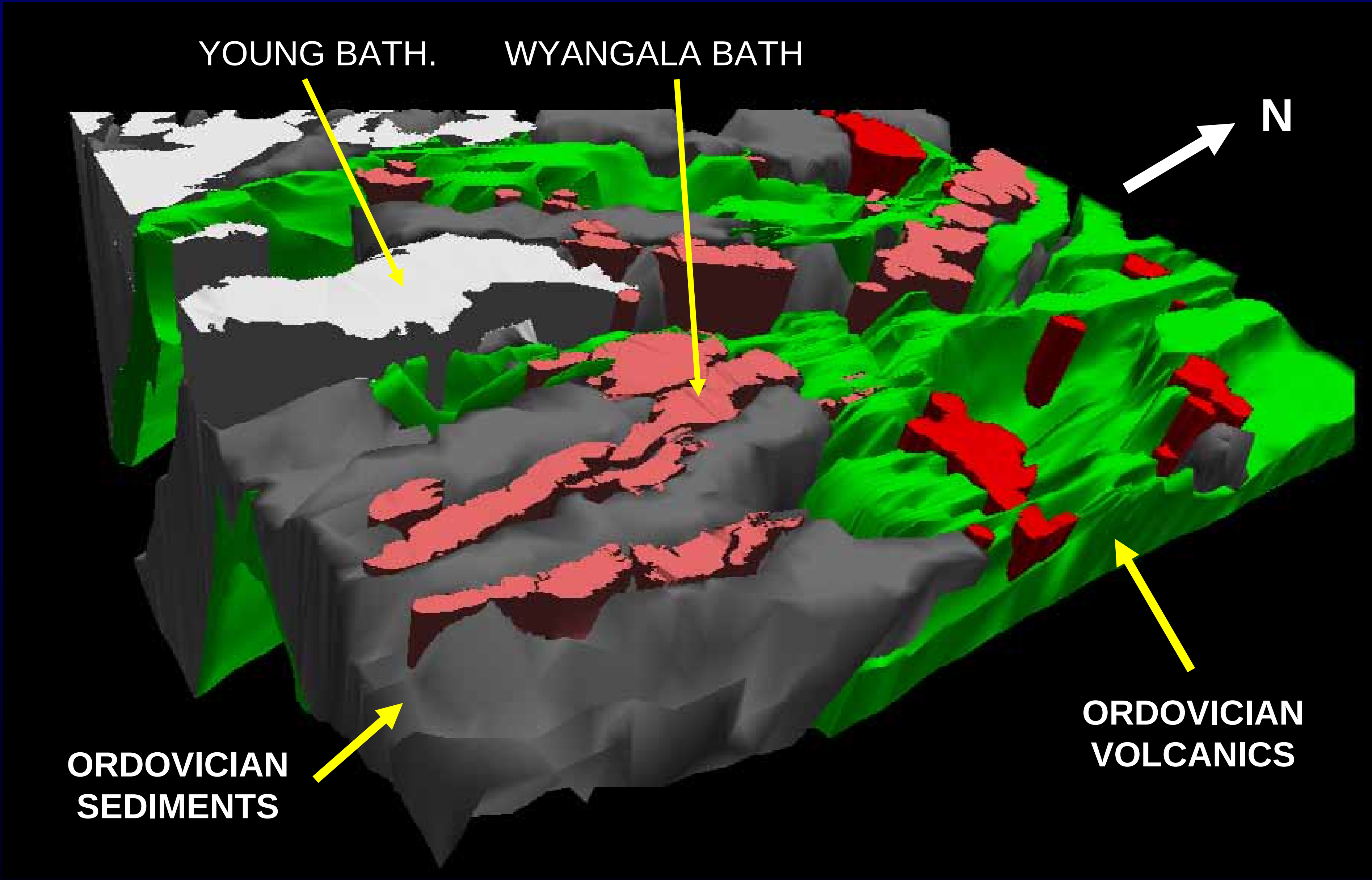


Nd mapping project

Radiogenic isotopes are identifying broad zones that reflect source regions, materials and crustal architecture.

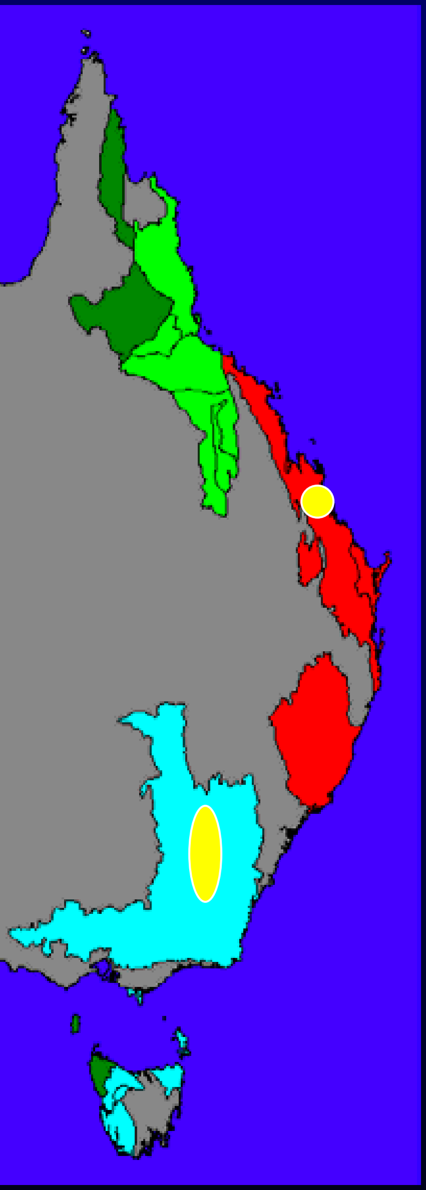


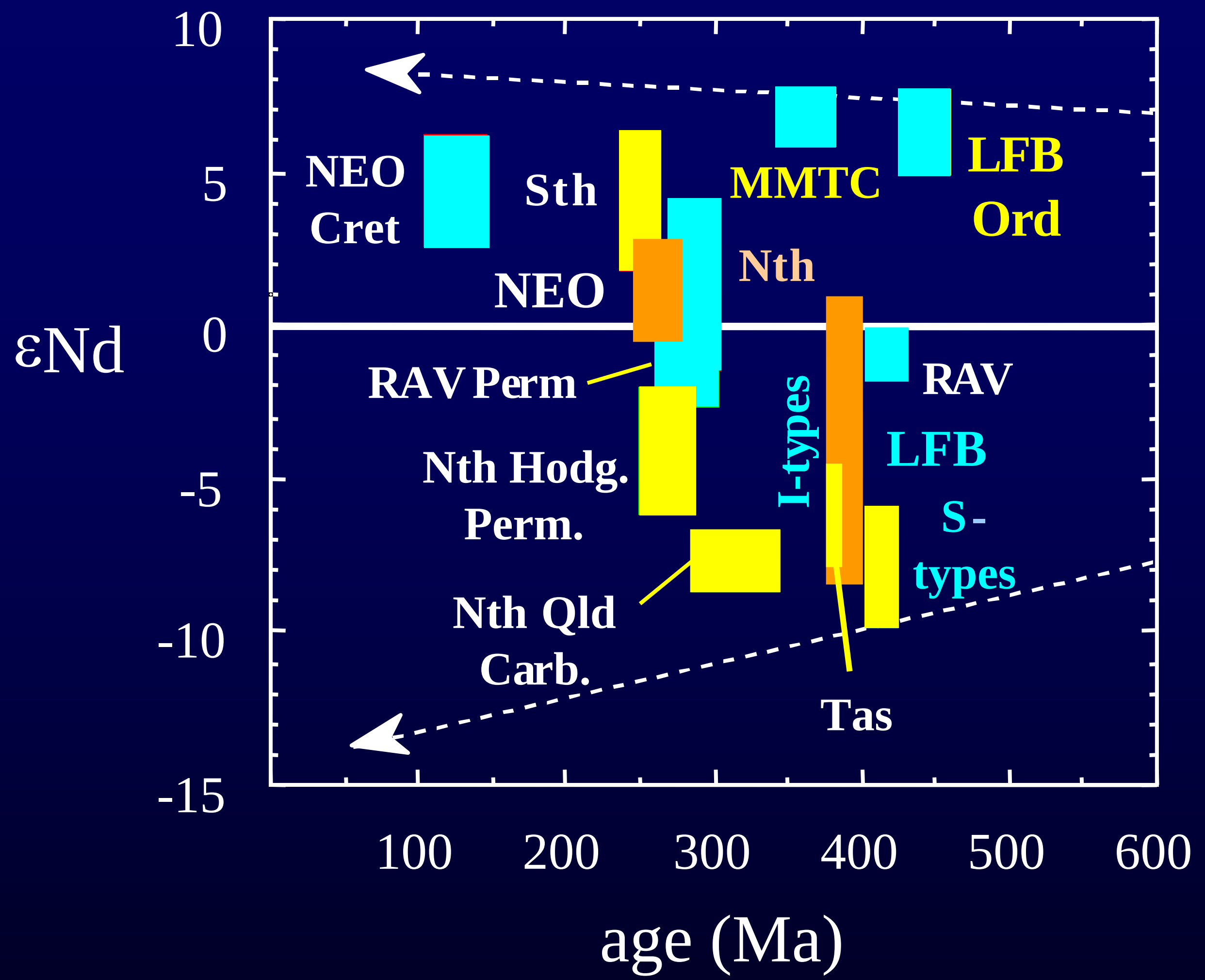




Eastern Lachlan Orogen 3D VRML Model 2007

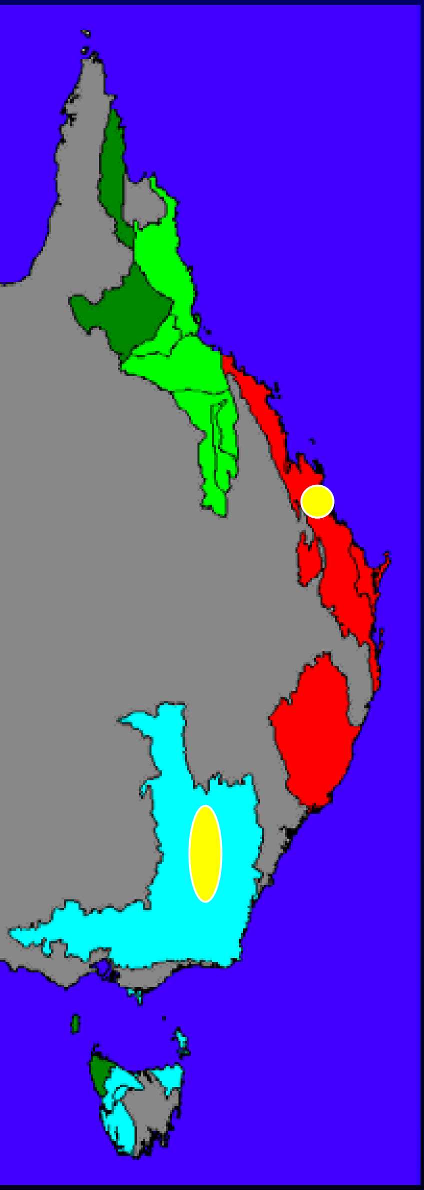
Sn

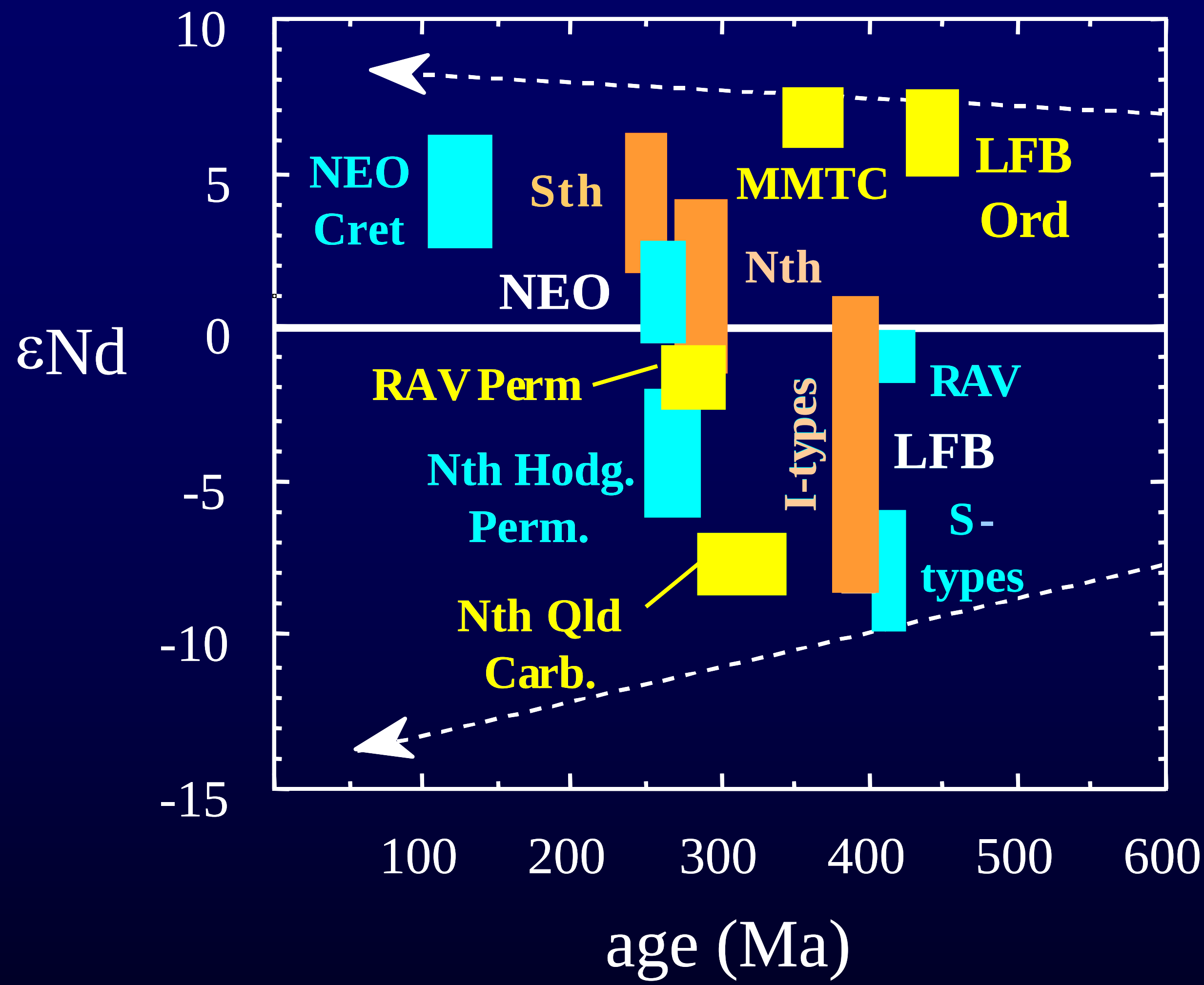




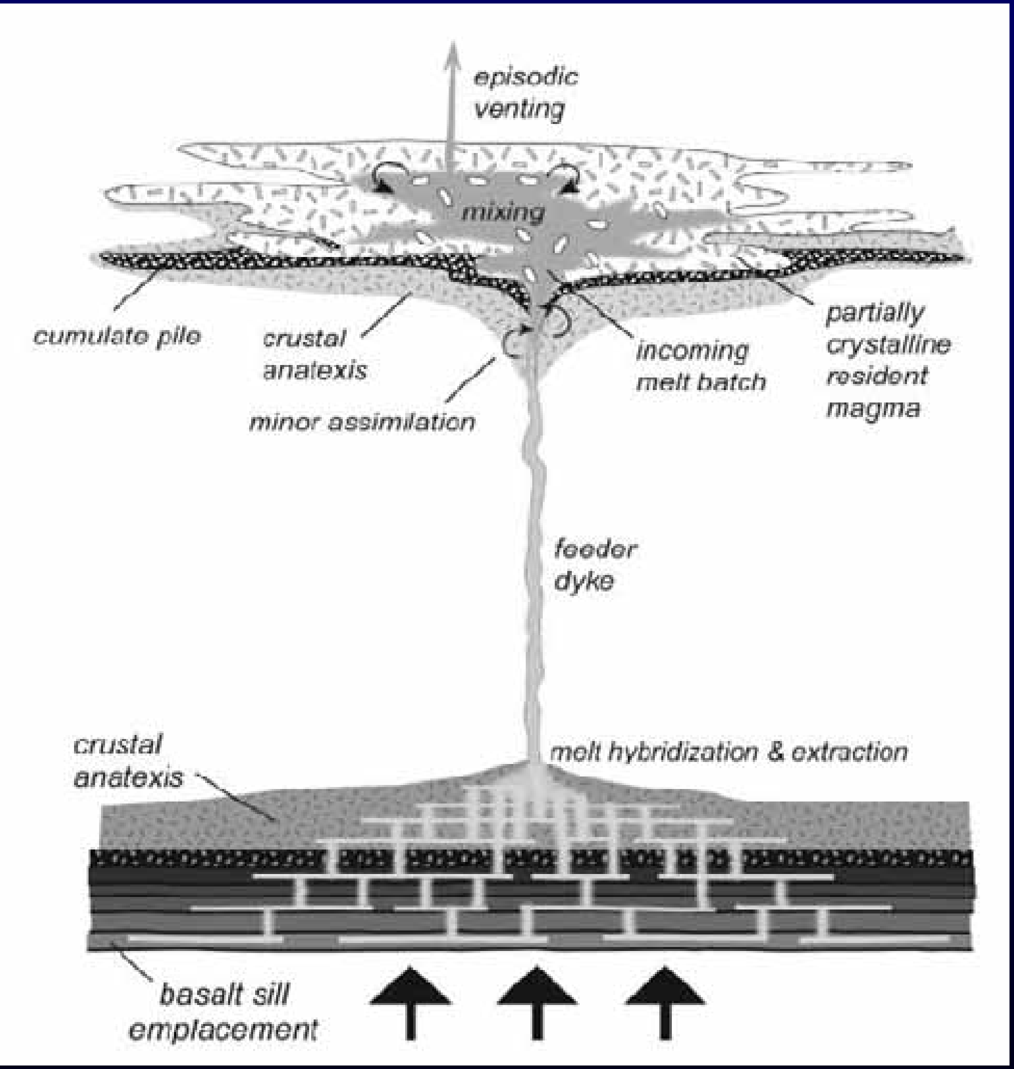
<10t Sn 10-10000t Sn >10000t Sn

Au





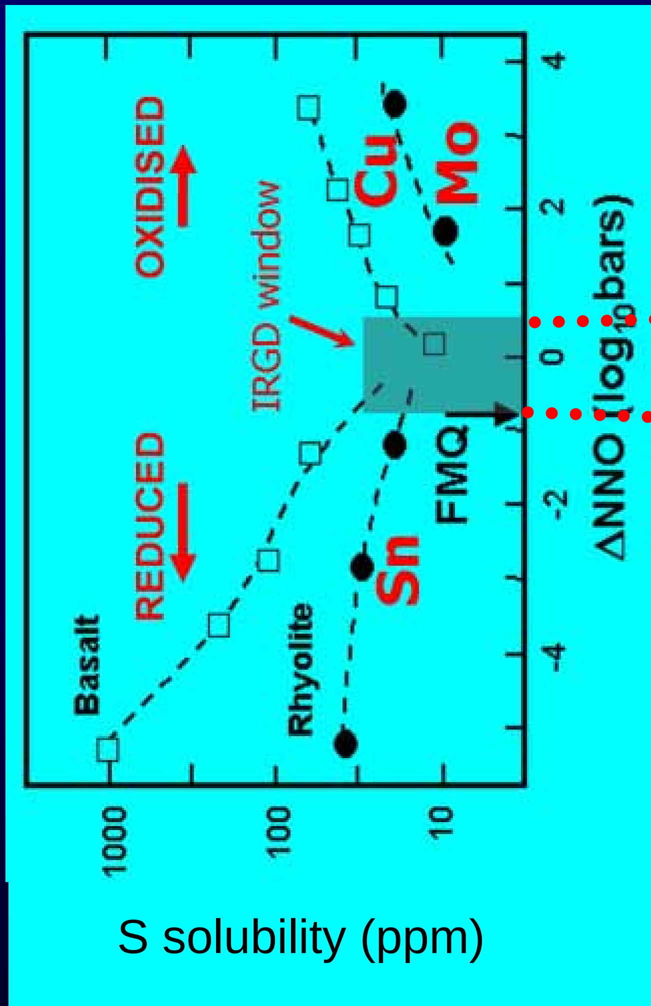
<10t Au   10-100t Au   >100t Au

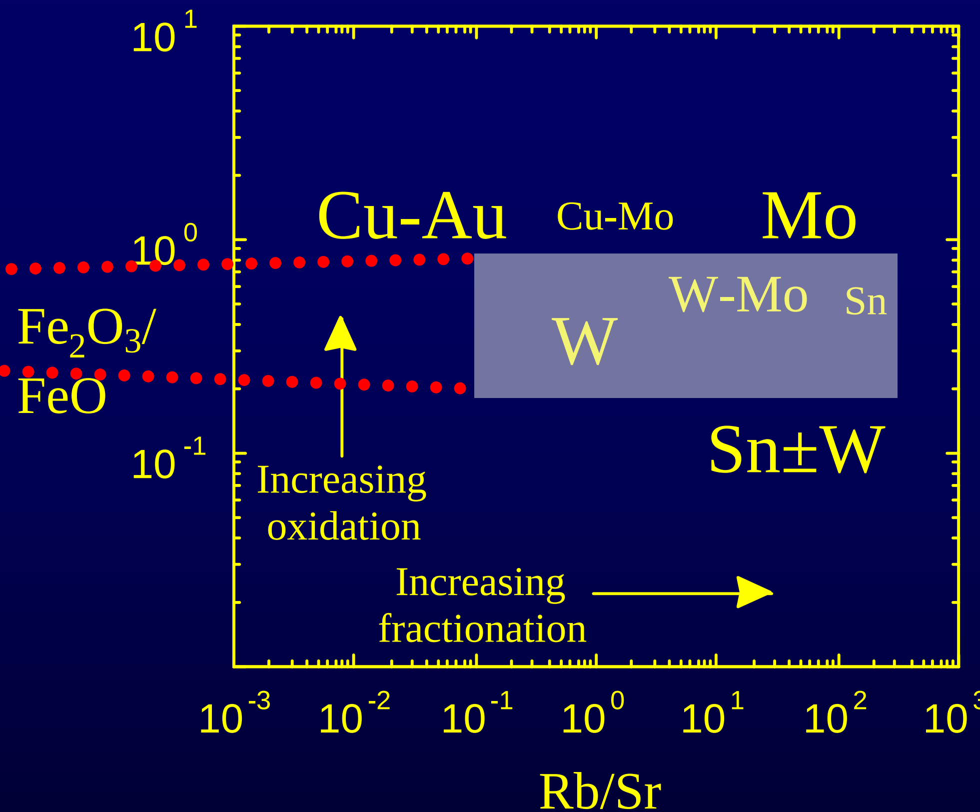


Recent detailed studies using combined Hf and O isotopes in zircons have confirmed that granites have complex source histories.

Such studies (with Nd etc) will help in understanding the relationship between metal sources and other inputs that also affect composition and intensive parameters.

Kemp et al., 2007

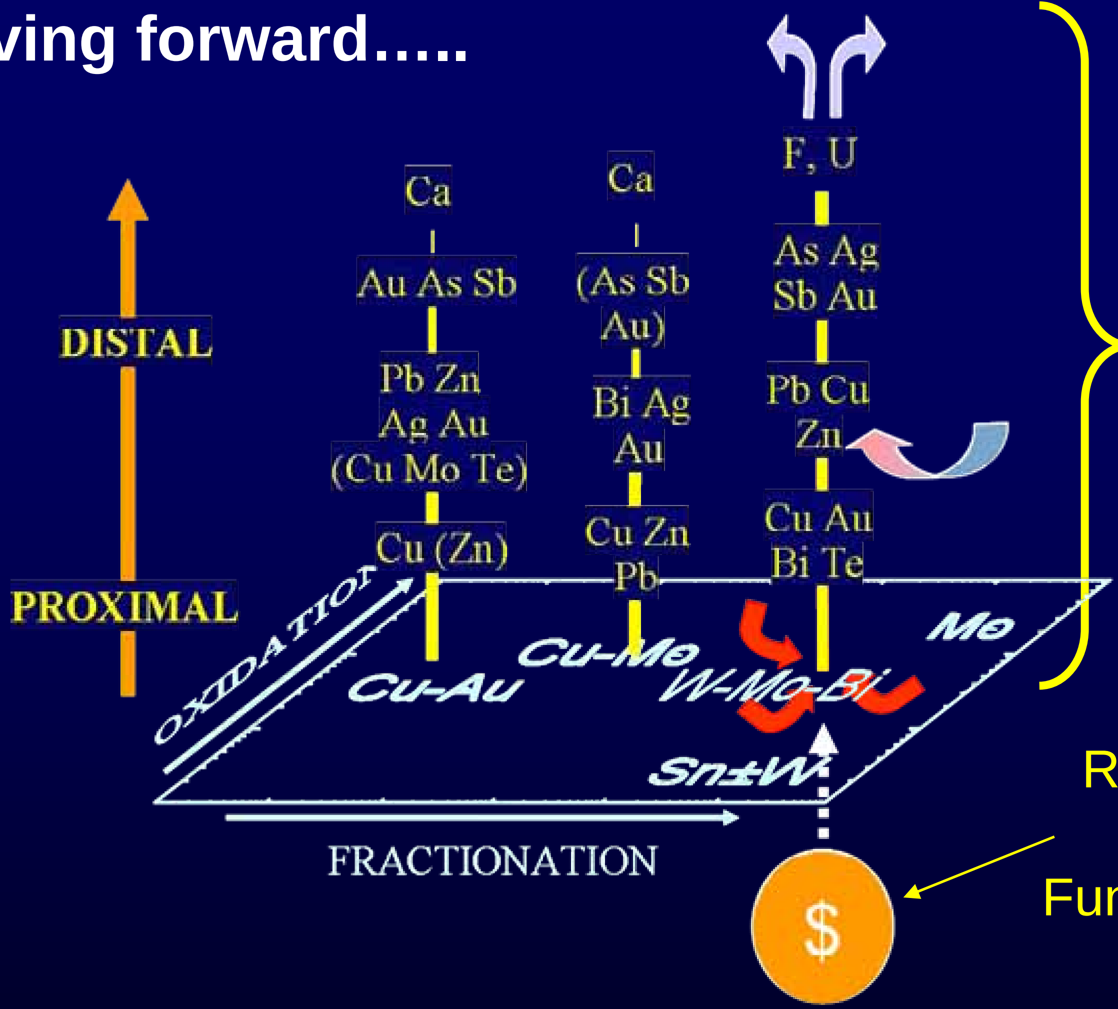




The “special” case of IRGD

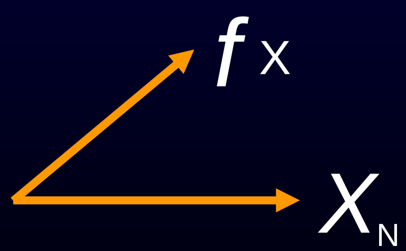
- *Do felsic Au systems require a special Au source?*
- *Why the coincidence of similar granite types with IRGD?*
- *Do they require the conjunction of a specialised Au source and an appropriate magma (i.e. is everyone correct?)*

Moving forward…..



- Mapping
- Geophysics
- Chemistry
- Alteration
- Isotopes

Redundant
or
Fundamental?



- Improved classification (chem, pet, geophys).
- Easier application.
- Mapping of provinces (isotopes, supersuites, crustal architecture).
- Comparative studies eg. IRGD, provinces