



Basement Geology of the Northern Tasmanides

What, When, Where & Why?

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Overview

- What? - Background and how the project idea began
- When? - Discovery in the Cape River Metamorphics
- Where? - Evidence for Mesoproterozoic basement across north Queensland
 - Argentine Metamorphics
 - Anakie Inlier
 - Greenvale Province
 - Iron Range Province
- Why? - Implications for tectonics and mineral deposit formation
 - New search spaces
 - New deposit styles

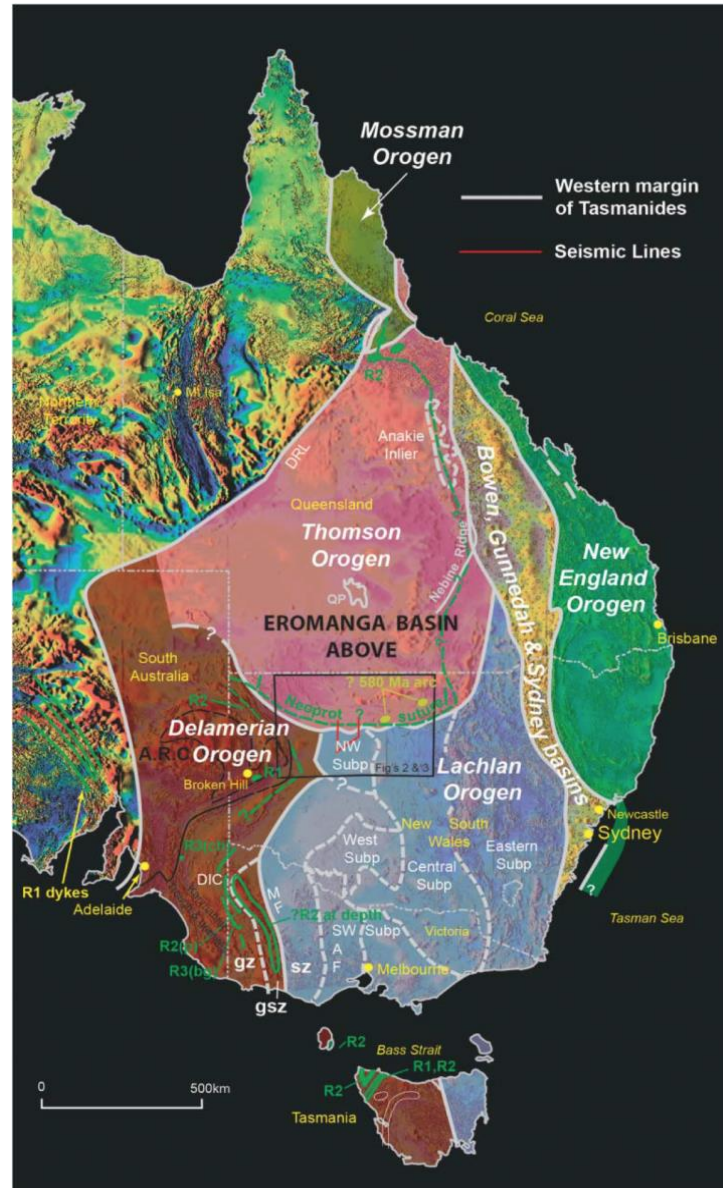
Background – Thought Evolution

Common Thinking

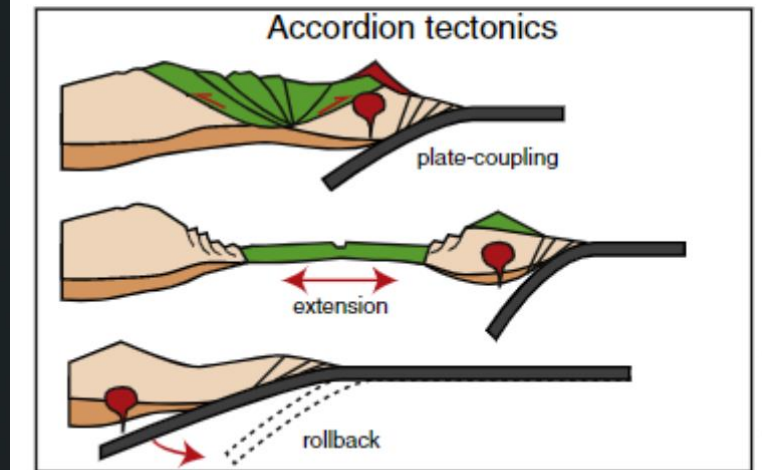
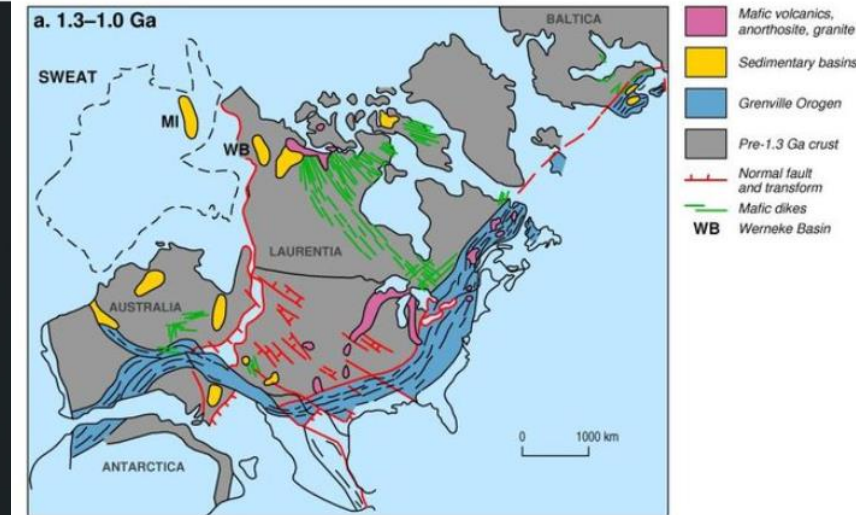
- Reconstructions of Rodinia situate eastern Australia along the western margin of Laurentia
- Neoproterozoic rifting along the “Tasman Line”
- Paleozoic convergence initiated outboard of the continental margin
- Accretionary-style orogen
- **Basement comprises Neoprot-Cambrian sequences deposited atop oceanic passive margin**

New Ideas

- Northern Queensland comprises a series of oceanic and micro-continental terranes
- Collisional tectonics contributed significantly to continent growth during the early-Paleozoic times



Gibson et al., 2012



Accretionary orogen:
Extension and plate-coupling

Aitchison and Buckman, 2012

Background – Fitting in the Cape River Mets

- Cape River Metamorphics comprise three main units – The Fat Hen Creek Complex (FHCC), the Cape River Beds, and the Morepork Member
- Interpreted to represent a conformable sequence of metasediments deposited within an early-Paleozoic back-arc basin
- Metamorphic grade generally decreases from east to west
- Detrital zircon record suggests the existence of either a major structure or unconformity

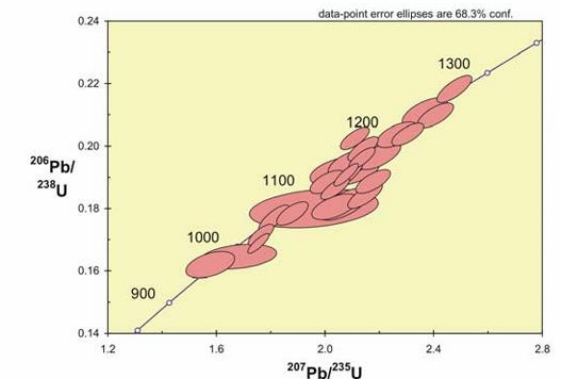
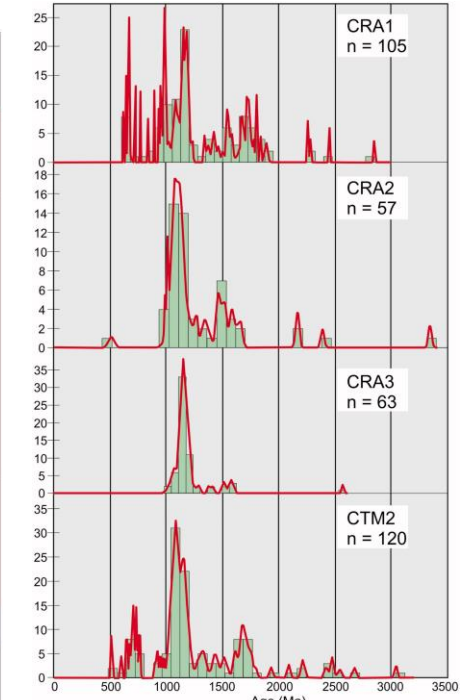
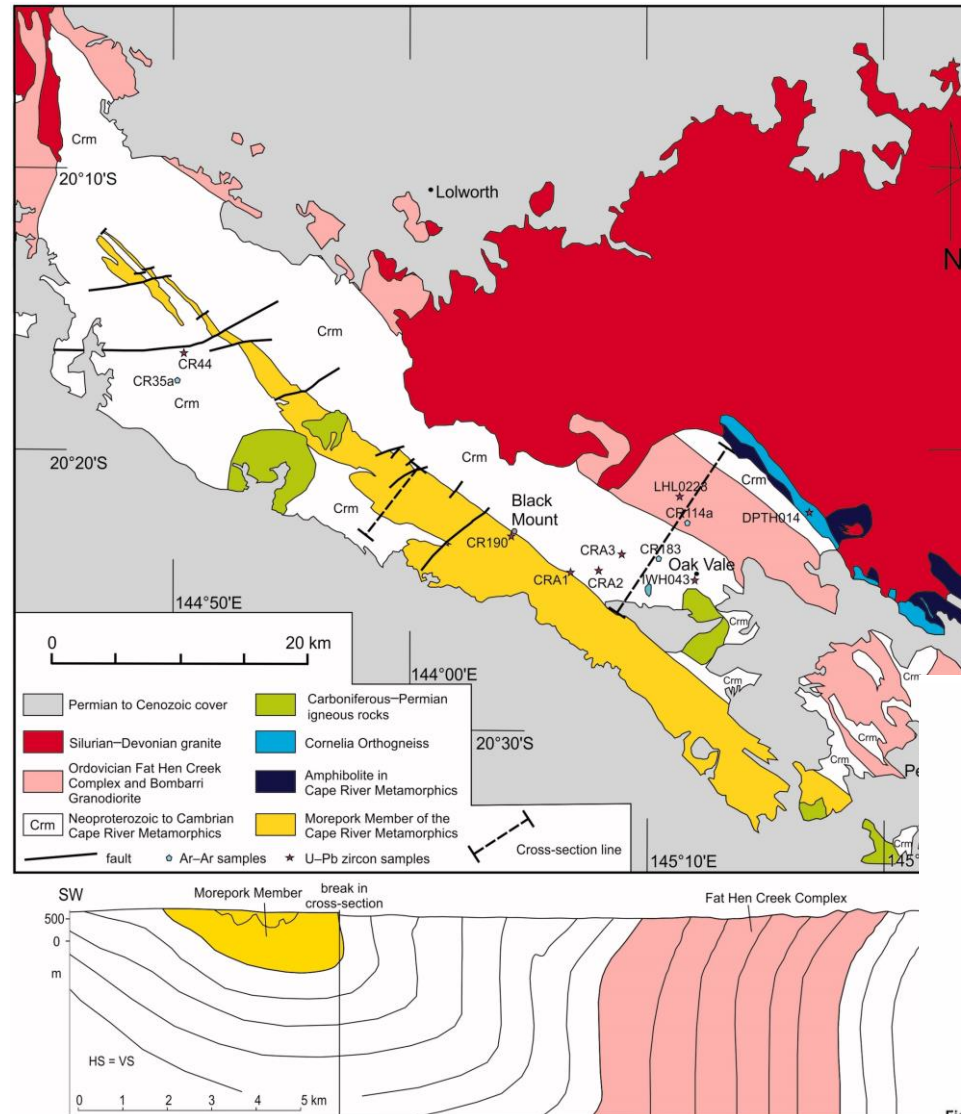
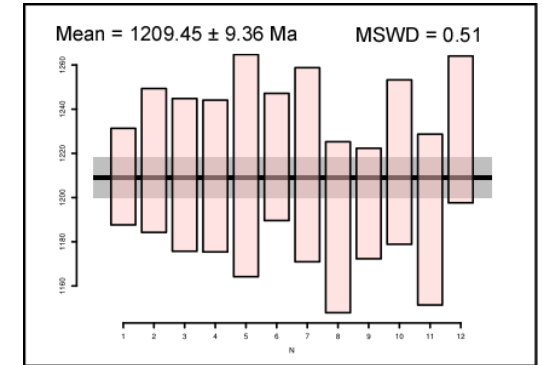
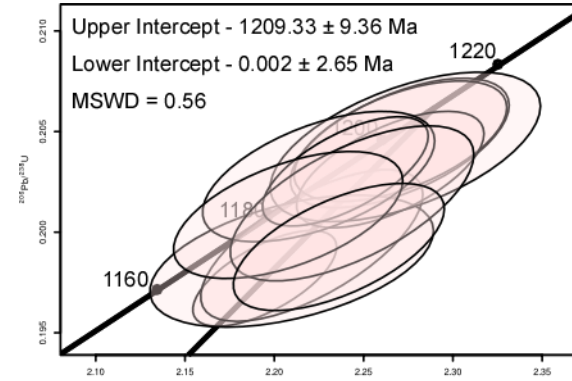
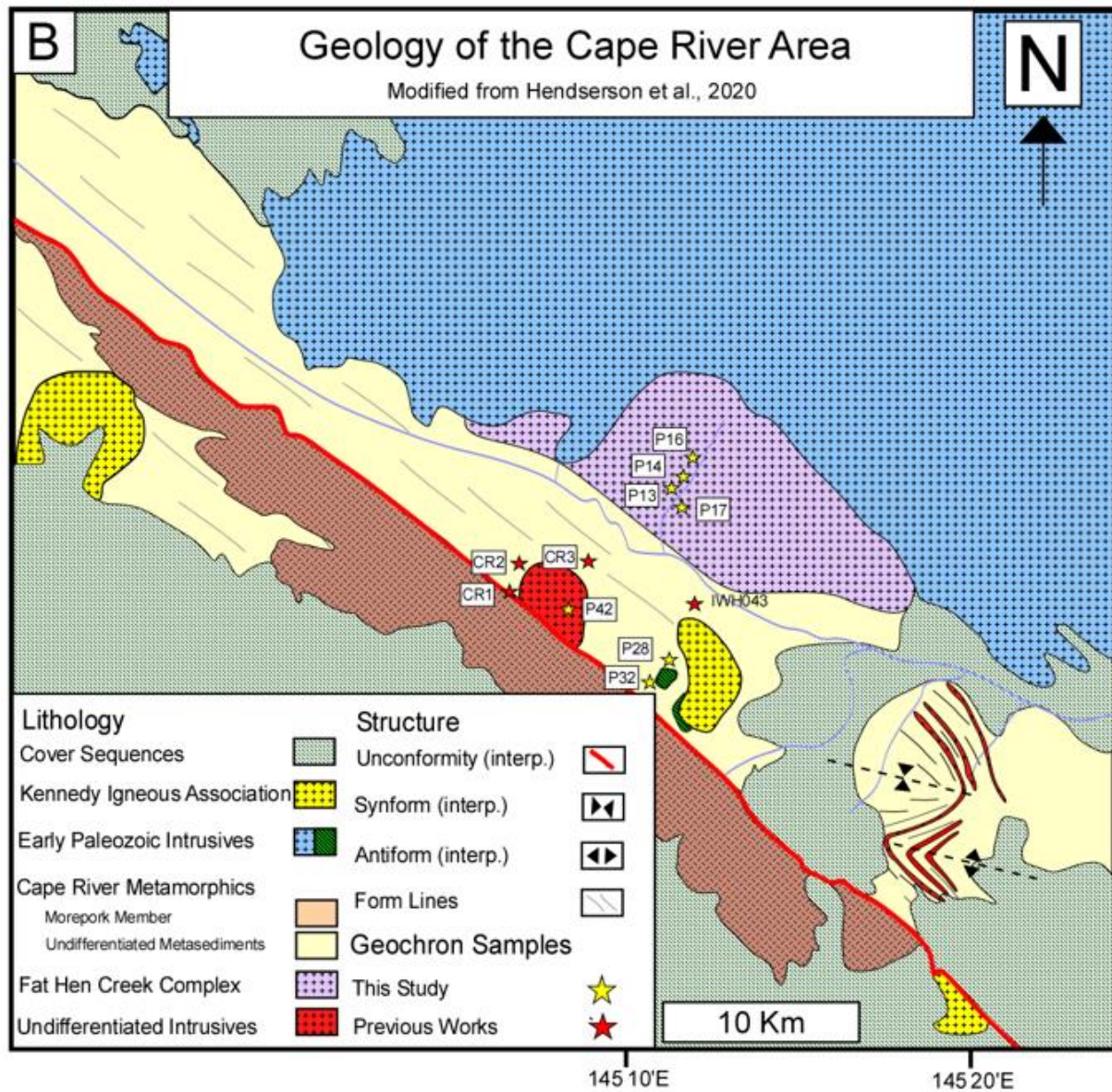


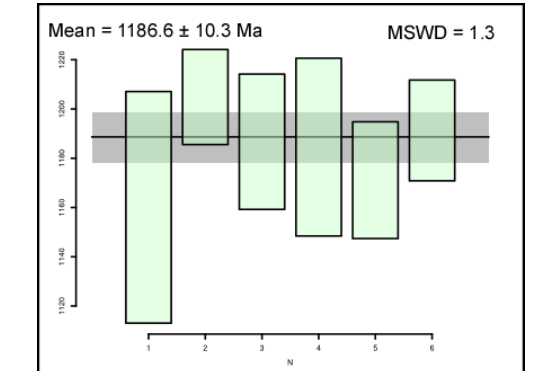
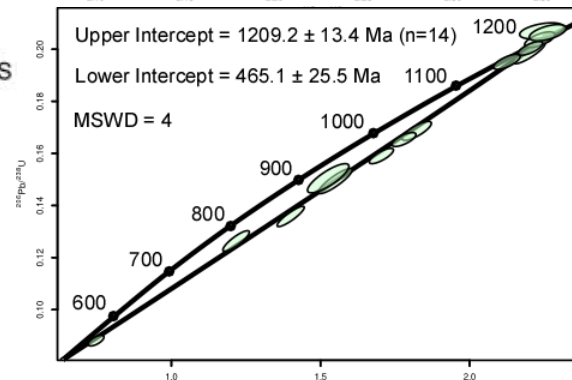
Figure 2.18a: Terra & Wasserburg concordia plot for sample LHL0230

Hornblende bearing granitic gneiss @ 1100-1200 Ma - Follow up work presented in Hutton, 2004 !

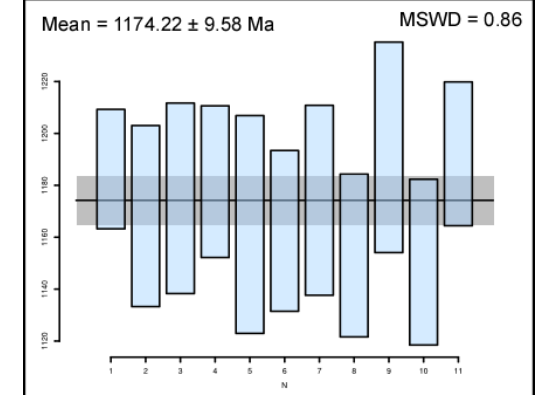
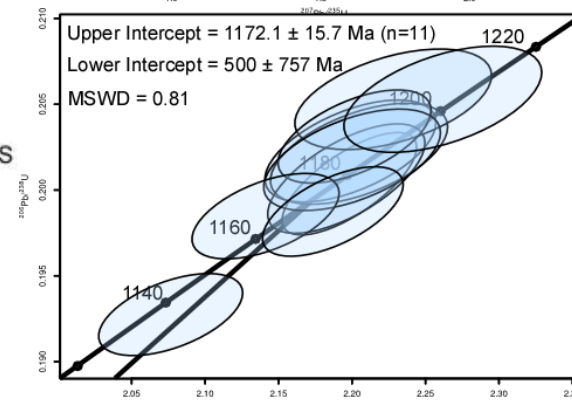
Background – Sampling intrusions below unconformity



P3/P28



FHCC

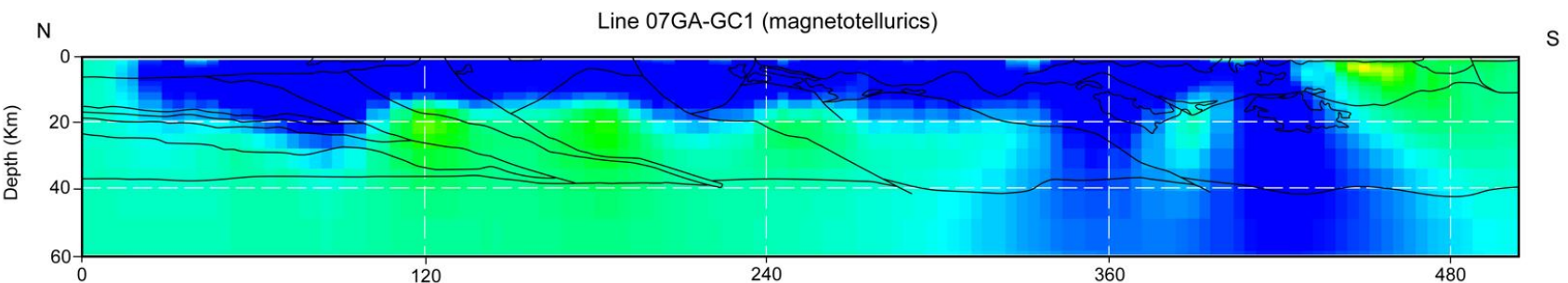
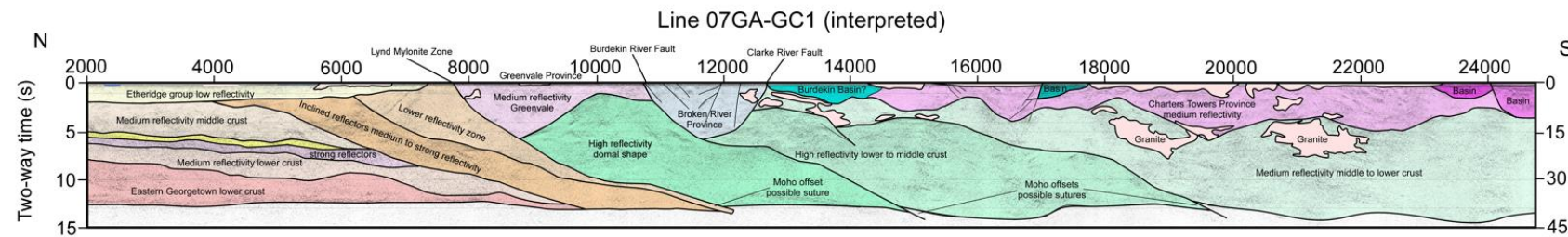
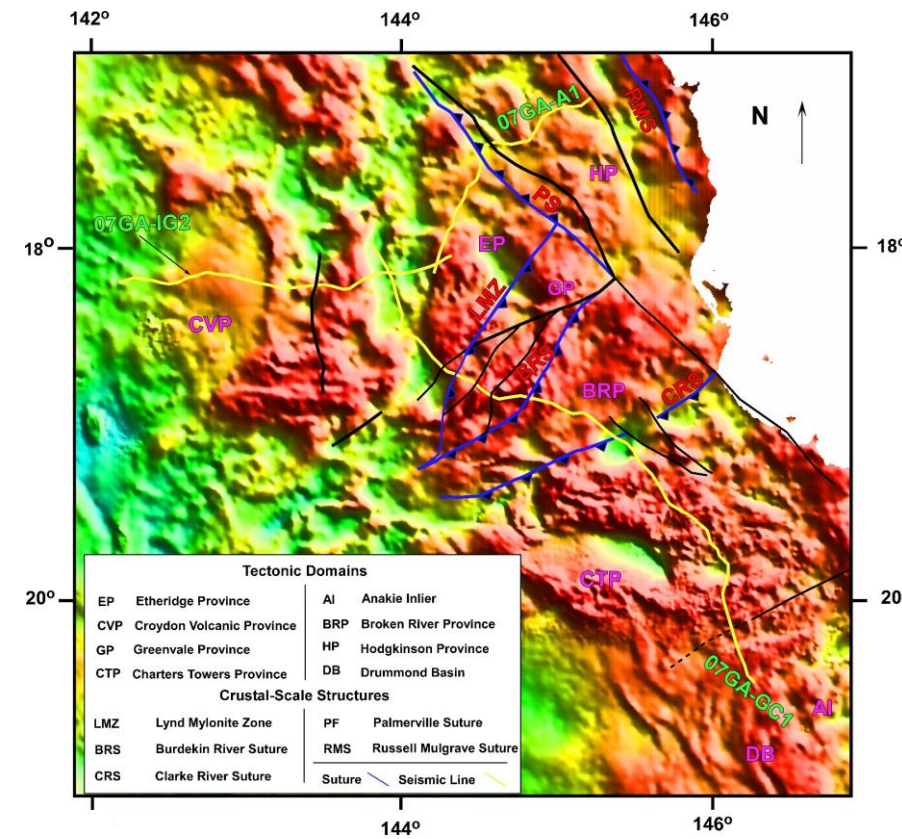
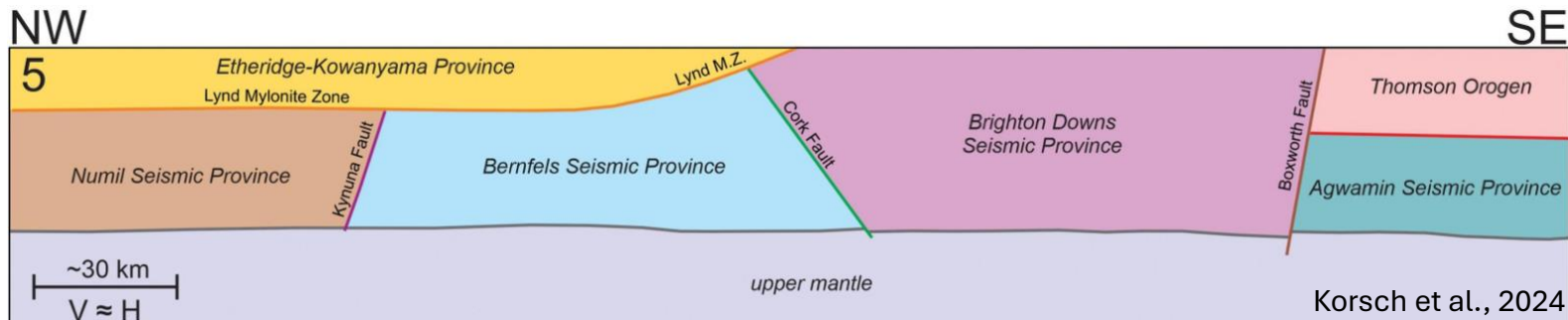


P42

1170 - 1210 Ma, I-type and S-type magmas of continental-arc affinity, intruding the Cape River Beds

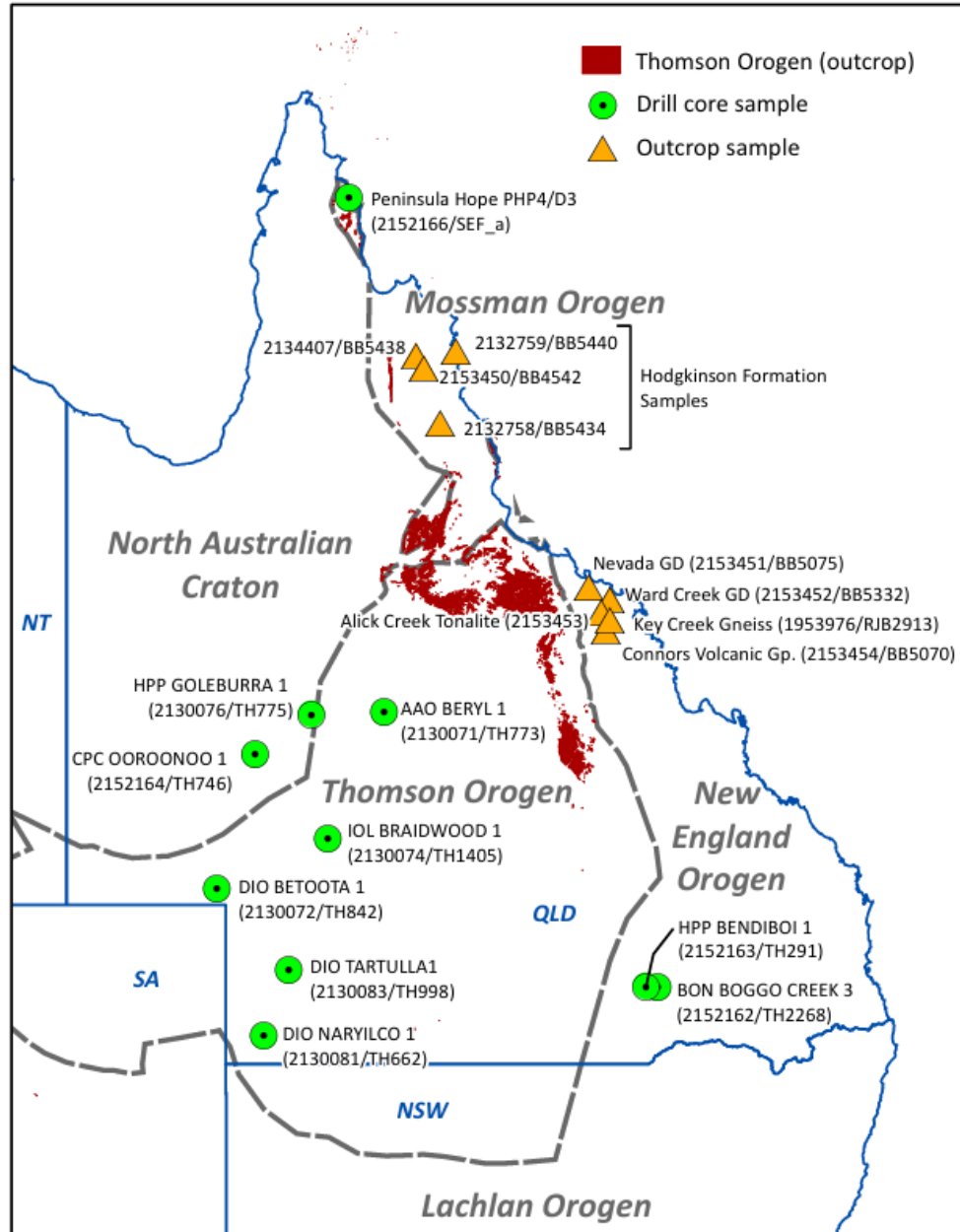
Background – Consistent with seismic interps

- Continental basement below the Thomson orogen termed the Oakvale Province – several possible affinities to Laurentia, China or other.
- Seismic interpretations by Korsch et al., 2024 suggest the existence of a basement terrane situated between the NAC and Neoprot-Cambrian Thomson Orogen termed the “Brighton Downs Seismic Province”.

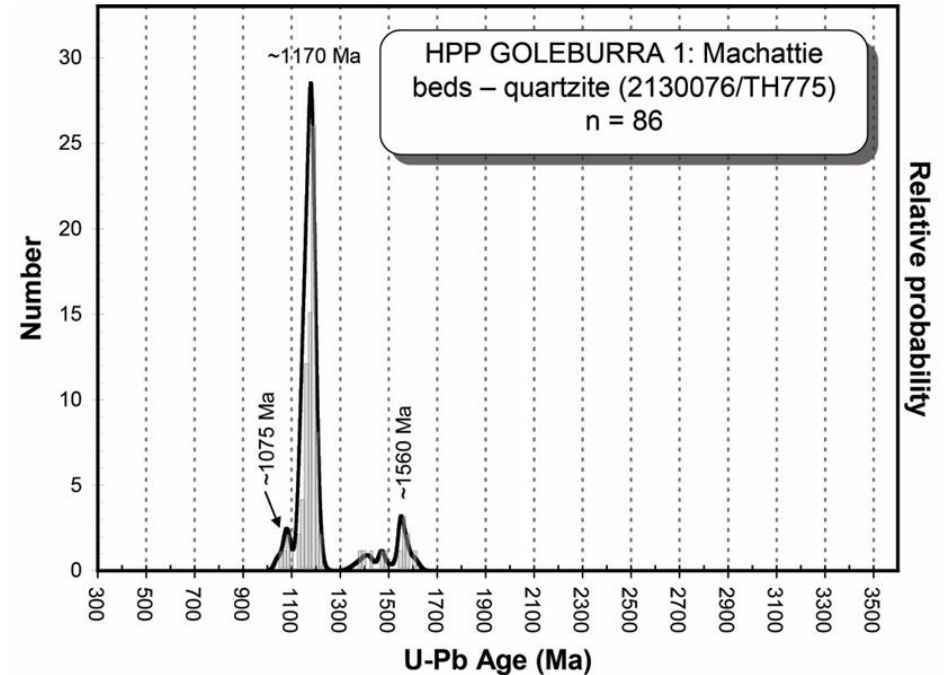
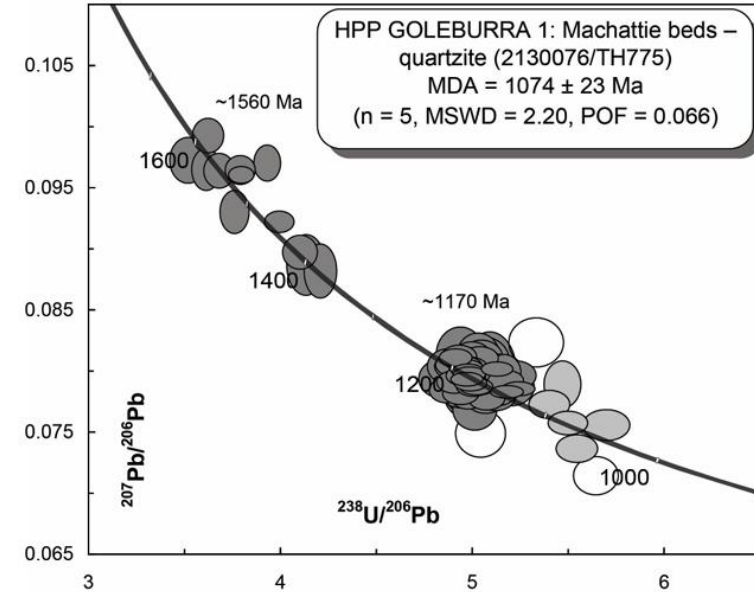


- Series of east-dipping reflectors, moho offsets, with consistent resistivity character
- Early thrusts re-activated as extensional faults?

Background – Consistent with Regional Deep Drilling Geochron



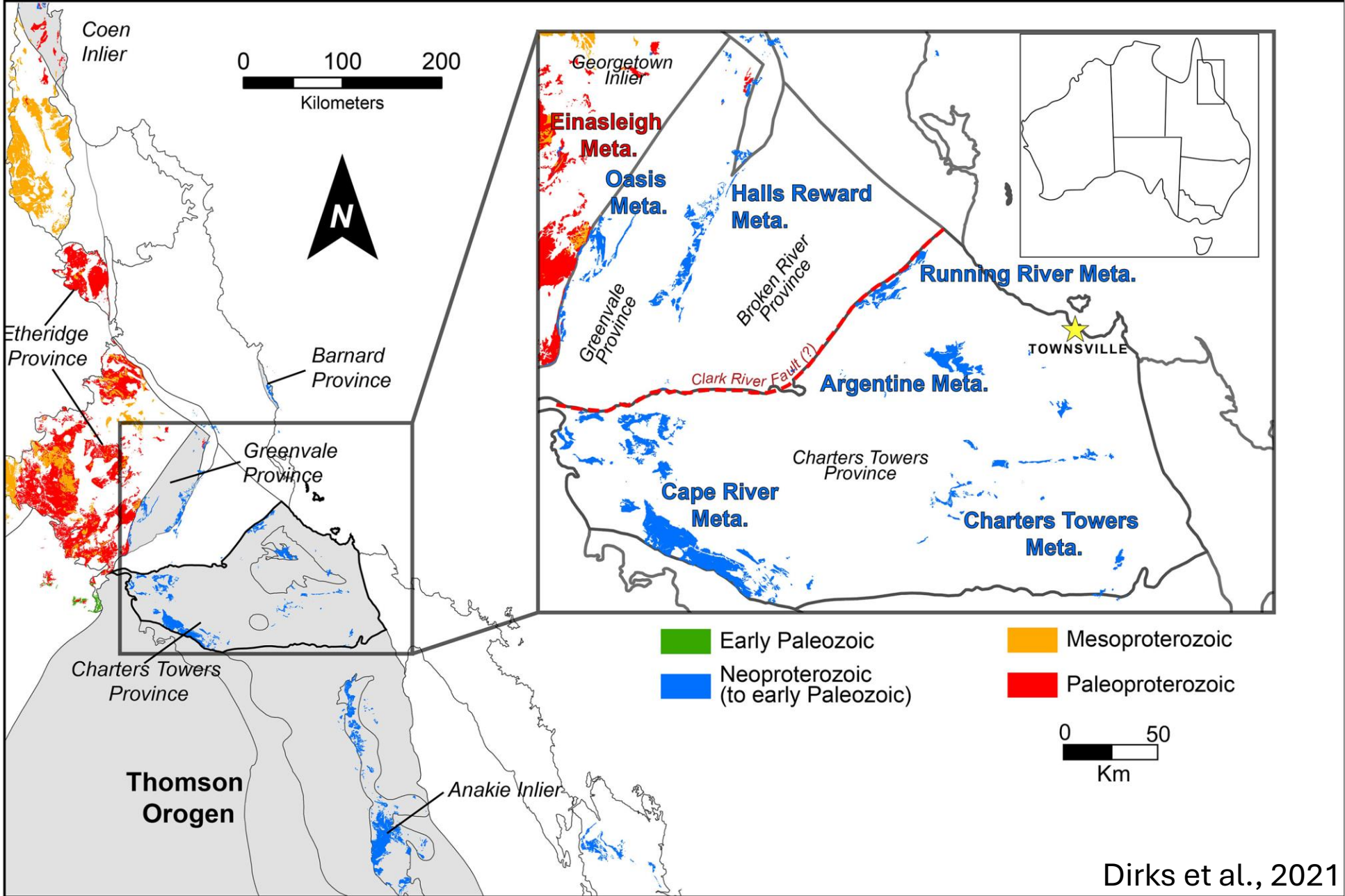
Cross et al., 2016



New Ideas - Preliminary “Where?”

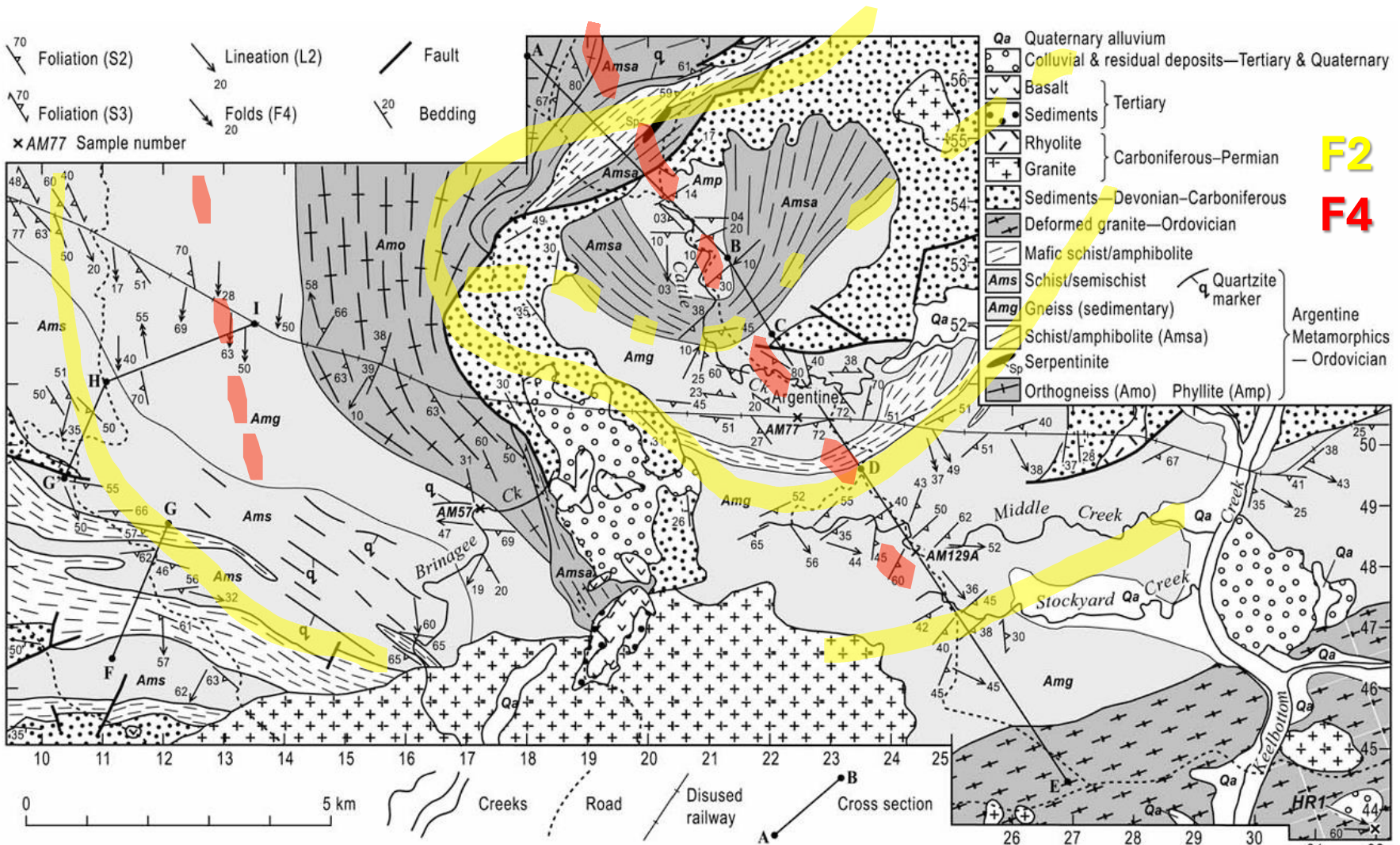
- With the establishment of the Oakvale Province, the next question is what are the lateral extents of this basement?
- Several Neoproterozoic – Cambrian basement inliers share common trends with the stratigraphy in the Cape River Metamorphics including
 - Apparent break in conformable stratigraphy evidenced by a distinct change in detritus age – Absence of “Pacific-Gondwana” in the lowermost stratigraphy
 - Distinct metamorphic records – high grade lower sequences, non-conformable lower grade upper sequence
 - Tectonic mafic-ultramafic assemblages within spatial proximity to potential stratigraphic unconformity
- Inliers for further investigation:
 - Cape River Metamorphics, Argentine Metamorphics, Greenvale Province, Anakie Inlier, Iron Range

Where? – Argentine Metamorphics

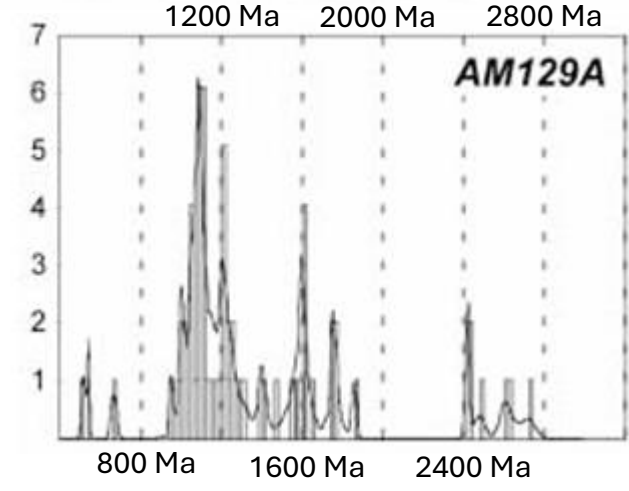
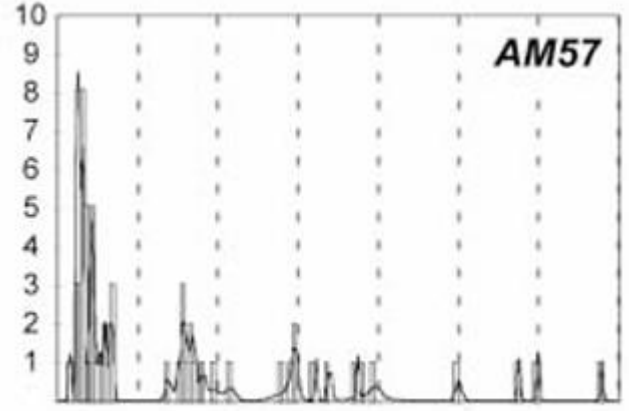
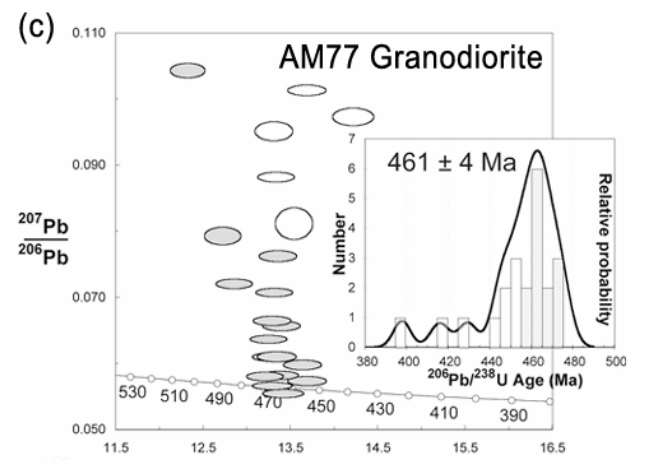


Where? – Argentine Metamorphics

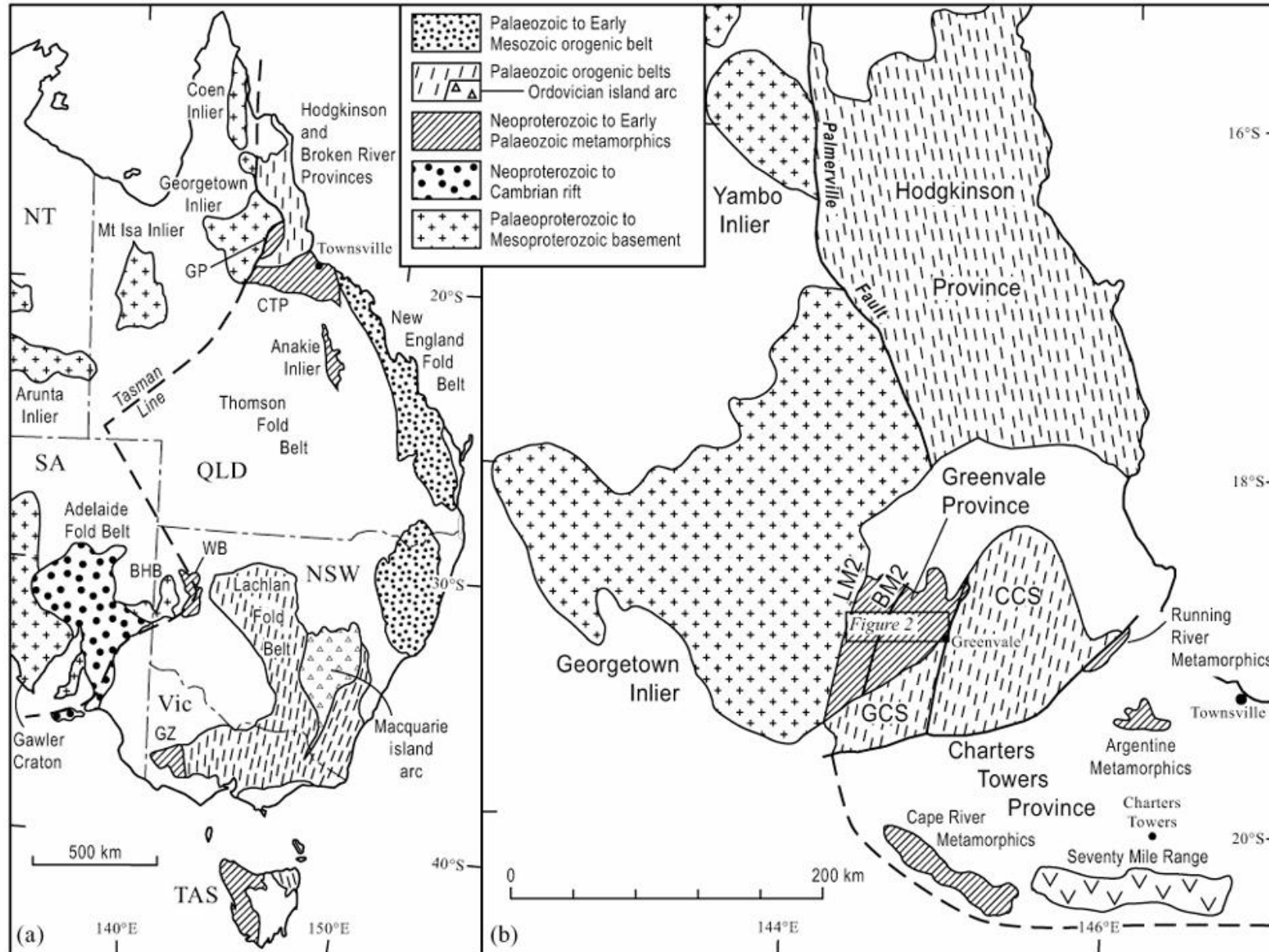
- Upper sequence comprising “semi-schist”, biotite schist, quartzite. ~ greenschist facies
- Lower sequence comprising paragneiss, orthogneiss, amphibolite (tholeiitic affinity), serpentinite, “mafic schist (intraplate affinity) migmatitic partial melts. Mid-upper amphibolite+ facies



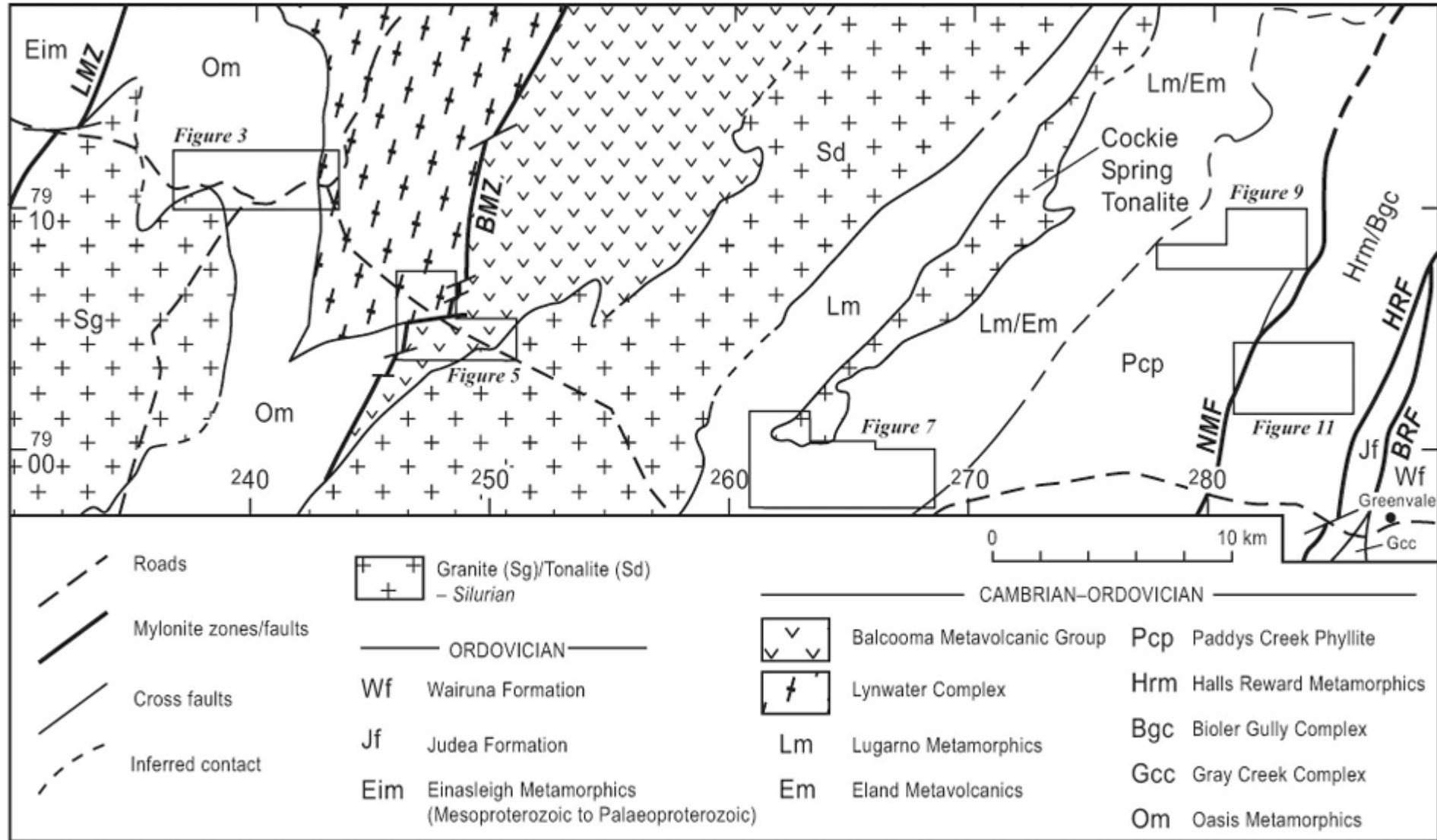
Fergusson et al., 2007



Where? – Oasis Metamorphics/Lynwater Complex

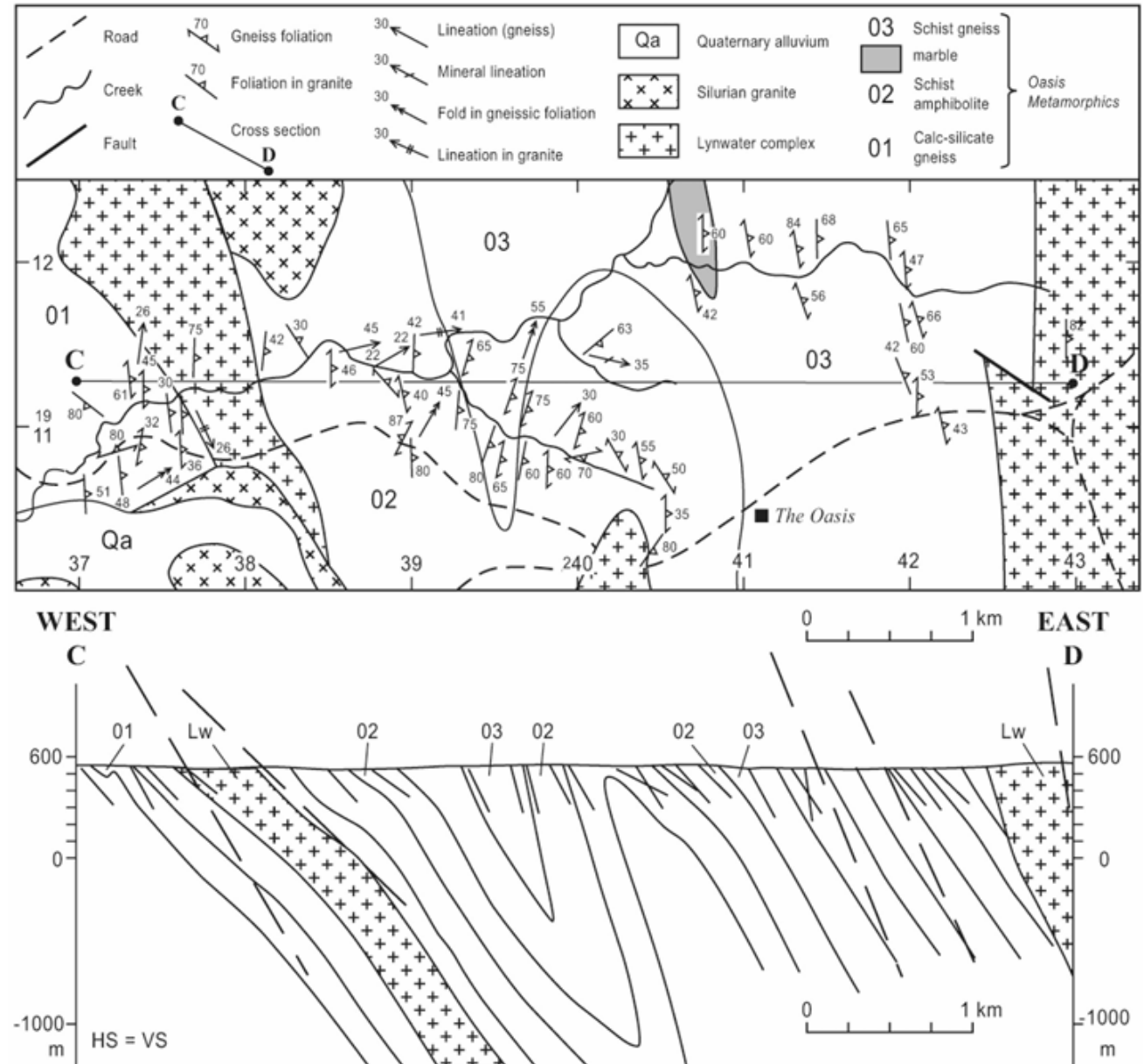


Where? – Oasis Metamorphics/Lynwater Complex



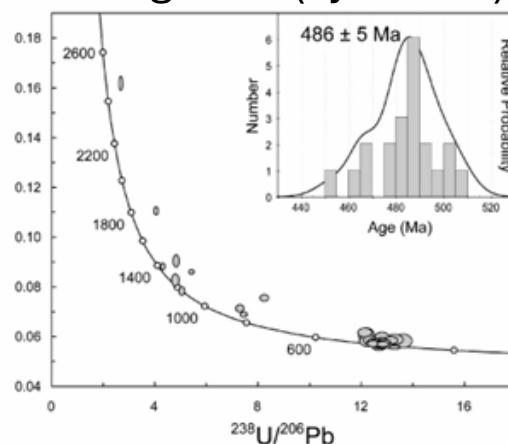
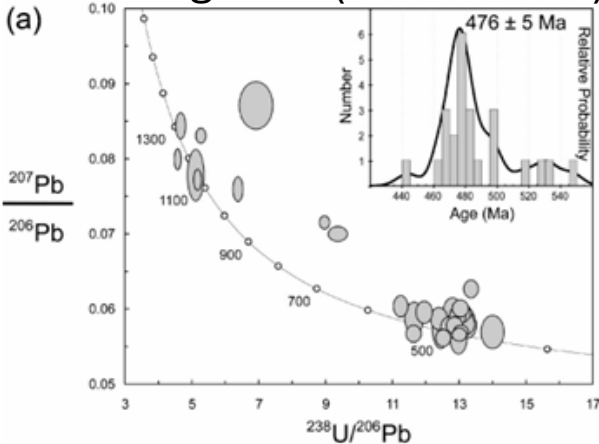
Where? – Oasis Metamorphics/Lynwater Complex

- Lynwater Complex – Hornblende-bearing (I-type) and two-mica (S-type) orthogneiss and paragneiss. Metamorphosed to upper amphibolite facies.
- Oasis Metamorphics interpreted as Neoproter-Cambrian deposition – however Neoproter-Cambrian detritus yet to be confirmed.



Paragneiss (Oasis mets.)

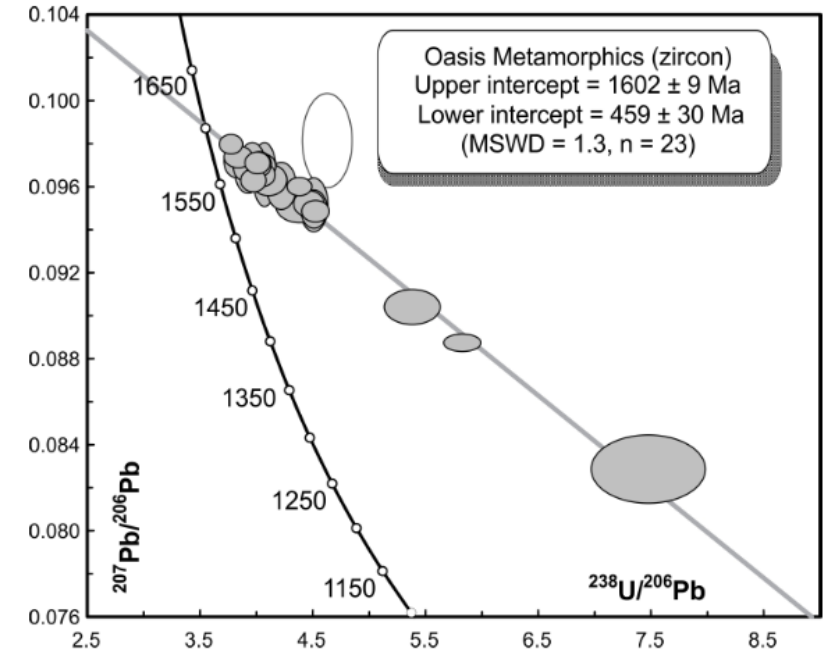
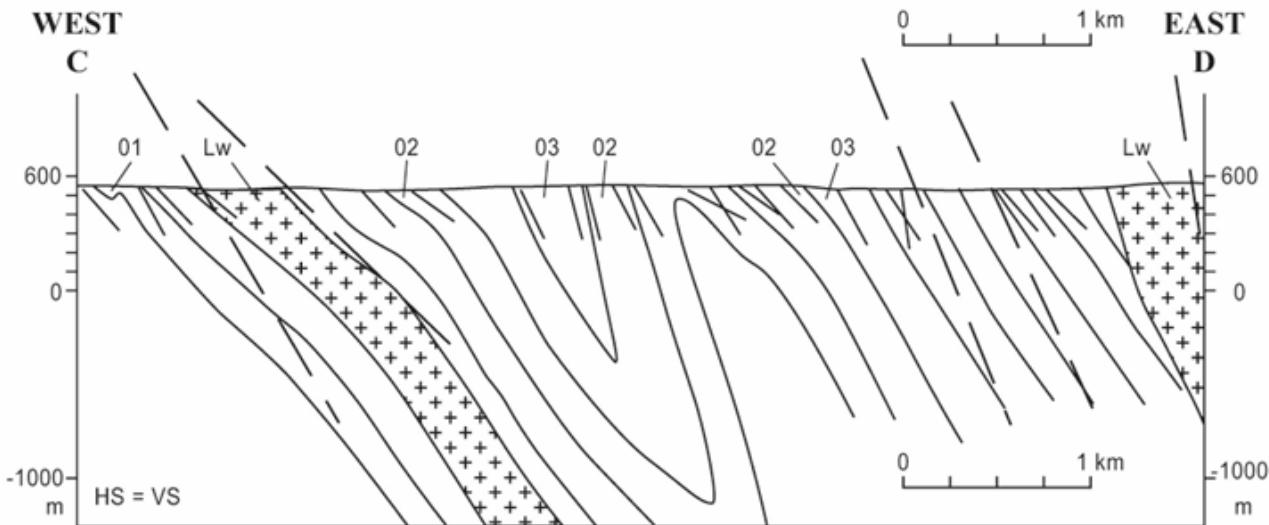
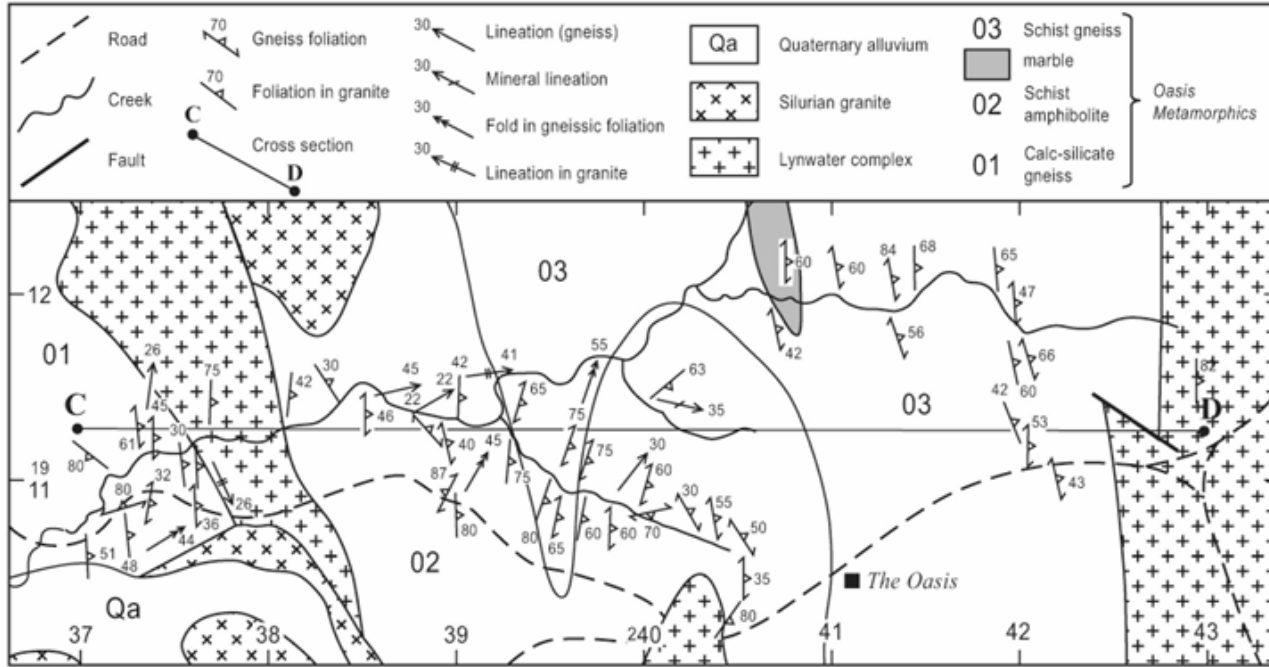
Orthogneiss (Lynwater)



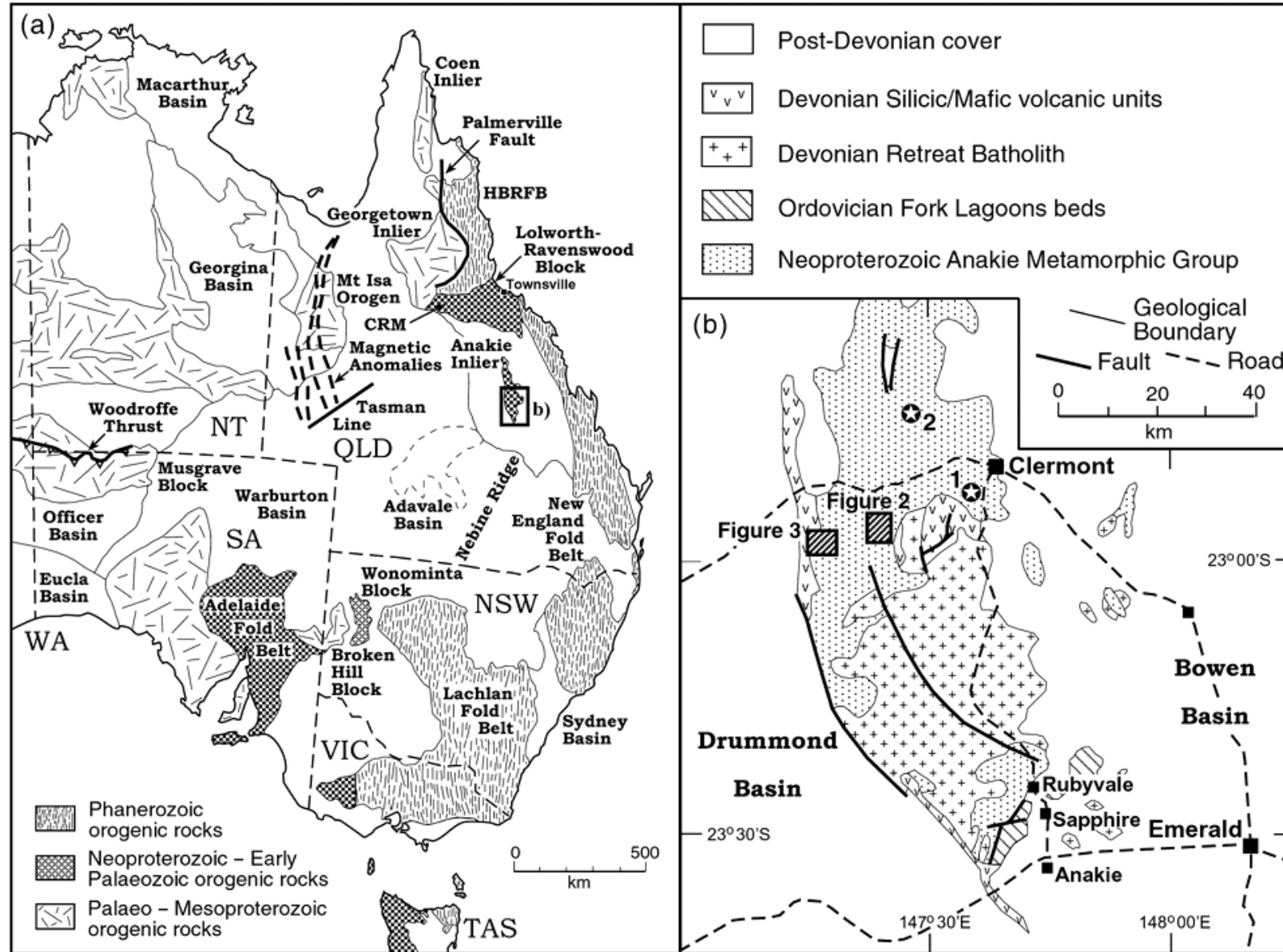
Only age on the Oasis Metamorphics outside of the calc-silicates.

Where? – Oasis Metamorphics/Lynwater Complex

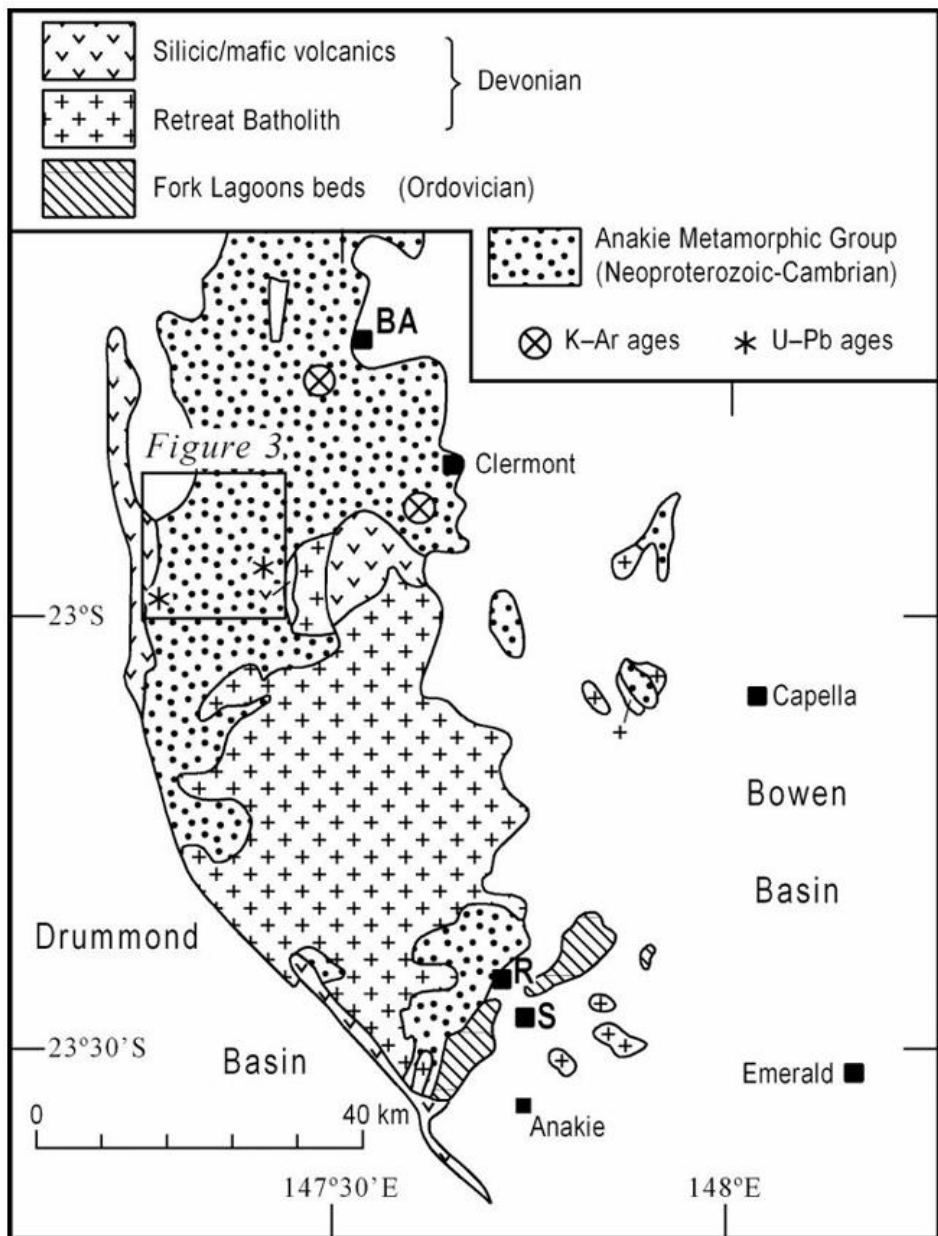
Cross et al., 2015



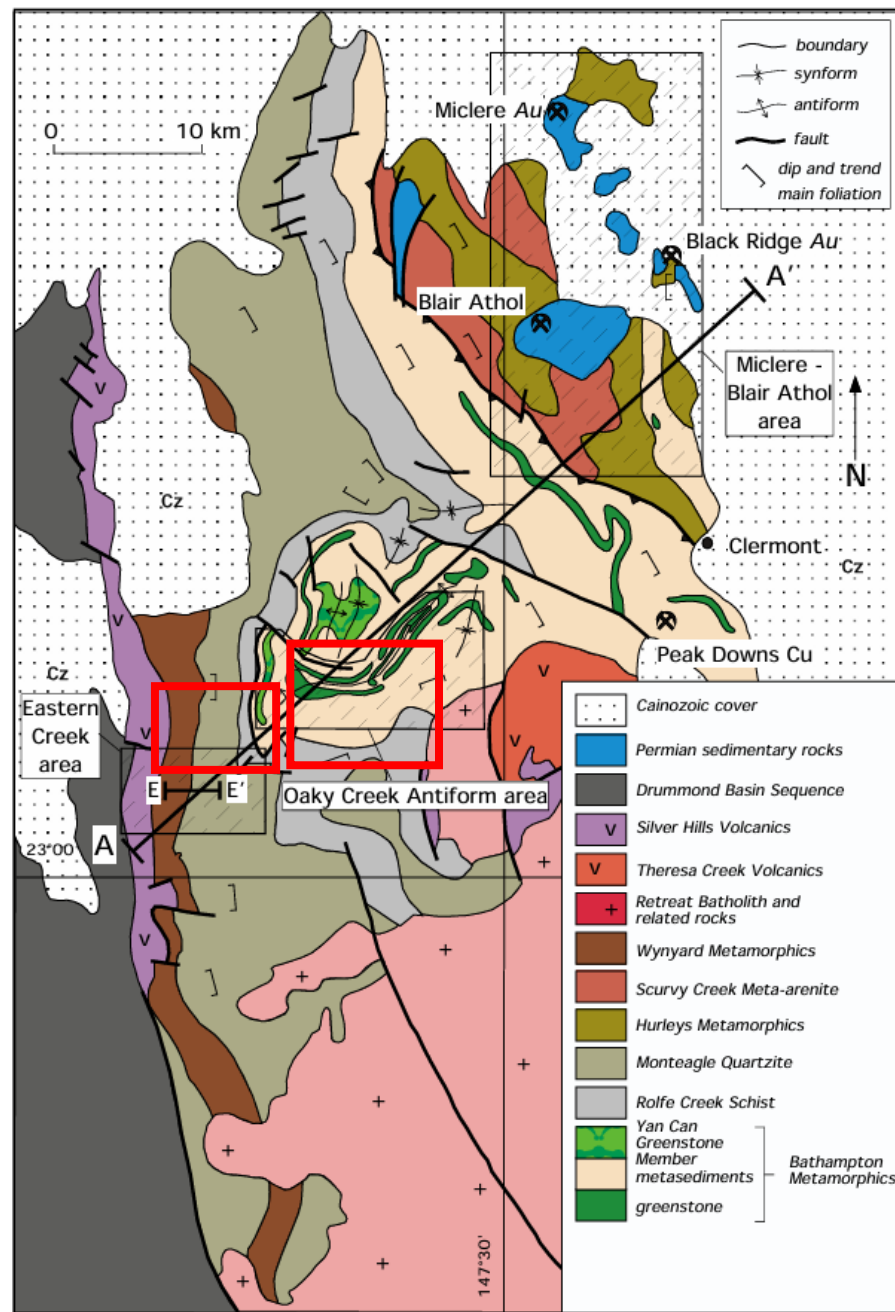
Where? – Anakie Inlier



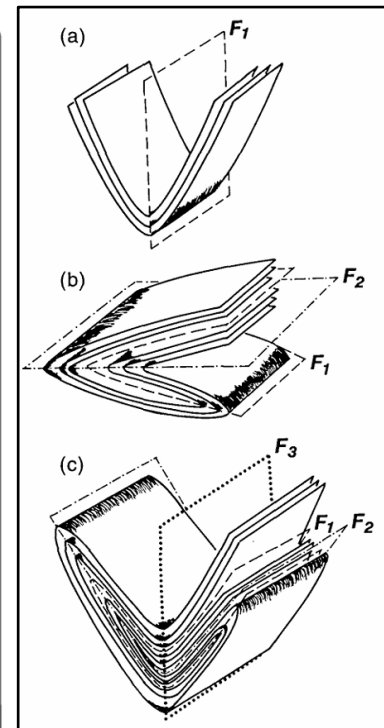
Where? – Anakie Inlier



Offler et al., 2011



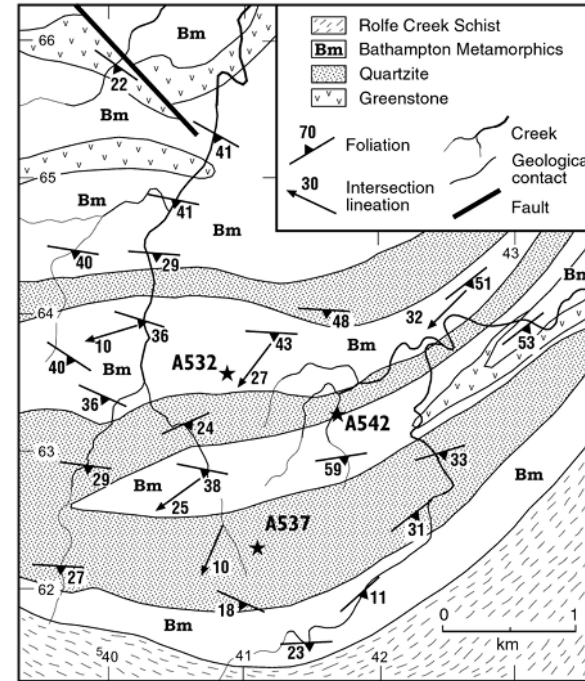
Wood, 2006



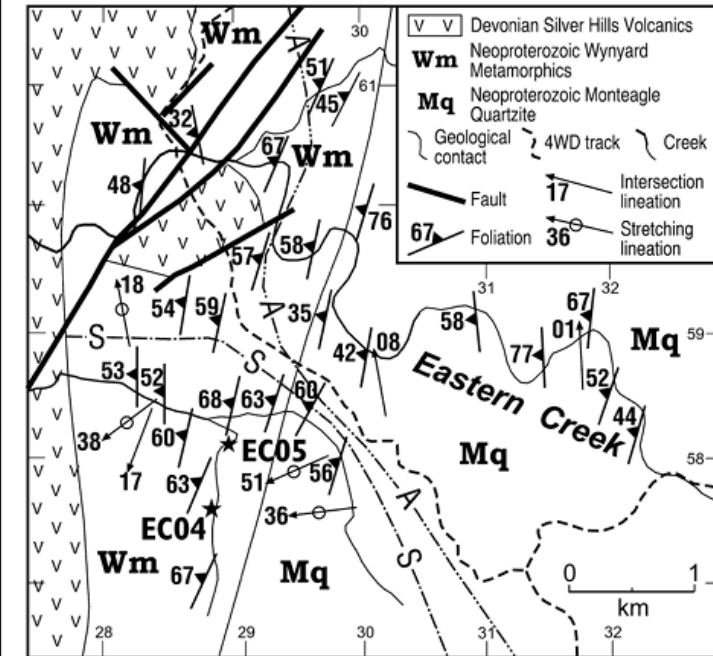
Where? – Anakie Inlier “Detrital” Zircon Geochron

- Detrital zircon populations from the Wynard-Bathampton Metamorphics show clear similarities to those at the Morepork Member – Cape River Beds from the Cape River Metamorphics
- Unusually, the higher-grade units are stratigraphically and structurally higher
- Interpreted depositional age of Bathampton Metamorphics ~ 600 Ma
- Potential for hydrothermal/metamorphic zircon growth ~500-600 Ma ?

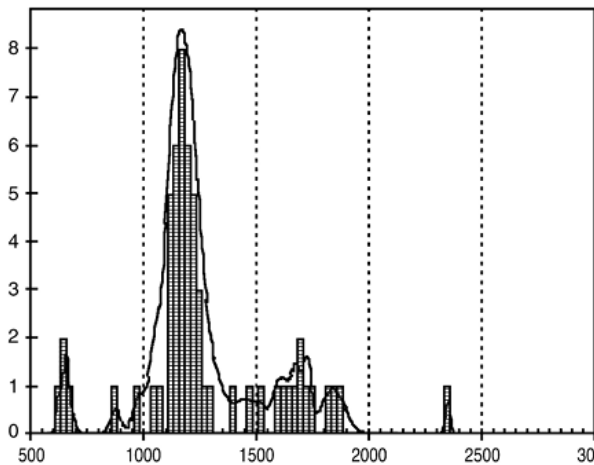
Lower sequence



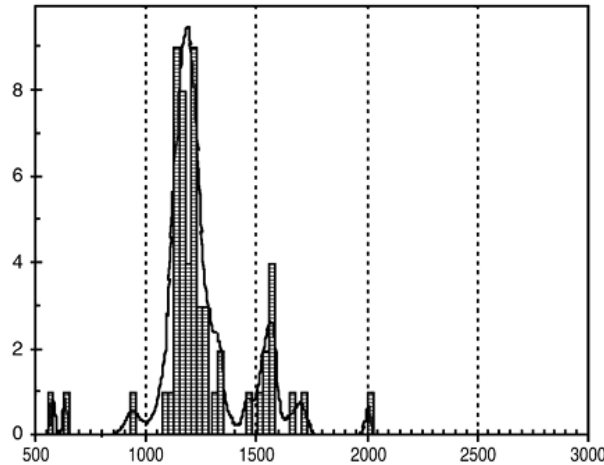
Upper sequence



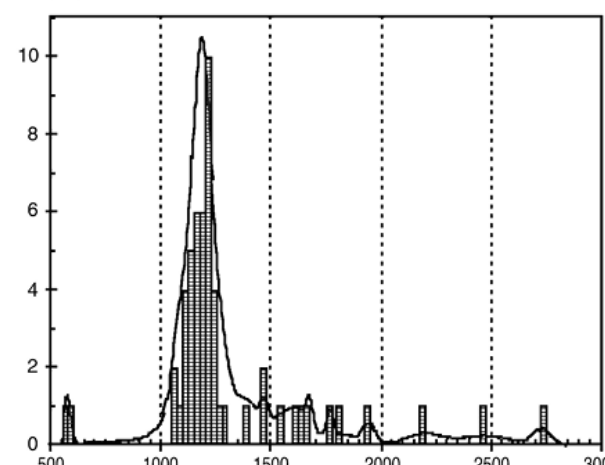
(a) A532



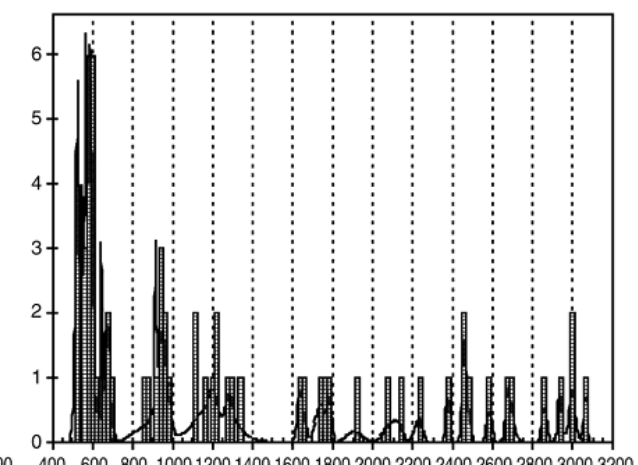
(b) A537



(c) A542



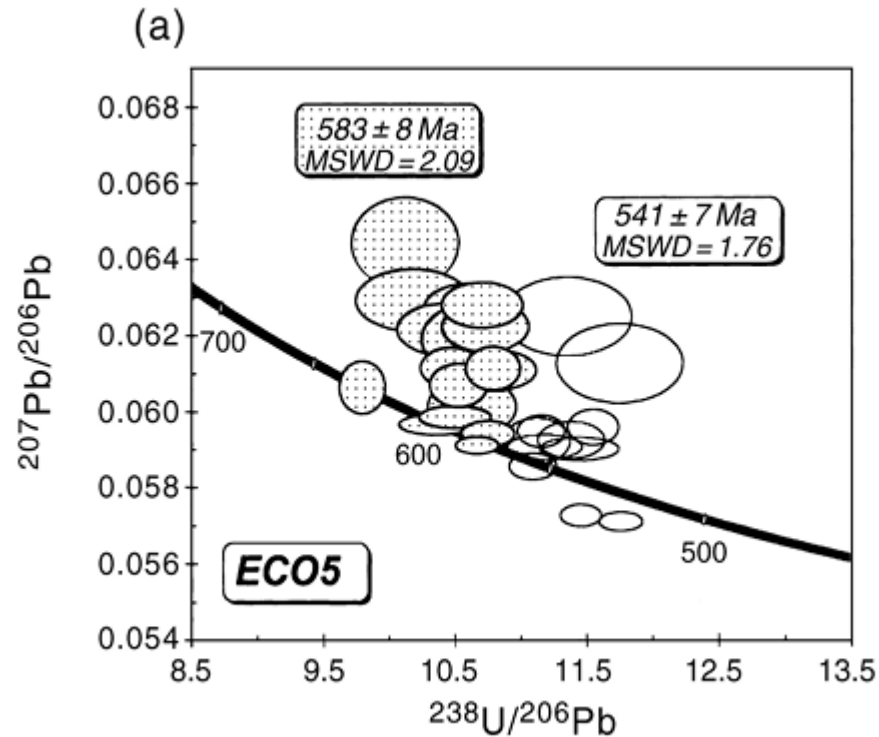
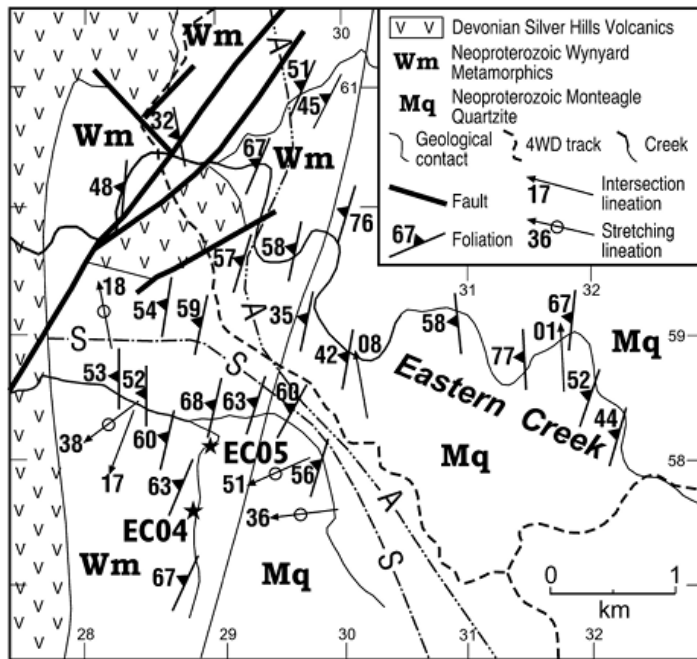
(d) EC04



Fergusson et al., 2001

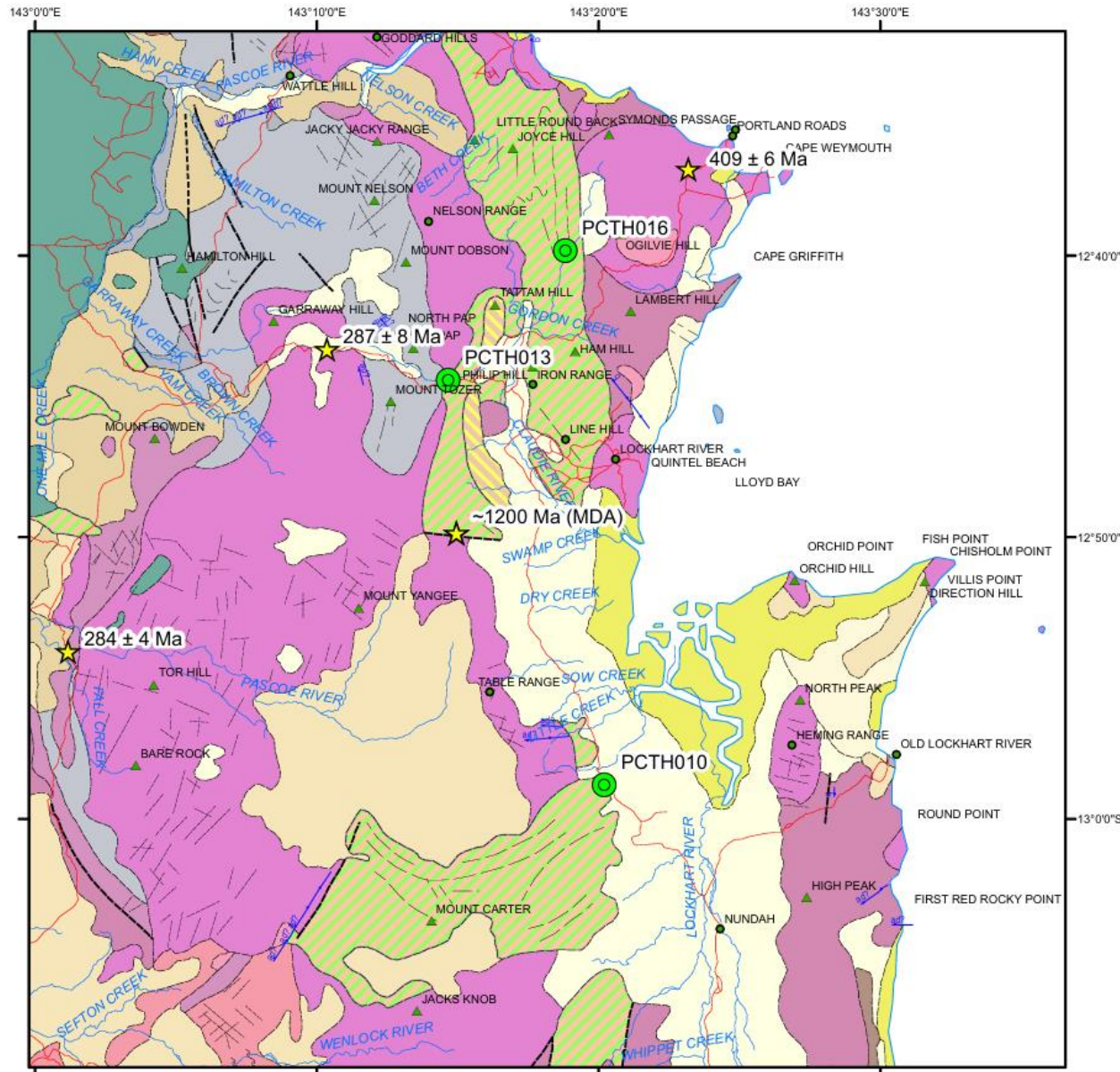
Where? – Anakie Inlier “Detrital” Monazite Geochron

Monazite interpreted to be of detrital origin from the Wynard Metamorphics – Confirmation bias?

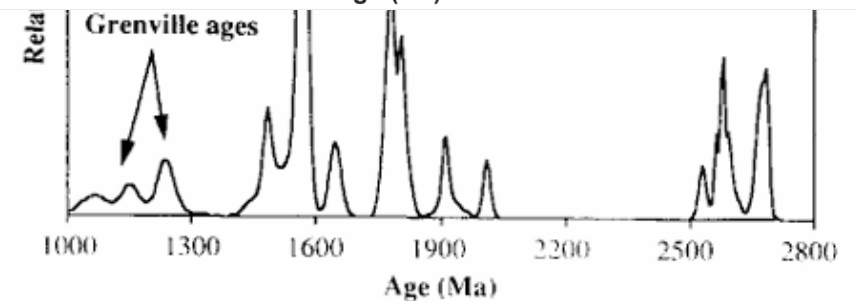
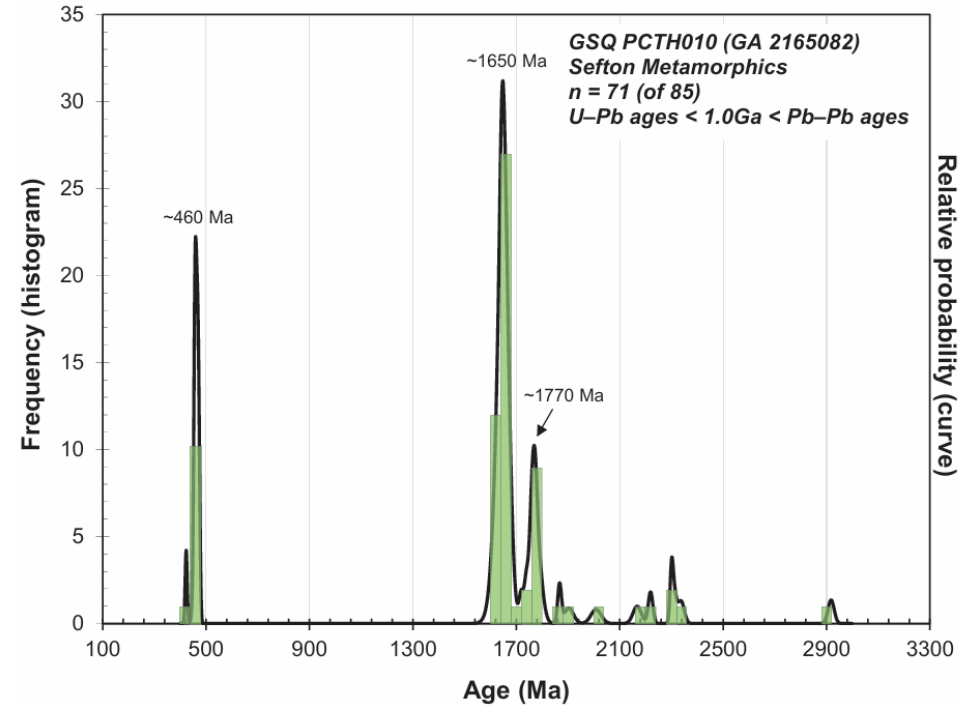
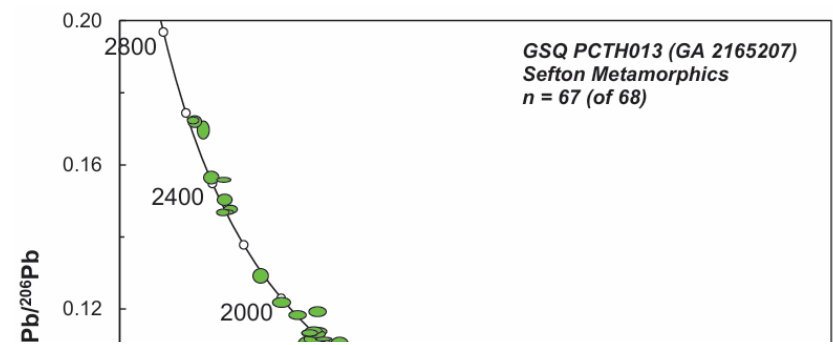


“ It is entirely possible for monazite to form under upper amphibolite metamorphic conditions (Kingsbury et al. 1993) and, therefore, monazite may have developed during the amphibolite metamorphism that formed rare, fresh staurolite and mainly retrogressed andalusite in the Wynard Metamorphics (T. J. Green unpubl. data). However, the detrital zircon ages from sample EC04 indicate that the ca 580Ma and ca 540Ma monazite age components are of detrital origin.” – Fergusson et al., 2001

Where? – Iron Range Province

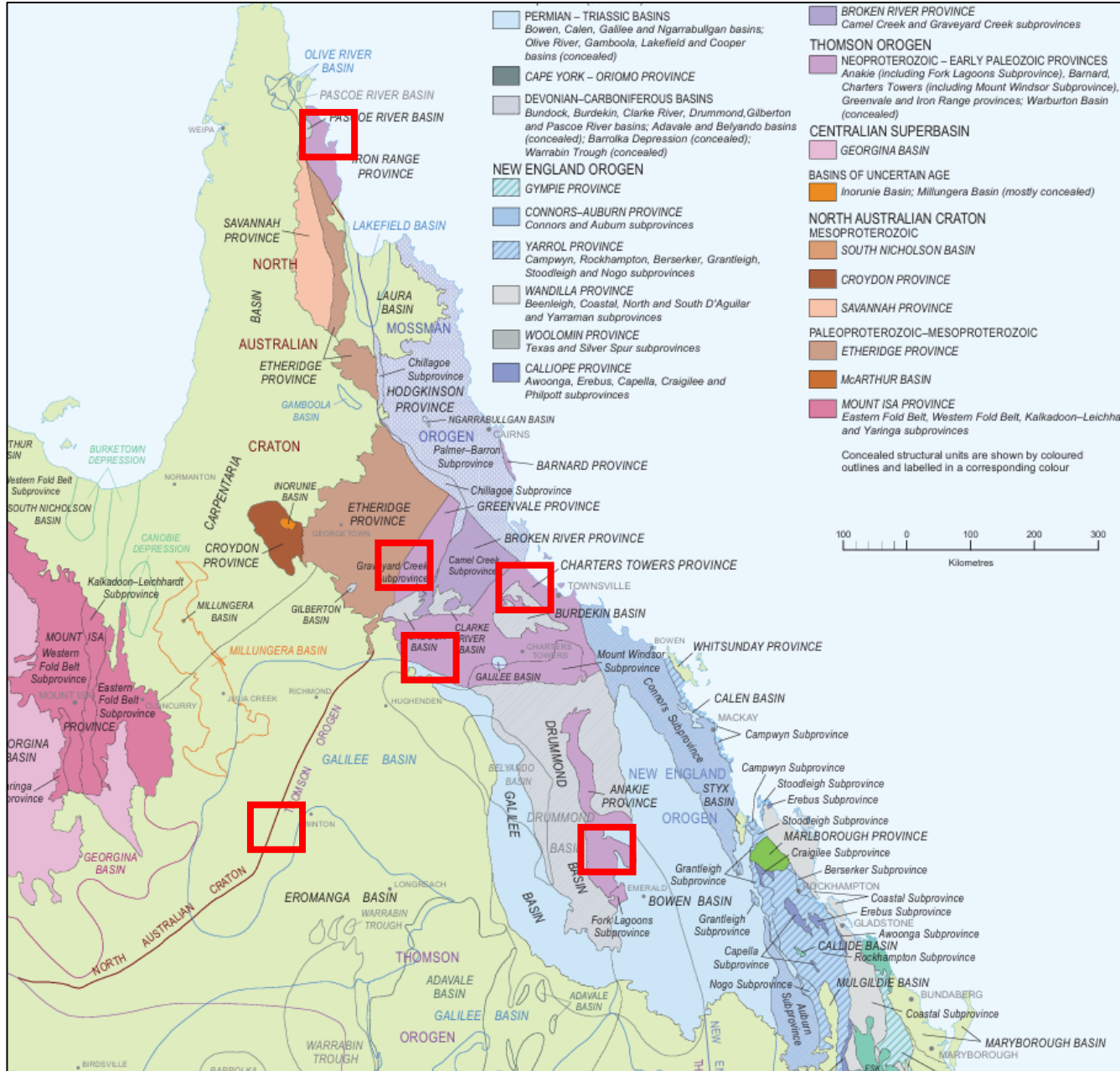


Kositcin et al., 2015



Sefton Metamorphics in Blewett et al., 1998

Where? – Summary



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Research Paper

A Mesoproterozoic missing link between eastern Australia and China during the transition from Nuna to Rodinia?

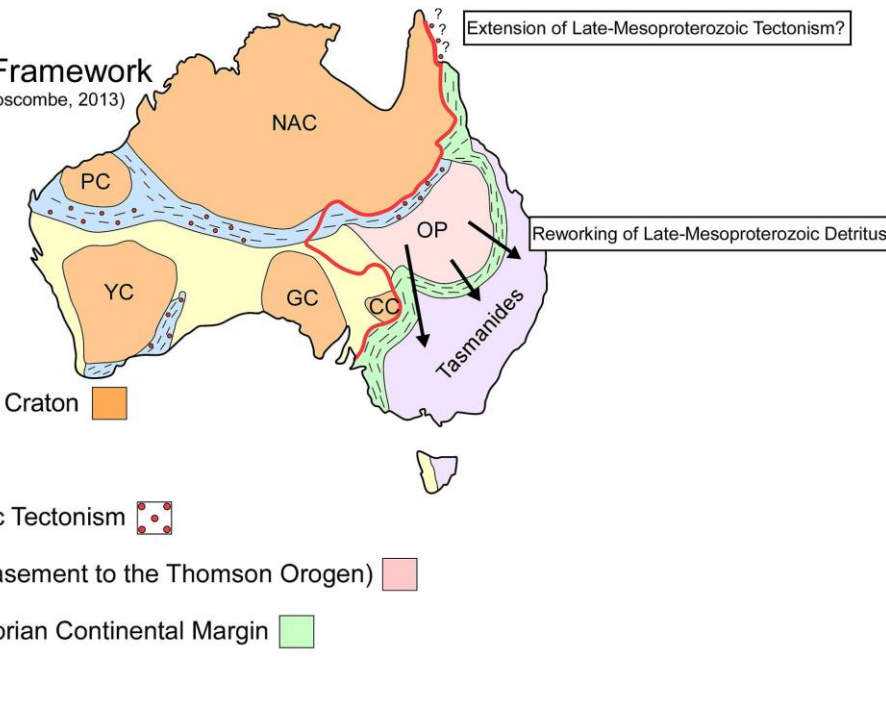
Alexander Edgar^{a,b,*}, Ioan Sanislav^a, Paul Dirks^a

^a College of Science and Engineering, Economic Geology Research Centre (EGRU), James Cook University, Townsville, Australia

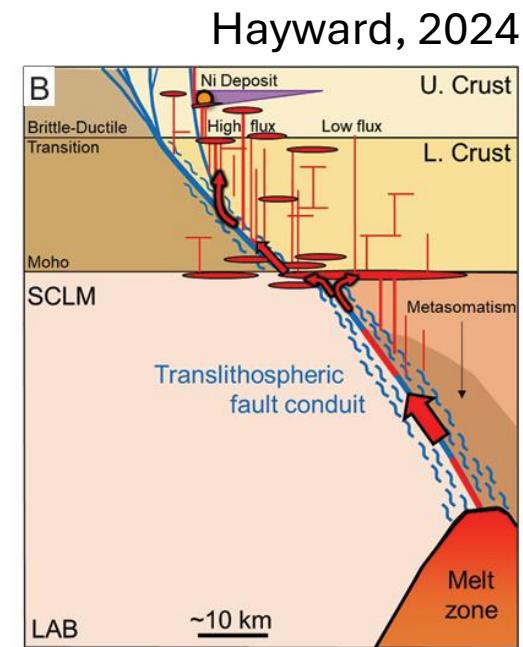
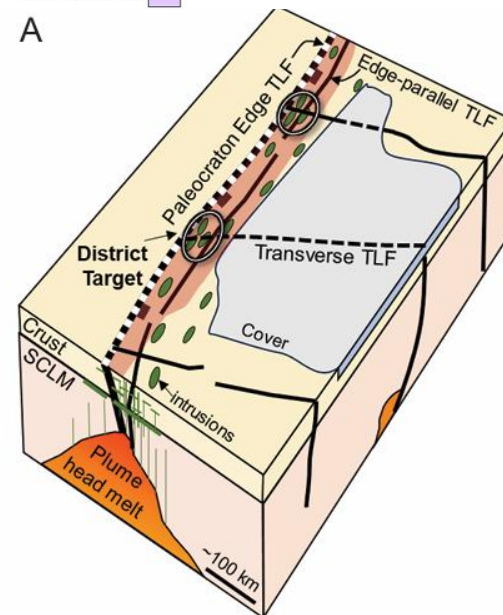
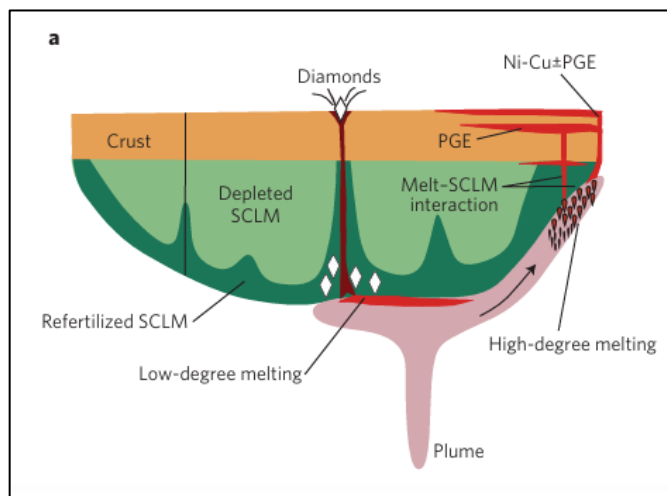
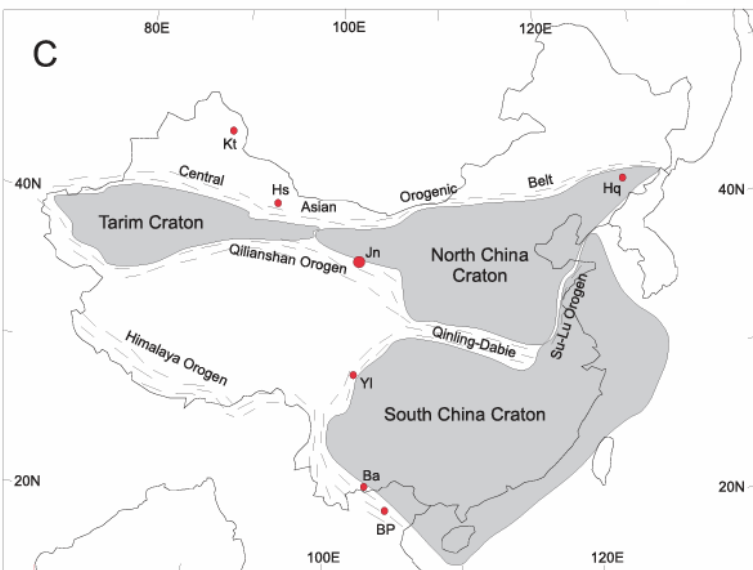
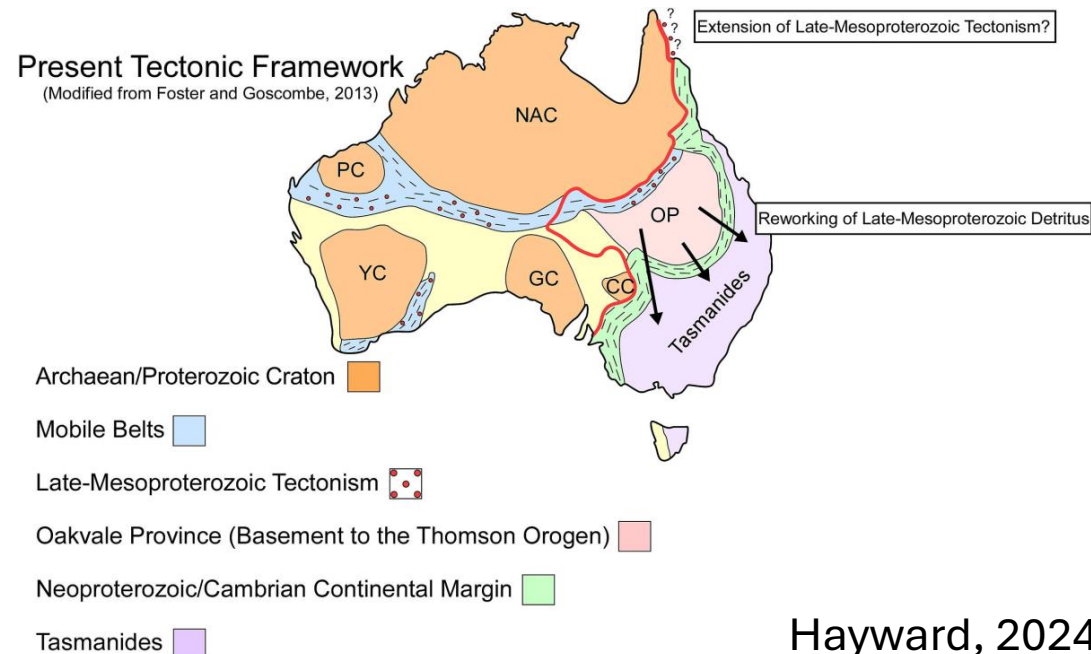
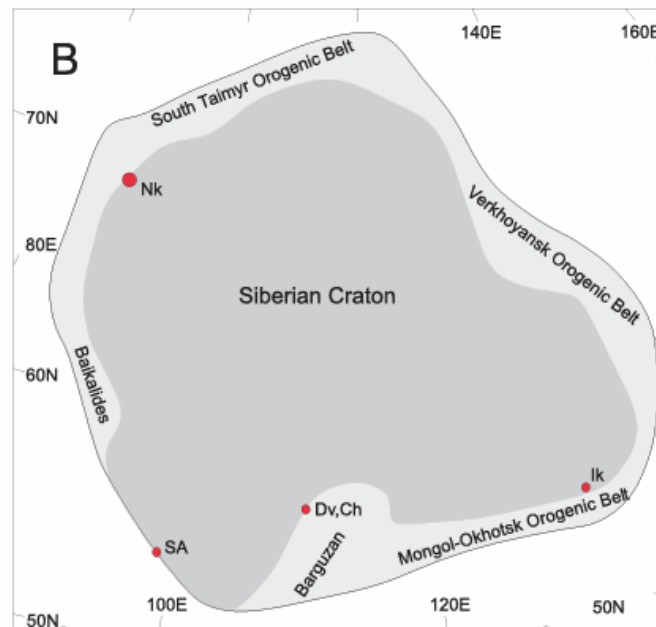
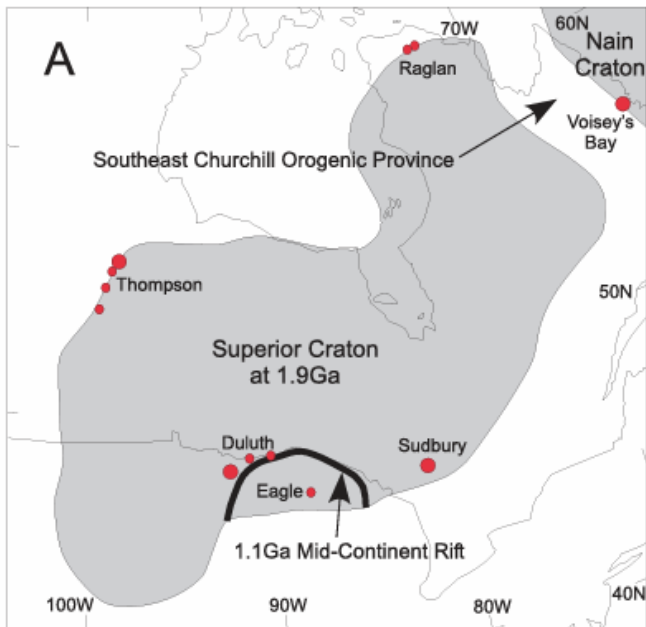
^b School of Earth Sciences – Centre for Exploration Targeting (CET), University of Western Australia, Perth, Australia



Present Tectonic Framework (Modified from Foster and Goscombe, 2013)



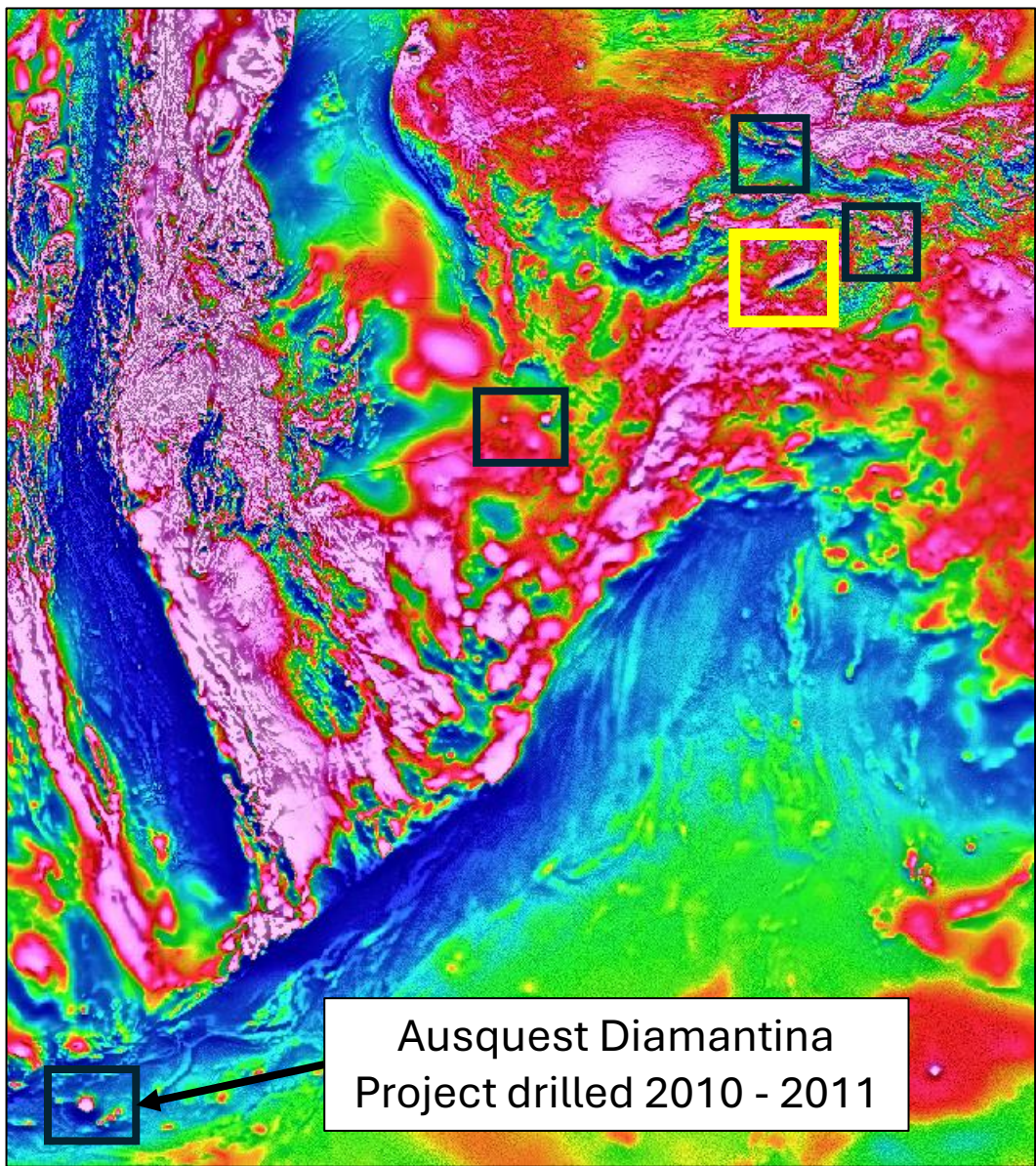
Why? Implications for Exploration Search Space



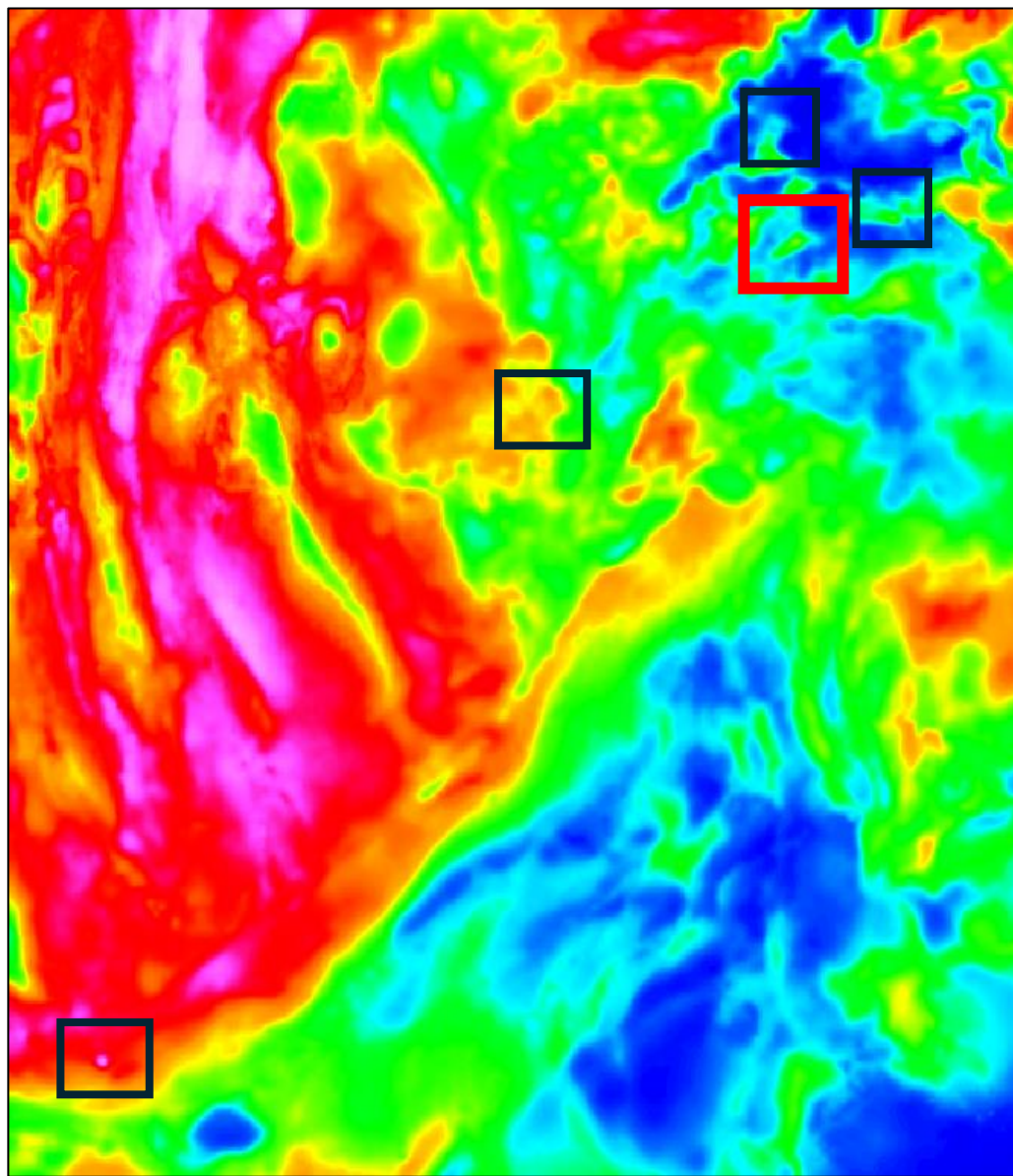
Begg et al., 2010

Griffin et al., 2013

Why? Implications for Exploration Search Space

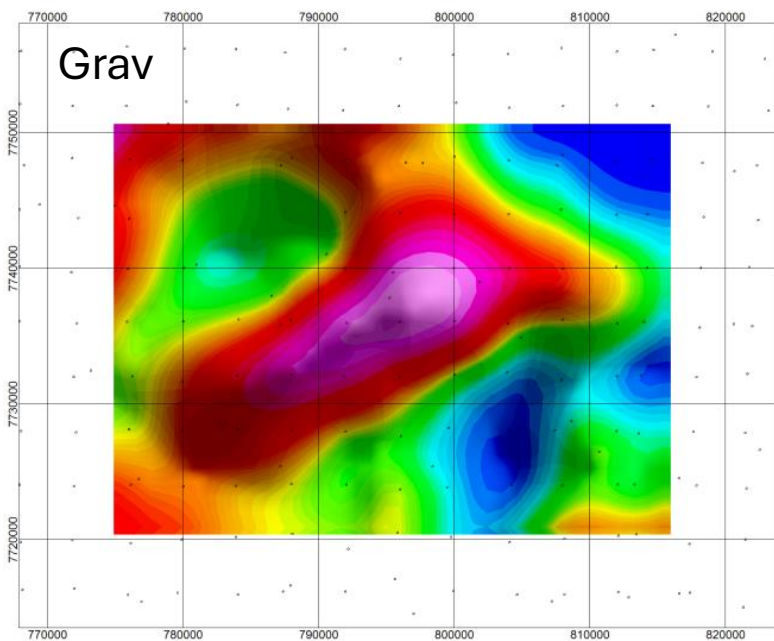
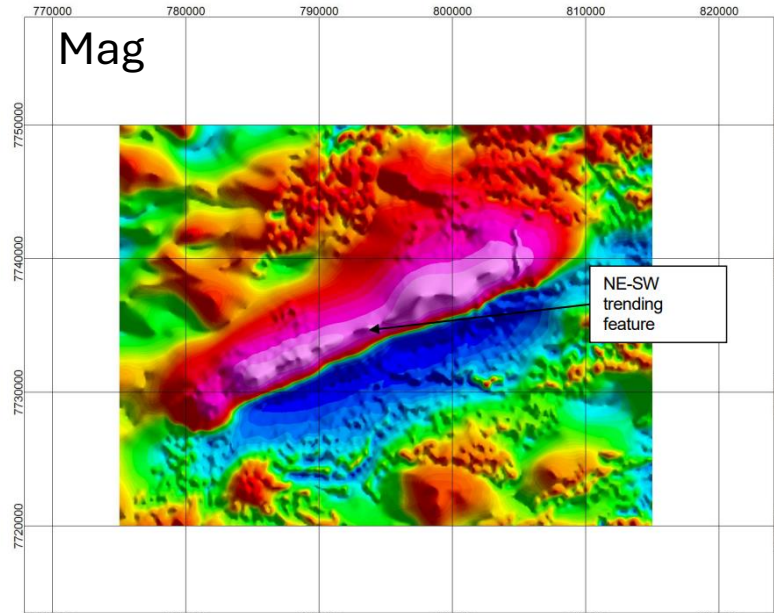


Regional Mag

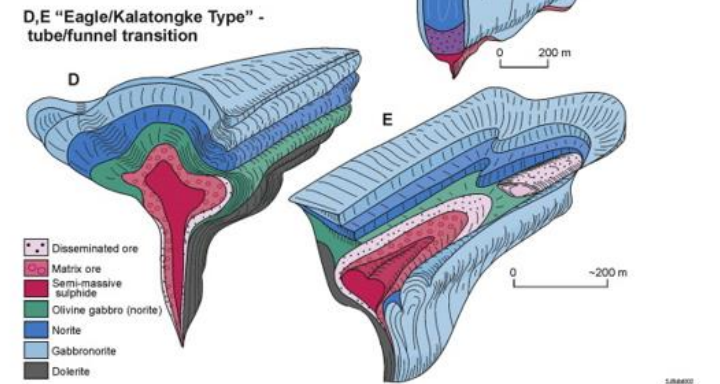
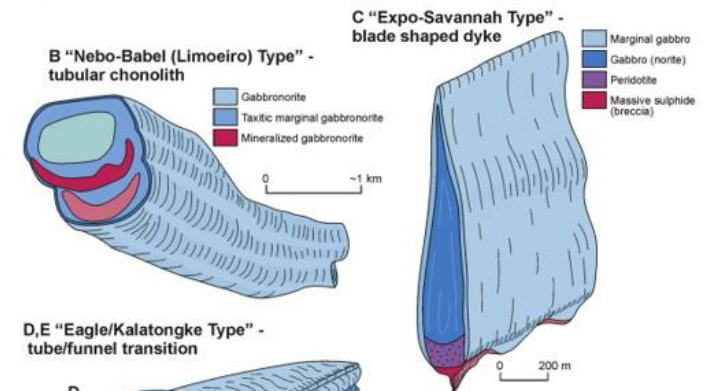
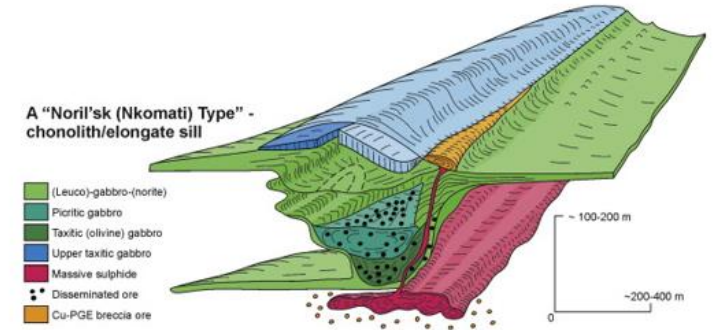
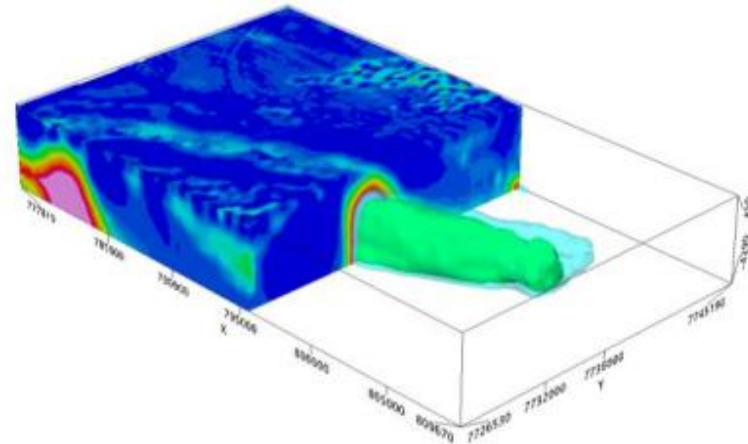
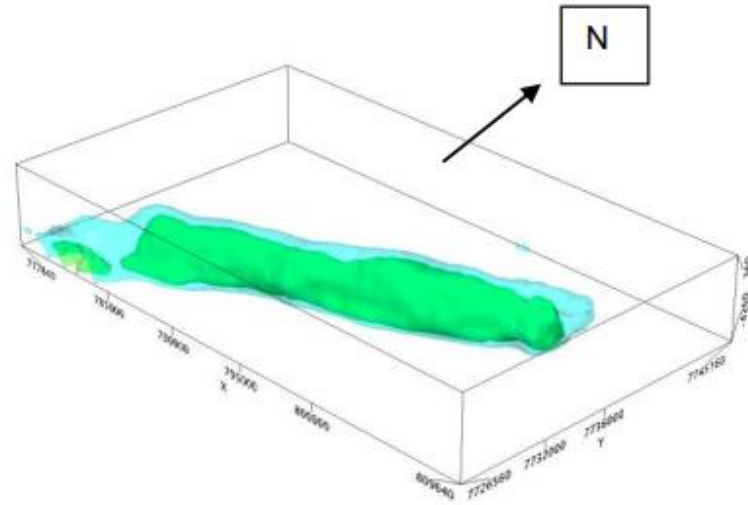


Regional Gravity

Why? Implications for Exploration Search Space



Reprocessed Mag



Conclusions and Proposal

- The Cape River Metamorphics record Mesoproterozoic continental-arc magmatism, indicative of a largely concealed, Mesoproterozoic basement terrane below the Thomson Orogen.
- Near identical patterns in detrital zircon geochronology can be observed across basement inliers of the northern Tasmanides – potentially extending as far south-east as the Anakie inlier.
- The existence of a large basement terrane implies continuity of the late-mesoproterozoic mobile belt through central Australia into northern Queensland.
- Furthermore, presence of the Oakvale Province, however extensive, implies that the position of the Neoproterozoic rift margin, which partially facilitated the separation of the Rodinia supercontinent, requires reconsideration, and likely is unrelated to the Tasman Line in Queensland.

Proposal:

Put together a consortium of industry parties with interests in mineral exploration across northern Queensland to re-visit these basement inliers and investigate the distribution of Mesoproterozoic basement across northern Queensland.

If you are interested, please come and have a chat!



Acknowledgements

- I'd like to thank Amanda and Kaylene for organising this workshop, and for providing the platform to share these ideas
- Thanks to Ioan and EGRU broadly for facilitating much of the work presented today