

Archean Mafic-Ultramafic Magmatism in Australia: New Map Promotes Mineral Prospectivity

Dean Hoatson & Subhash Jaireth Contributions from: Alan Whitaker, David Champion, Jon Claoué-Long, Lynton Jaques & Mike Huleatt

Comb spinifex: distinctive texture of Archean komatiitic rocks



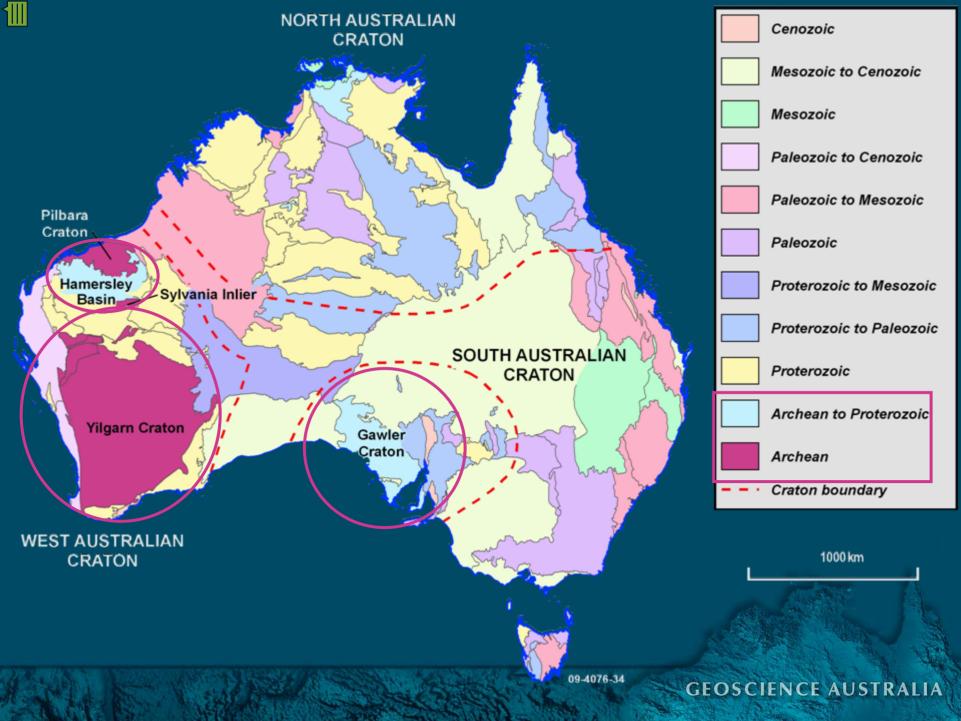
Australian Government Geoscience Australia Australian Nickel Conference 14-15th October 2009

Critical Questions for Explorers ...

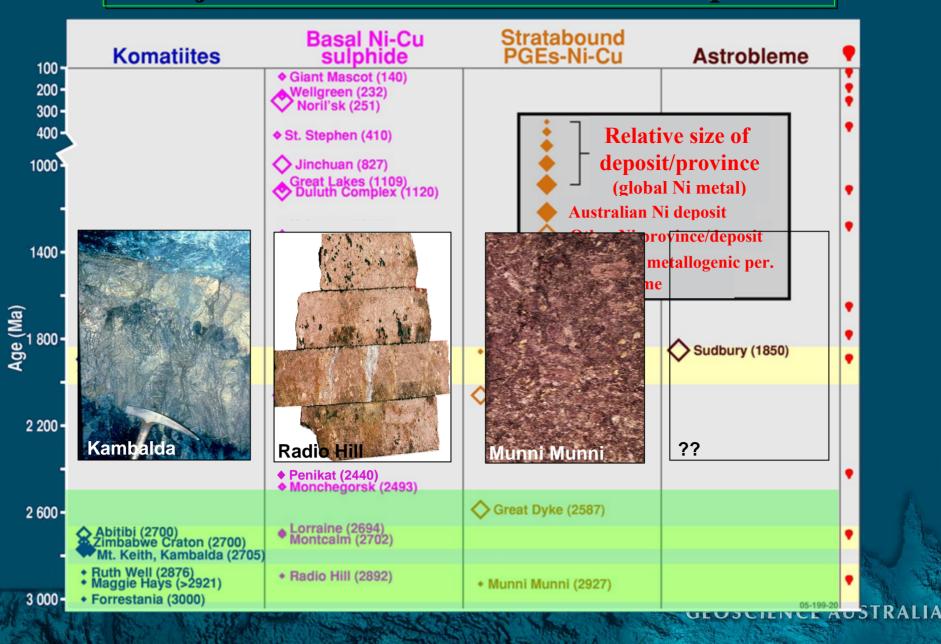
Where are the Archean mafic-ultramafic magmatic systems?

Which Archean Magmatic Events have ultramafic associations that are important for fertile Ni, Cr, PGE systems?

Can we correlate Archean Magmatic Events that are known to be mineralised especially under cover?



Major Archean Nickel and PGE Deposits



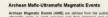
Definitions and Methods

- Archean Magmatic Event (AME): Probable geological incident of significance (4000 to 2500 Ma) that is suggested by isotopic, geological, or other evidence (2005 Glossary of Geology)
- Characterisation of Rocks: Province, Formation, Age, Rock Types, Bulk Composition, Setting, Mode of Occurrence, Thickness, Country Rocks, Mineralisation; ARC GIS 9.3 environment
- Magmatic Event Criteria. Several hundred, reliable (>95% U-Pb zirc/badd) ages of mafic & ultramafic rocks
- Base Maps: Major Crustal Provinces and Solid Geology....
 Economic potential → important to assess total volume of magmatic system



AUSTRALIAN ARCHEAN MAFIC-ULTRAMAFIC MAGMATIC EVENTS

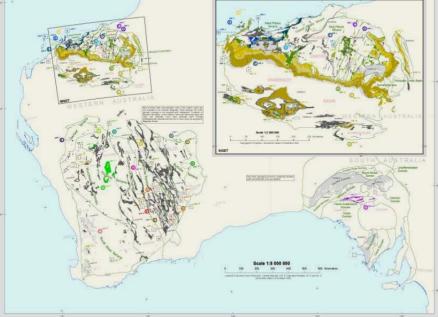
Sheet 1 of 2

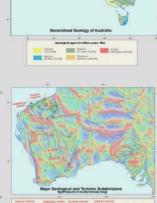


Subordinals matic-ultramatic rocks of the same are within a regional rock nurbane are

Note that the presence of mafic and ultramatic rocks in some areas is interpreted only from









Sheet 1: Map of Australian Archean Maflo-Ultramafic Magmatic Events Time-Space-Event Chart Sheet 2: Maps of Interpreted Distribution, Characterisation, and Nickel Resources of Archean Maflo-Ultramafic Rocks in the Yilisam Cration

Locations of additional ages and other geological data

- (an angled on 1:5 000 000 map from north to south) Brodey Evert AME 6 (ruc) 2015 Ms. 3171 z 3 Ms (ChiffaRF Orth propriate Interbedded ARI basel of Woodbrook Formal

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- Karmaida Event ARE 19 year -2705 No. 2709 ± 7 Sta (SYRISM U-P) promit decile consol with kornetific Saland-Last Chanc

Locations of type examples of dated Archean Magmatic Events

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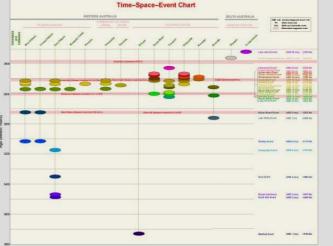
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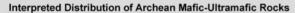
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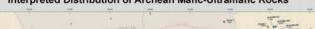
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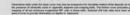
AUSTRALIAN ARCHEAN MAFIC-ULTRAMAFIC MAGMATIC EVENTS: YILGARN CRATON, WESTERN AUSTRALIA





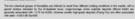




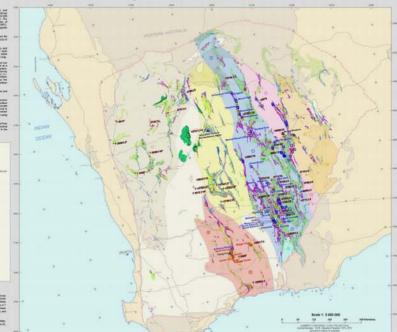






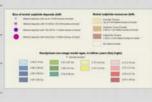


Interpreted Characterisation of Komatiites









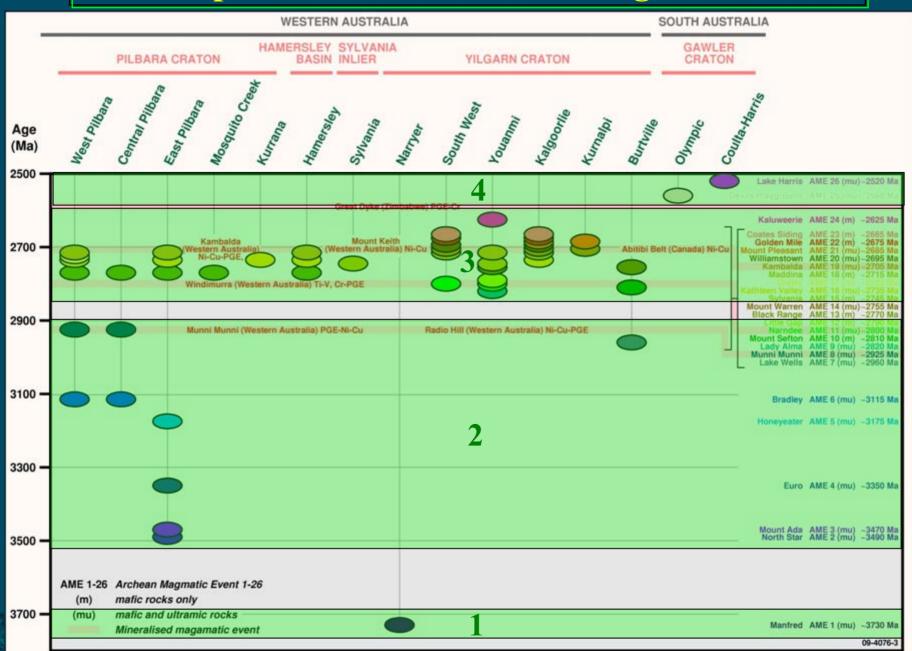
Crustal Neodymium Model Ages



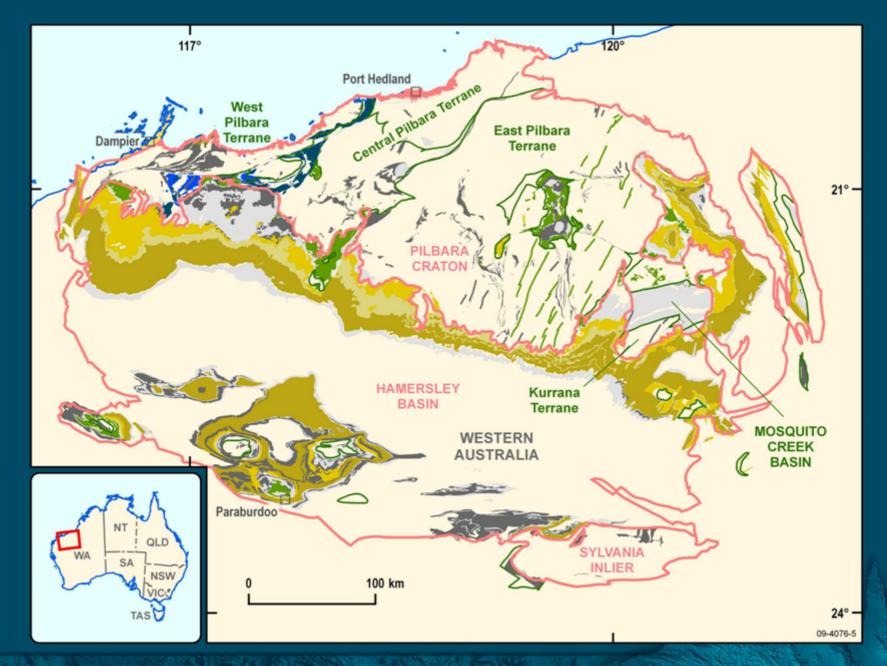


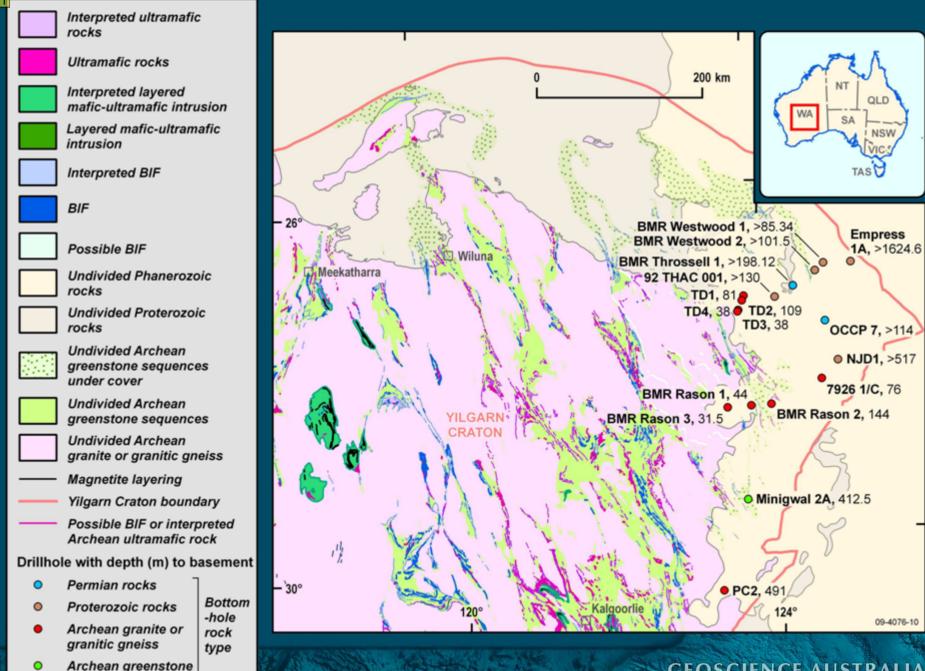
AUSTRALIAN ARCHEAN MAFIC-ULTRAMAFIC MAGMATIC EVENTS: TILGARN CRATON, WESTERN AUSTRALIA

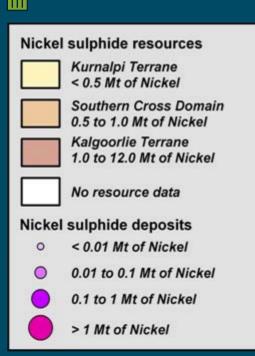
Time—Space—Event Chart: 26 Magmatic Events

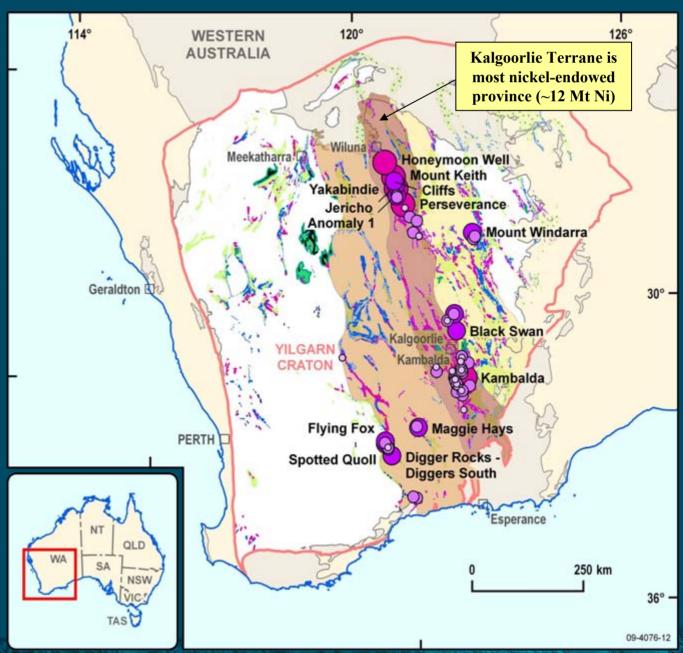


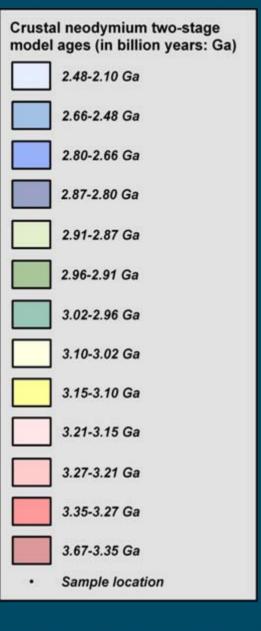


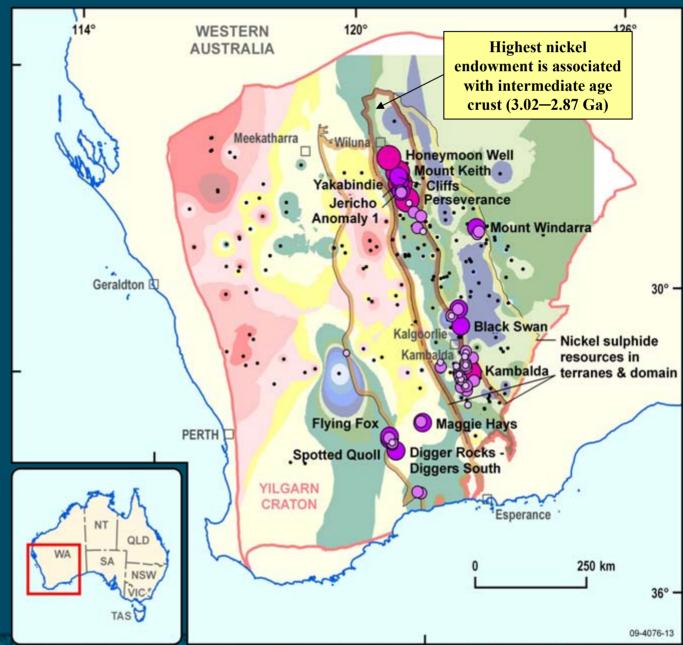






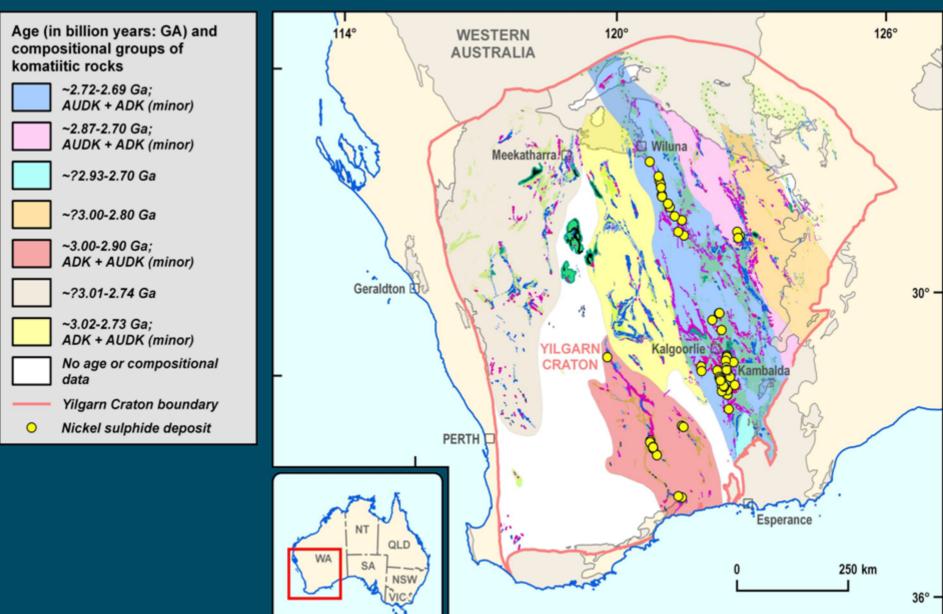






GEOSCIENCE AUSTRALIA





PILBARA CRATON

- 1. West Pilbara Terrane
- 2. Central Pilbara Terrane
- 3. East Pilbara Terrane
- 4. Mosquito Creek Basin
- 5. Kurrana Terrane

HAMERSLEY BASIN

6. Hamersley Basin

SYLVANIA INLIER

7. Sylvania Inlier

YILGARN CRATON

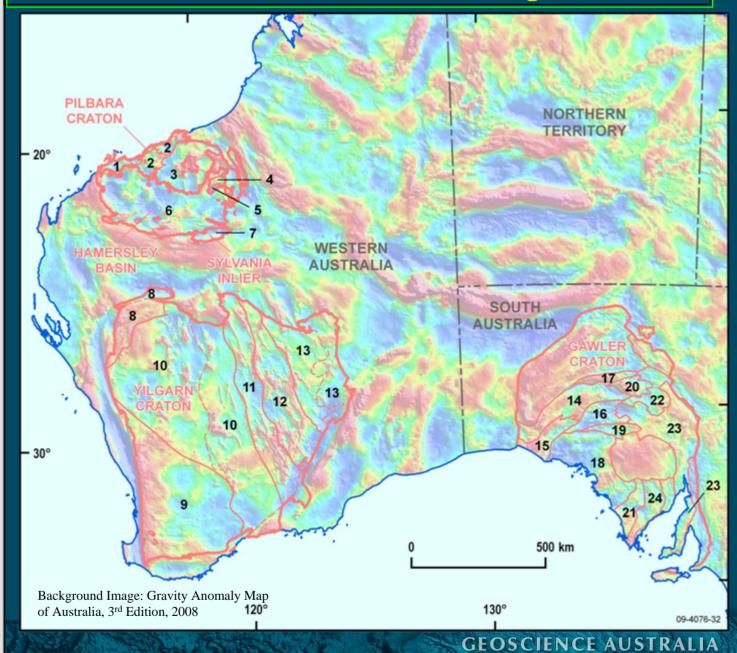
- 8. Narryer Terrane
- 9. South West Terrane
- 10. Youanmi Terrane
- 11. Kalgoorlie Terrane
- 12. Kurnalpi Terrane
- 13. Burtville Terrane

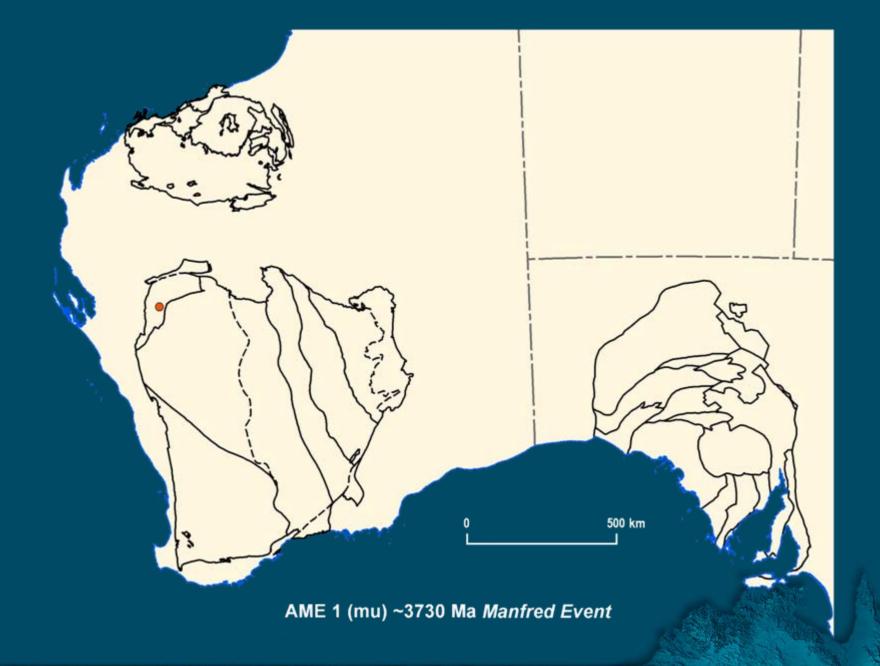
GAWLER CRATON

- 14. Christie Domain
- 15. Fowler Domain
- 16. Wilgena Domain
- 17. Coober Pedy Domain
- 18. Nuyts Domain
- 19. Harris Greenstone Domain
- 20. Mount Woods Domain
- 21. Coulta Domain
- 22. Undifferentiated Domain
- 23. Olympic Domain
- 24. Cleve Domain
- Craton, inlier & basin boundary
- Terrane & domain boundary
- Internal subdivision of terrane

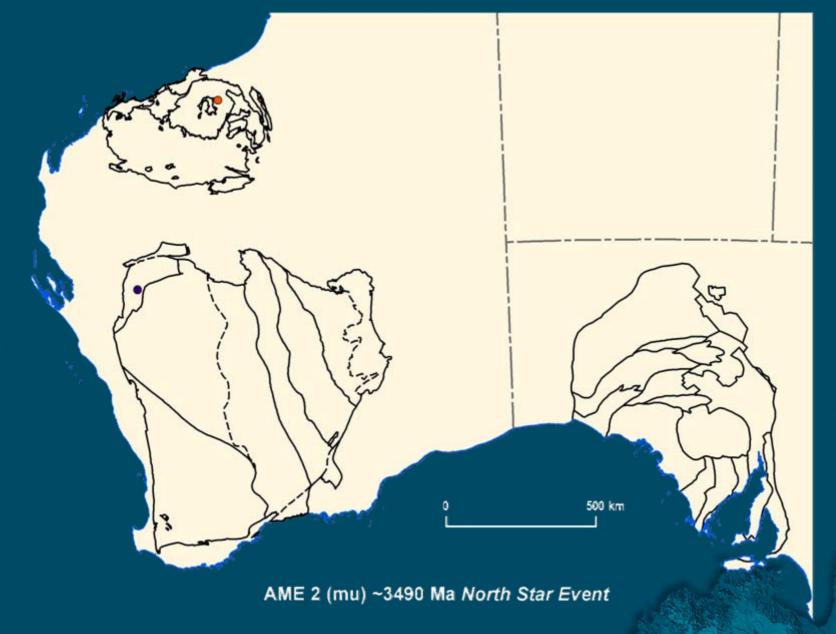
Note: Only those provinces containing Archean mafic and/or ultramafic rocks are labelled.

Time-Slice Animation of 26 Archean Magmatic Events

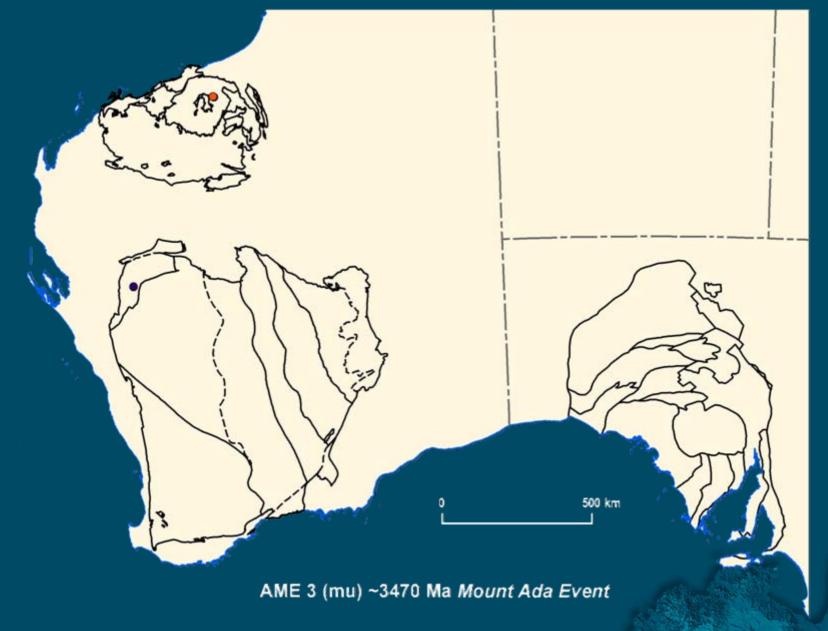






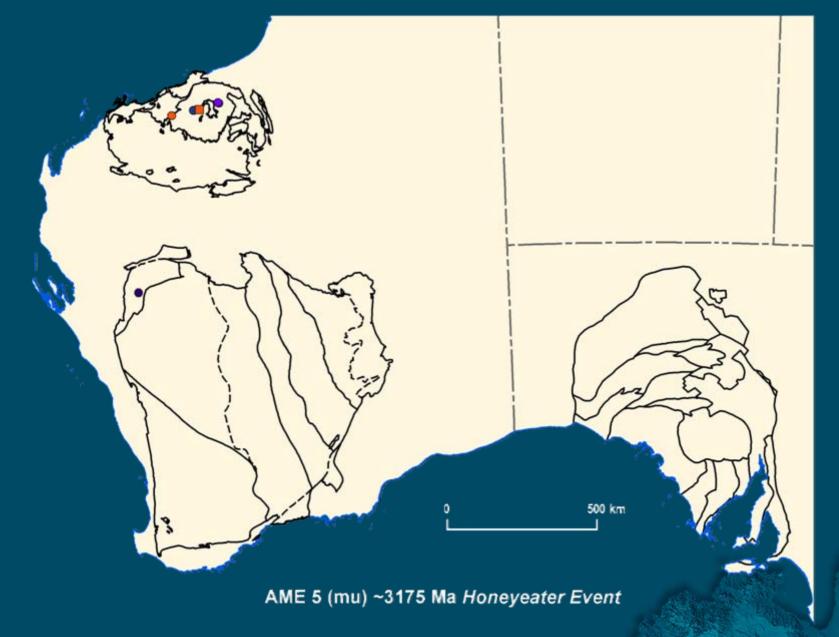




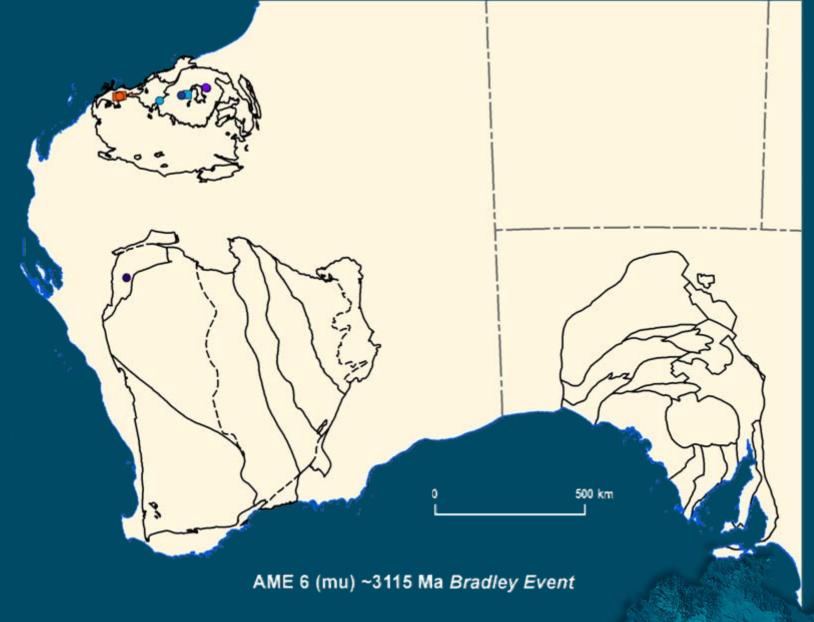




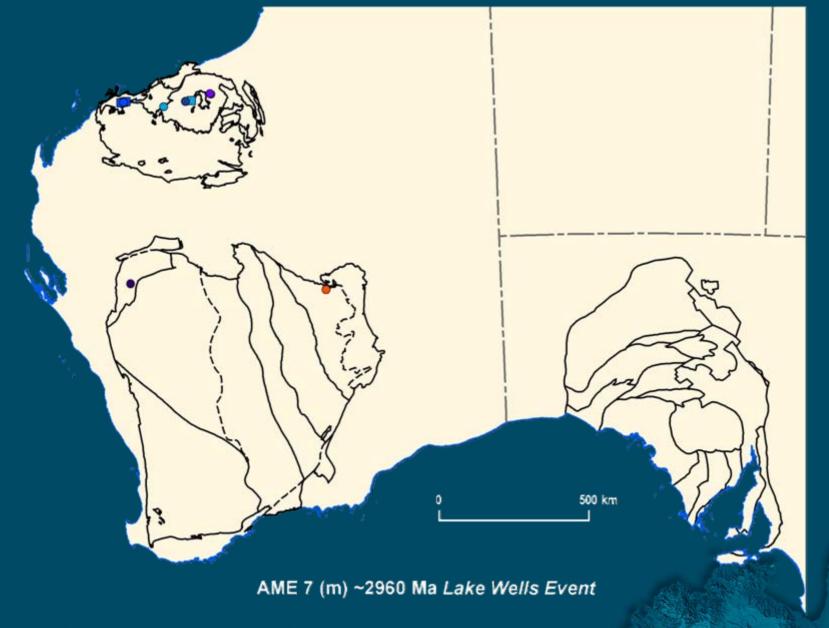




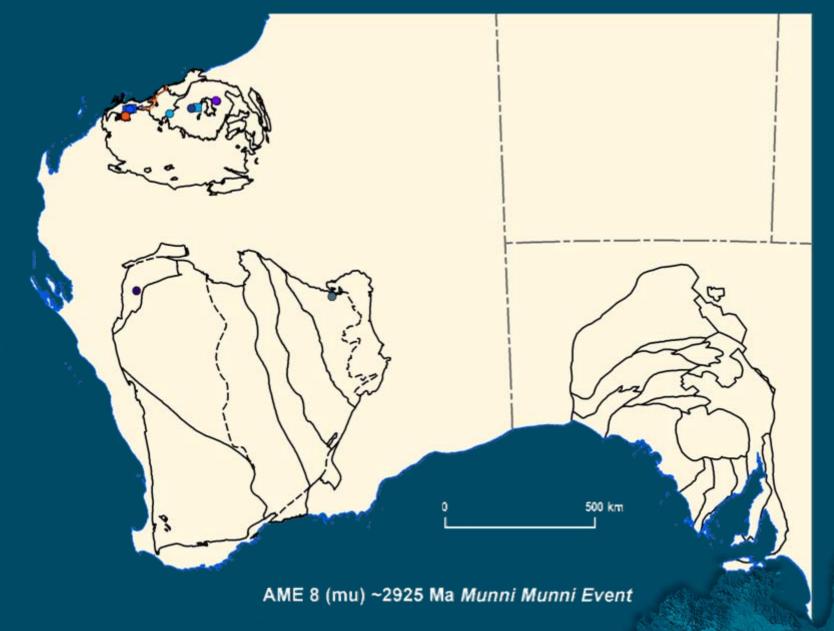




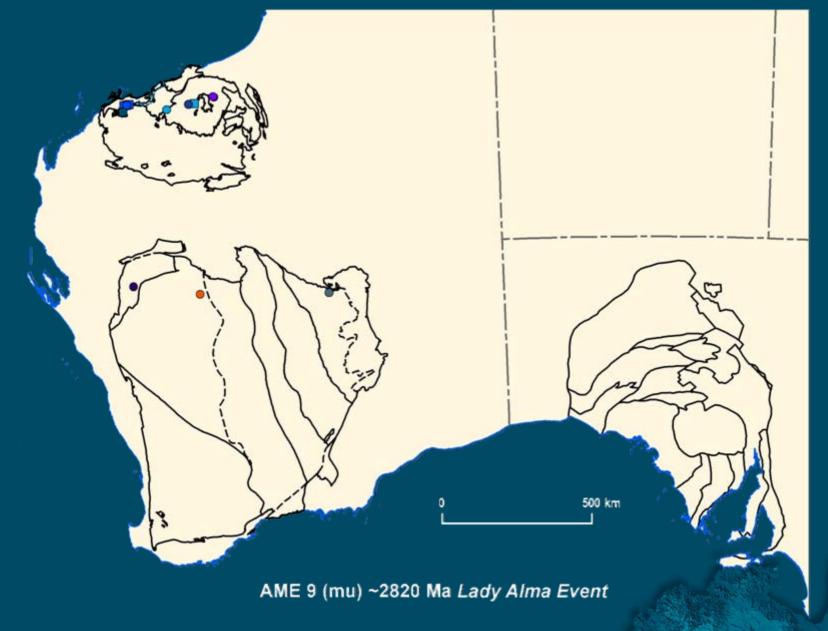




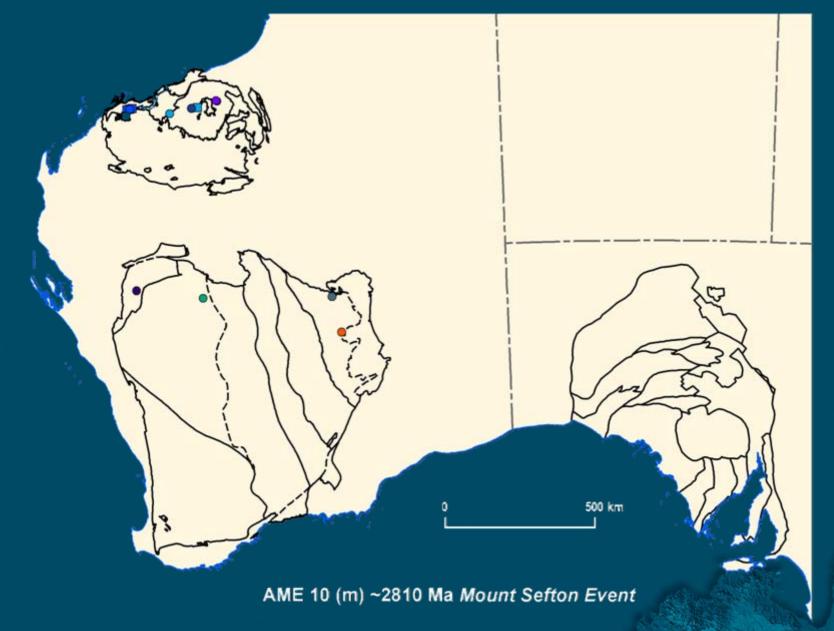






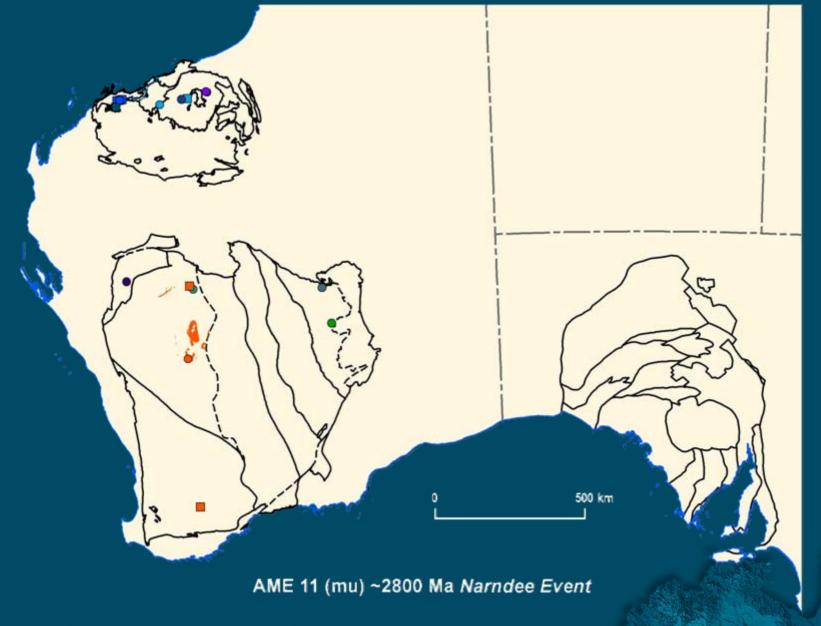




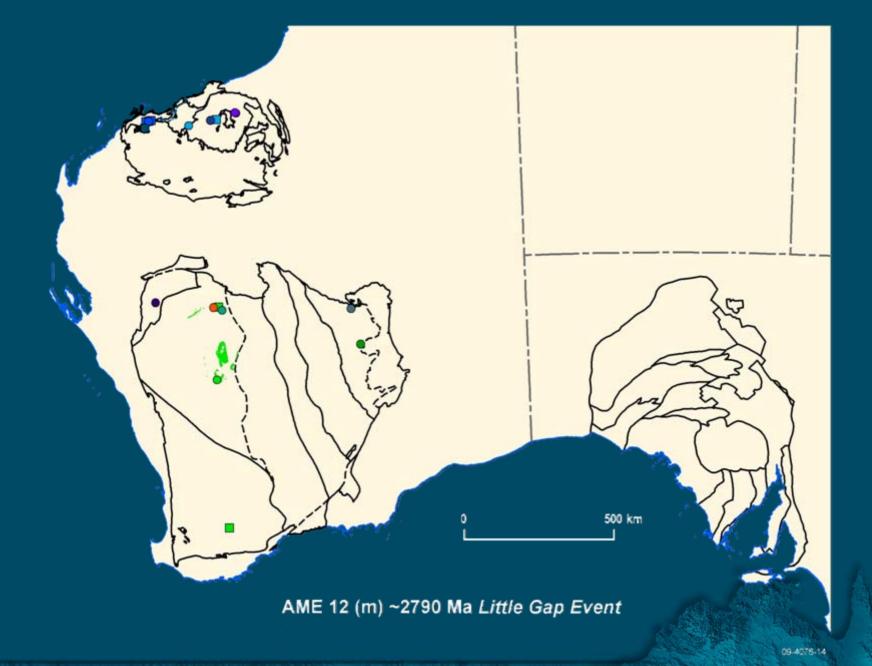


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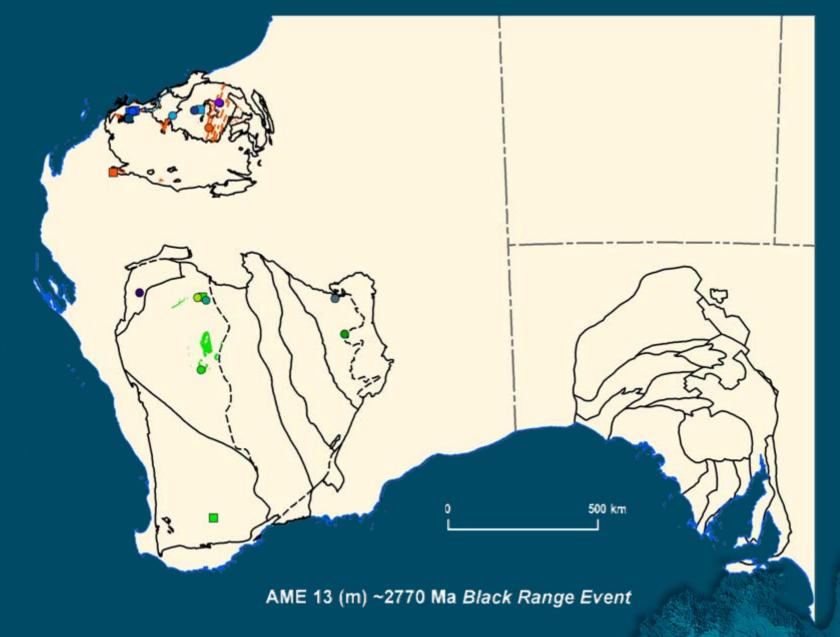




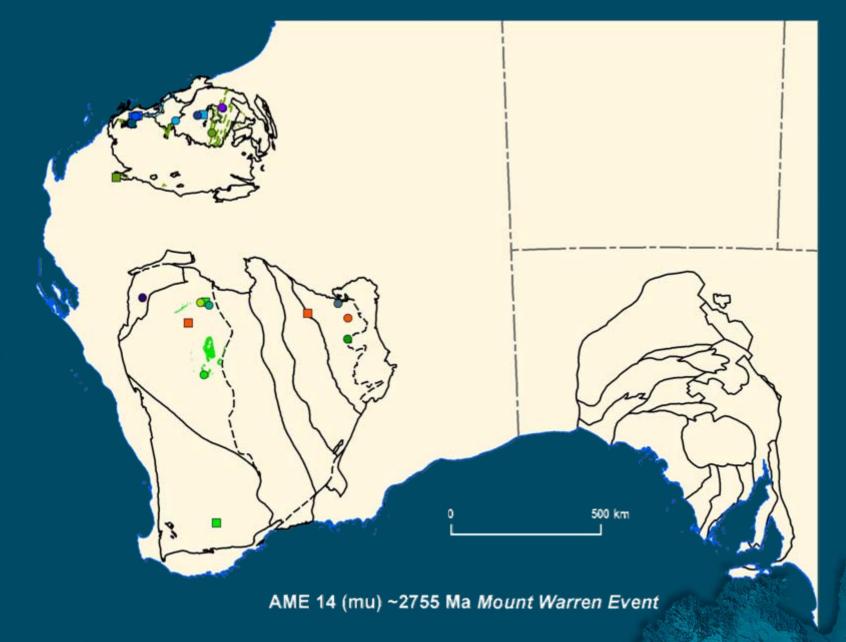




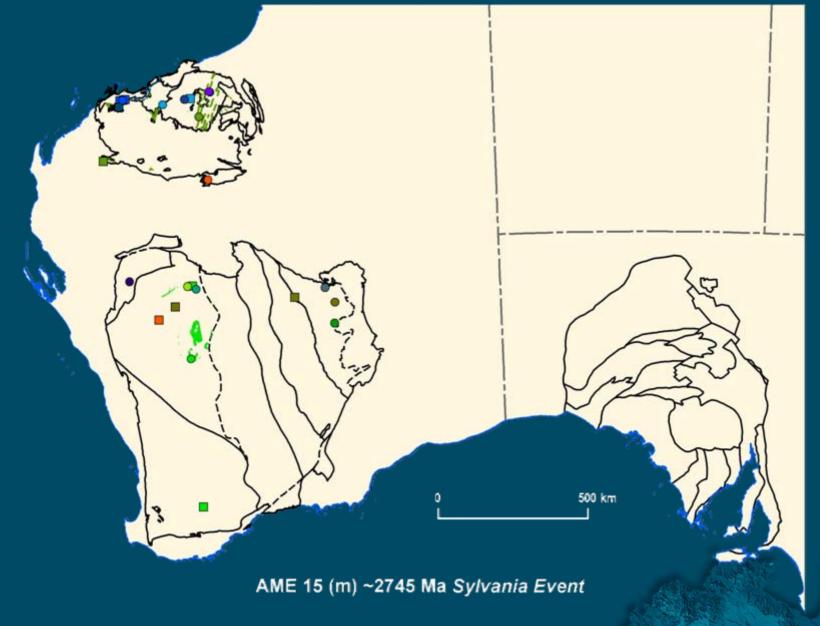




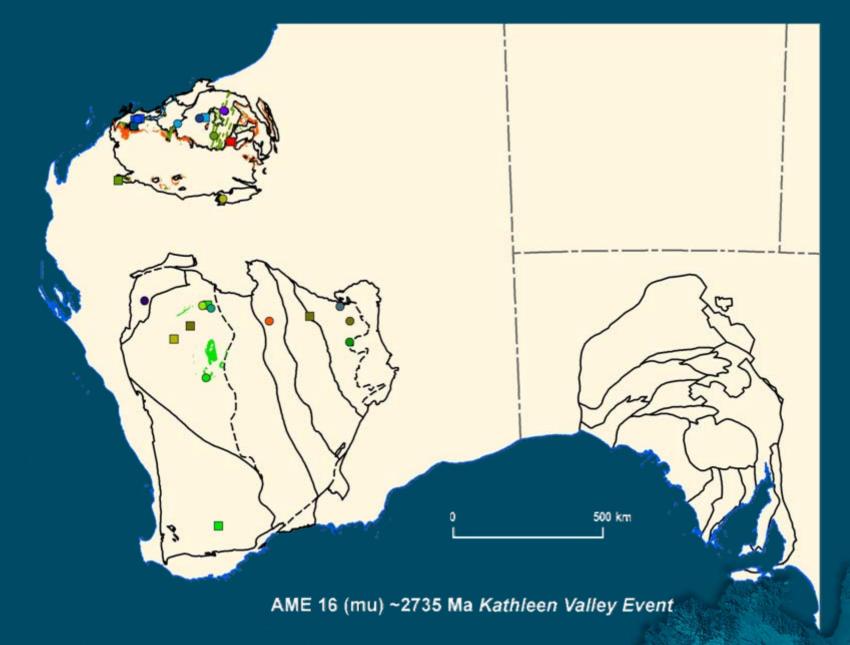


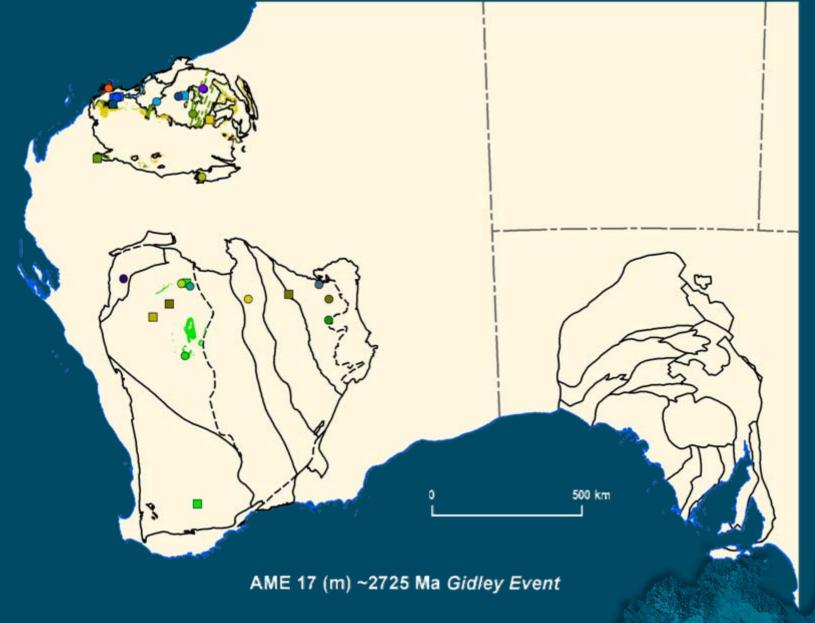




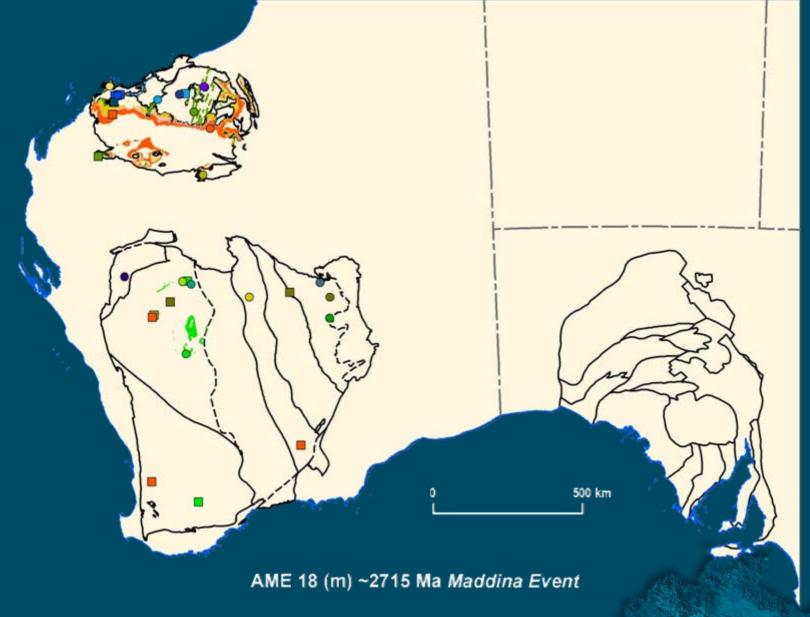




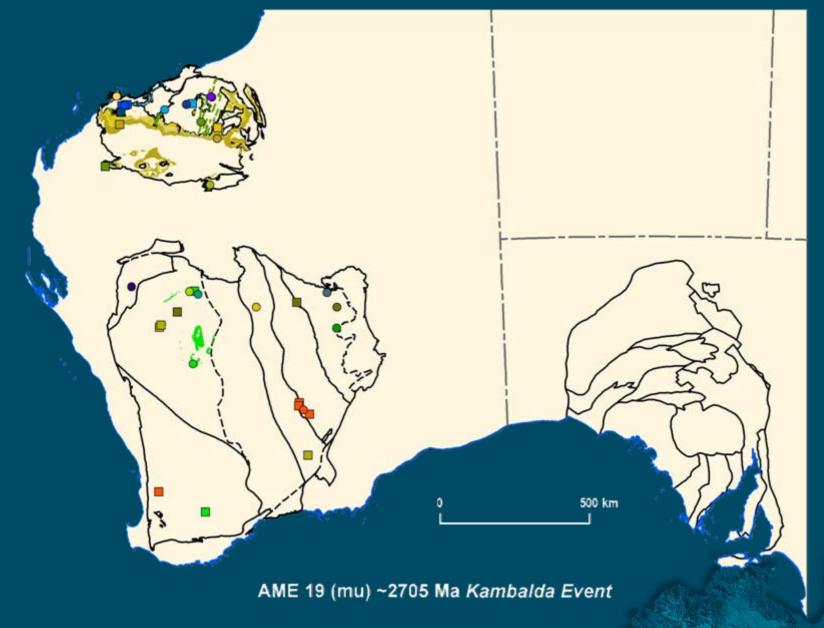






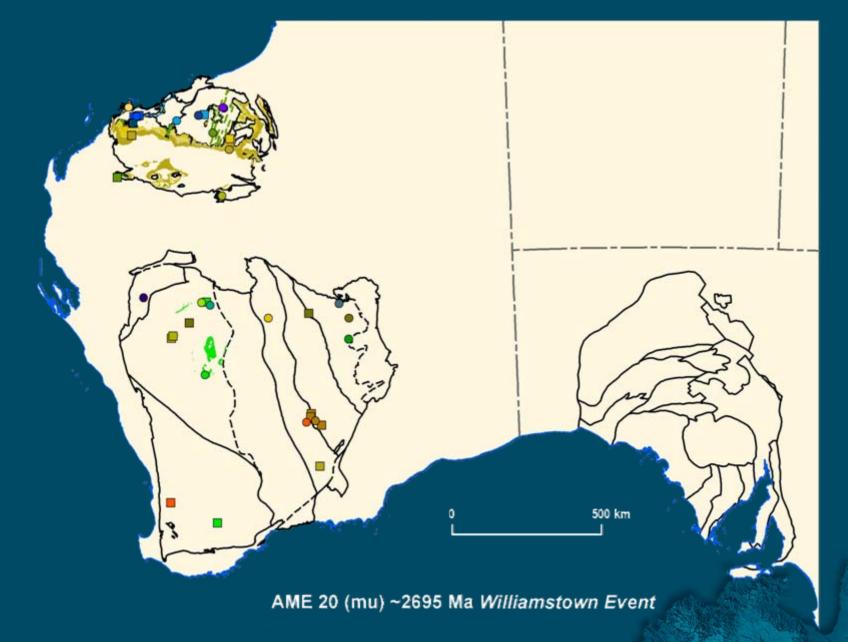




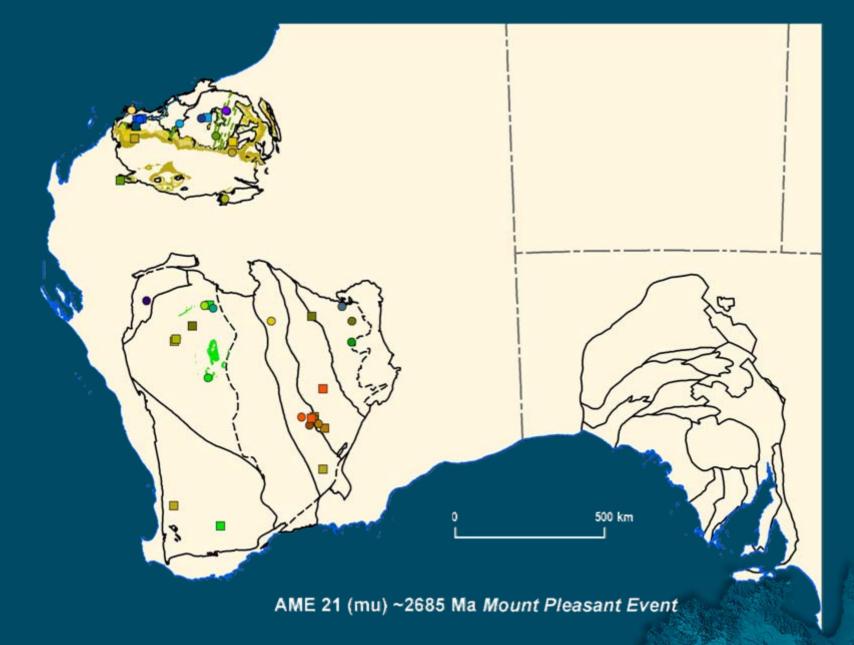


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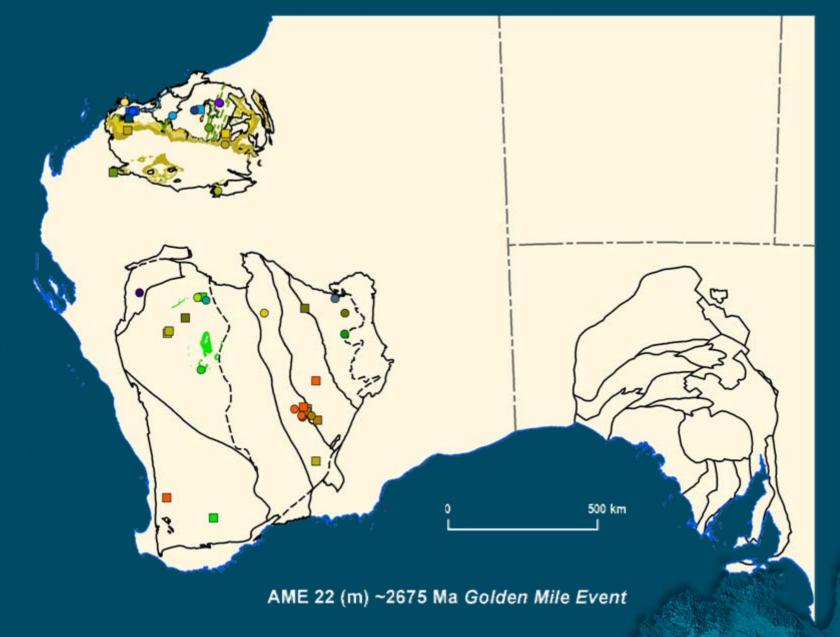




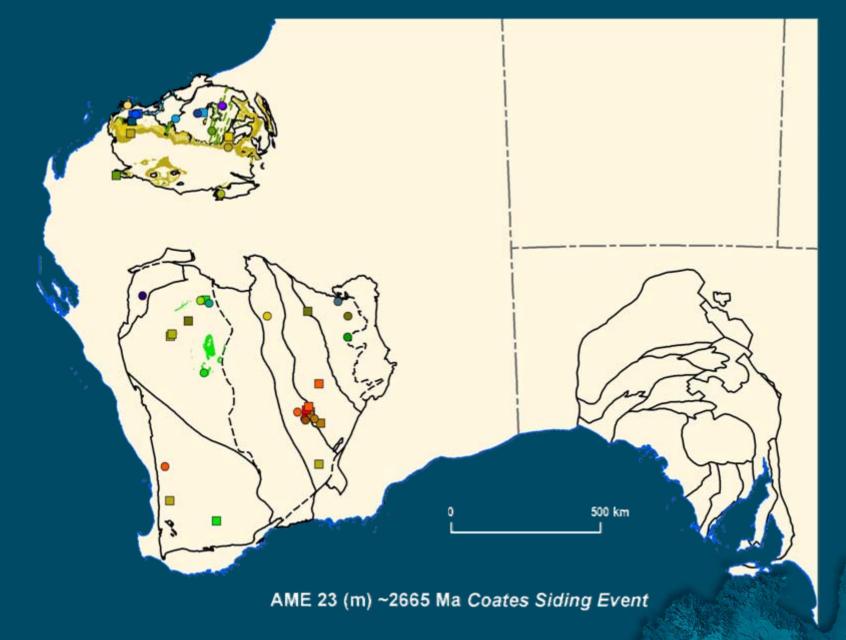




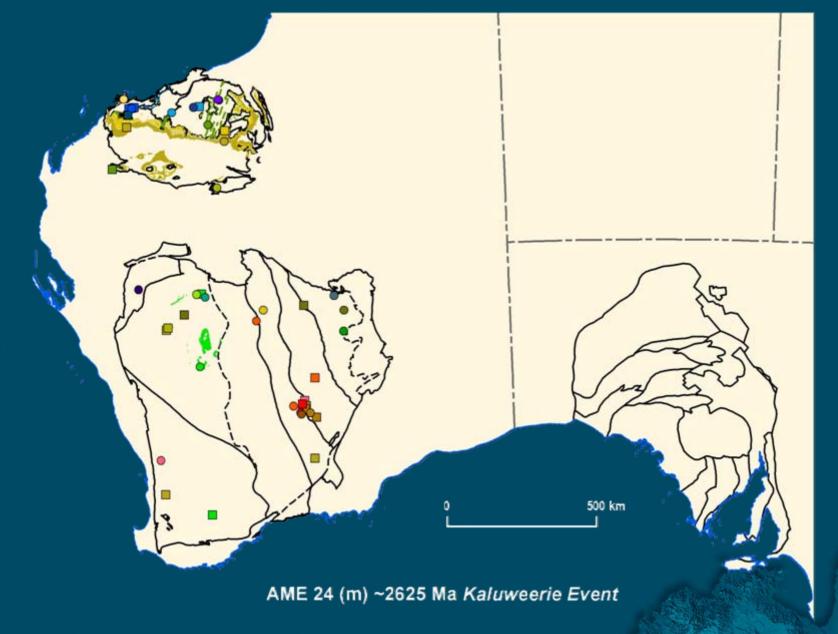




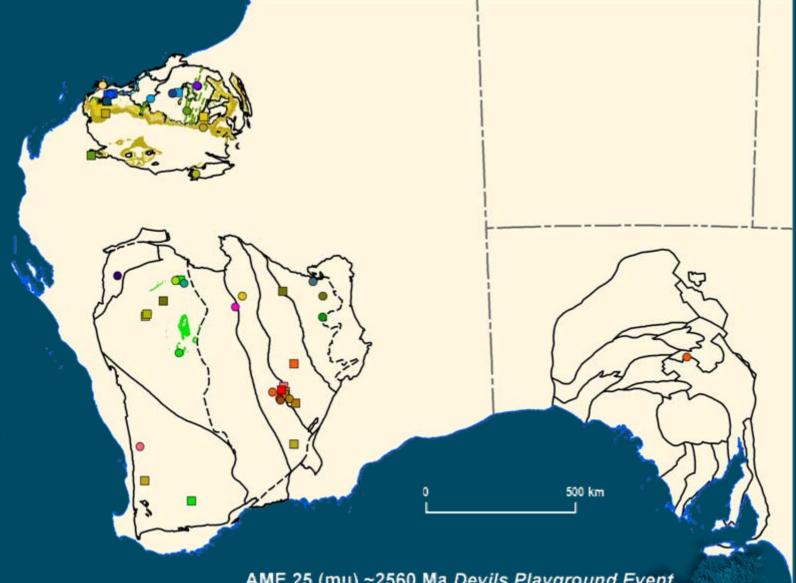






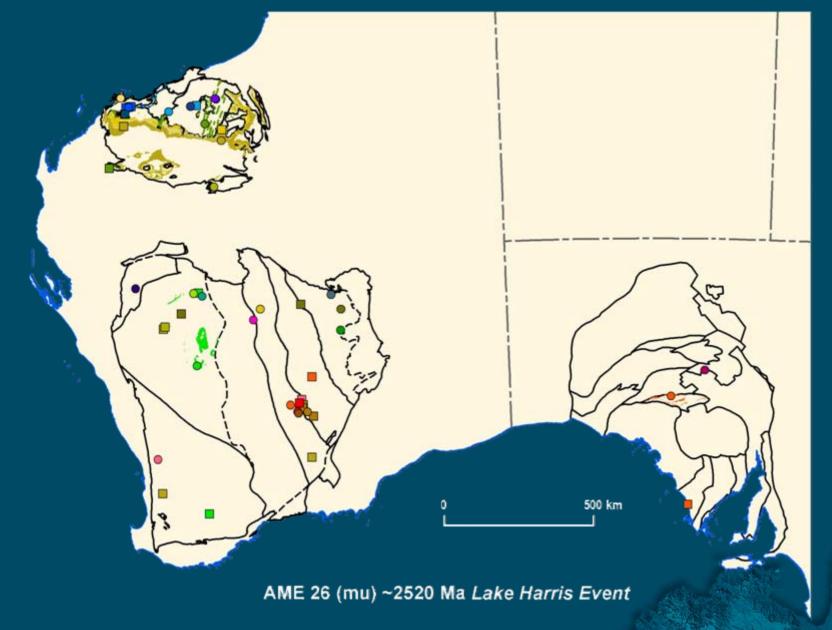






AME 25 (mu) ~2560 Ma Devils Playground Event

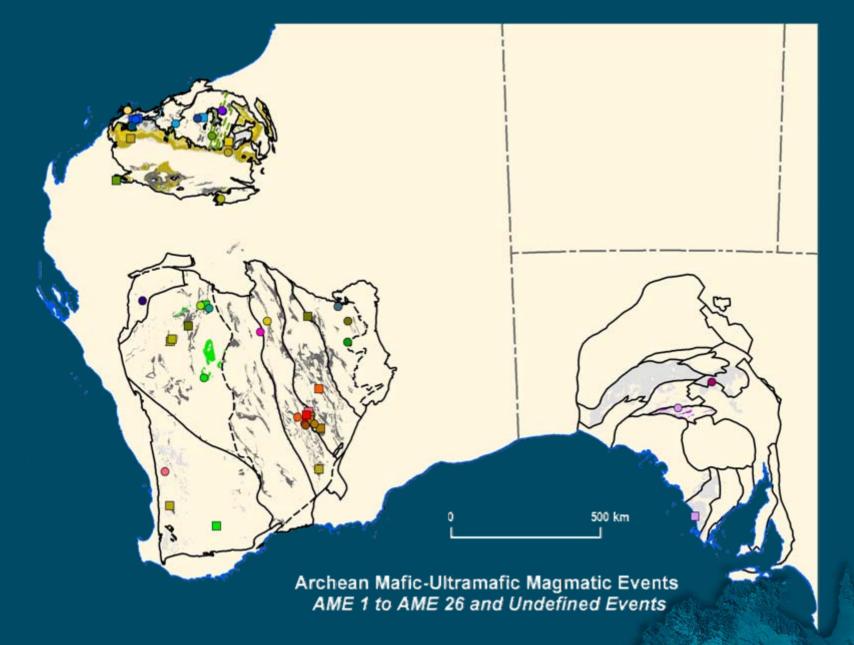




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Unknown Age Undefined Event

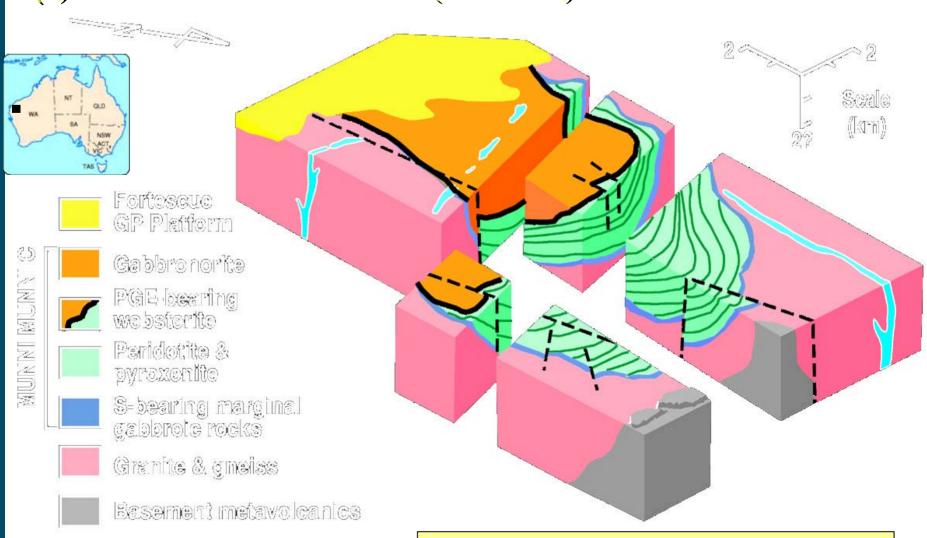




Diverse Styles of Archean Mineralisation

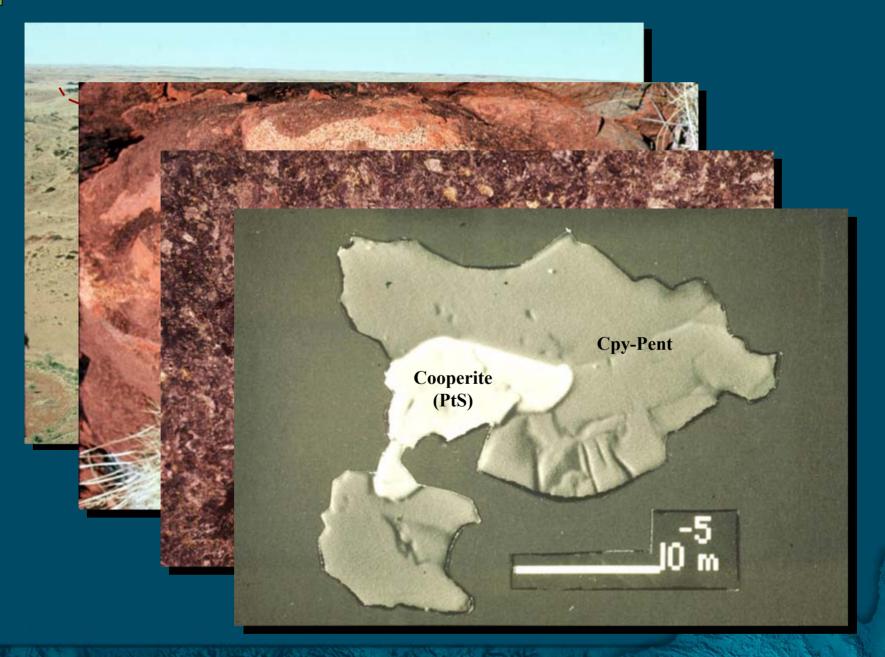
- (1) PGE-Ni-Cu sulphides:
- ~2925 Ma AME 8 (mu): Munni Munni Intrusion
- (2) Ti-V oxides:
- ~2800 Ma AME 11 (mu): Windimurra Intrusion
- (3) Ni-Cu±PGE sulphides:
- ~2705 Ma AME 19 (mu): Kambalda Komatiite

(1) Munni Munni Intrusion (2925 Ma): Pilbara Craton



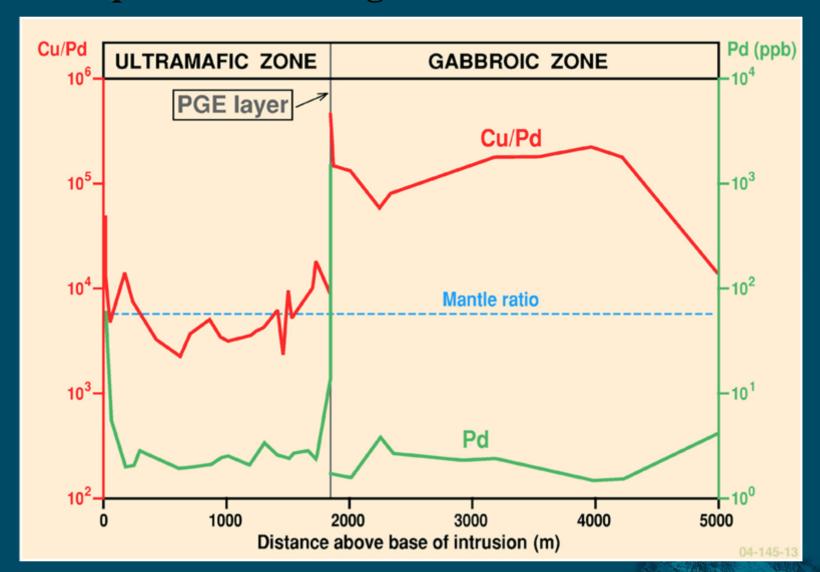
Largest resource of PGEs in Australia 24 Mt @ 2.9 g/t PGE+Au, 0.3% Cu, 0.2% Ni





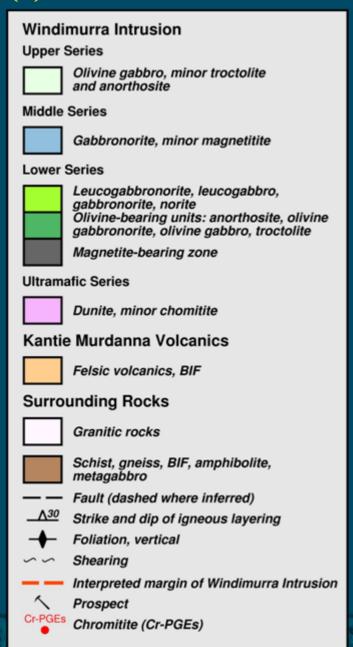


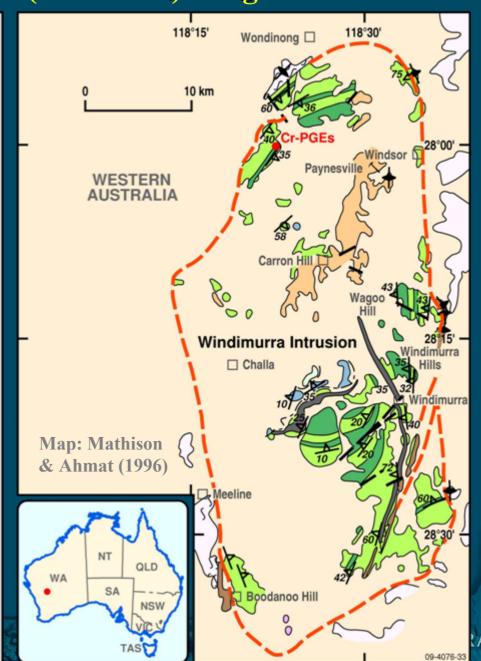
Exploration Strategies from Munni Munni



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(2) Windimurra Intrusion (~2800 Ma): Yilgarn Craton

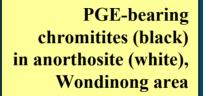








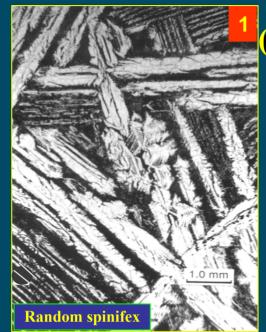
Cyclic Ti-V-magnetitite layers (grey) in leucogabbro (white), Windimurra Vanadium Ltd pit

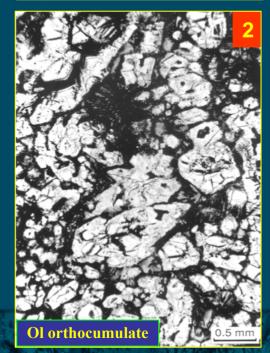




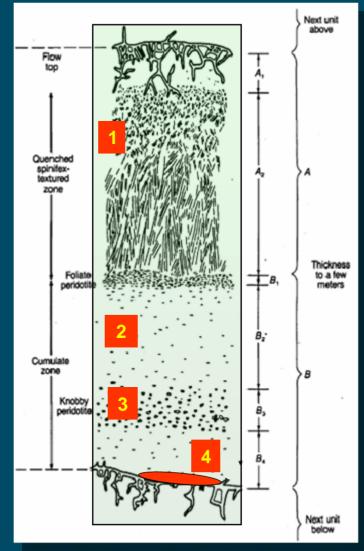


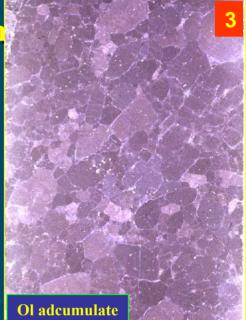
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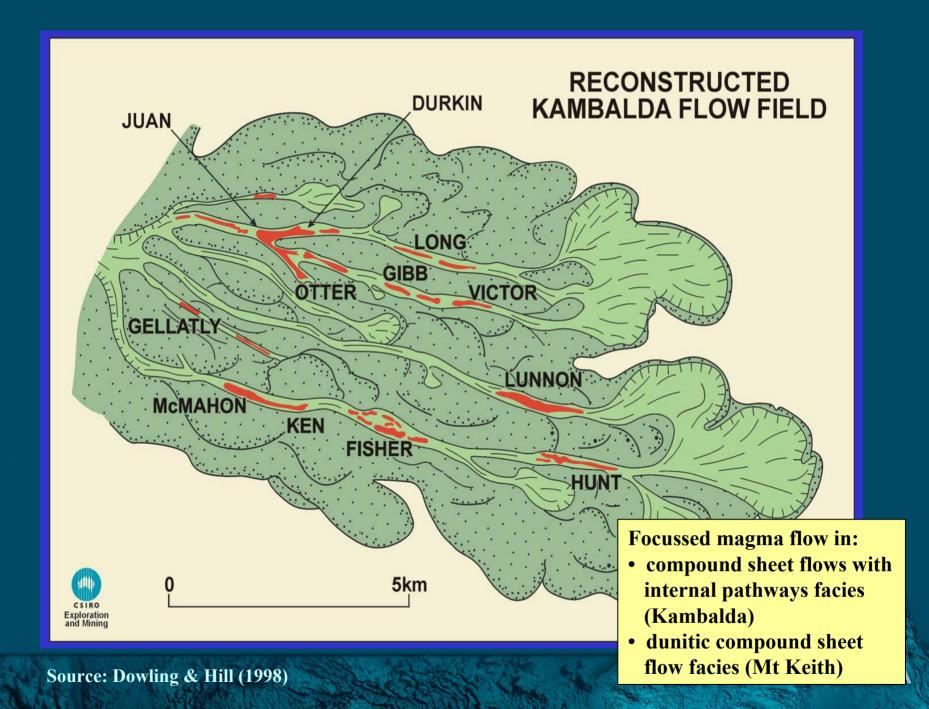
(3) Kambalda Komatiite (~2705 Ma): Yilgarn Craton





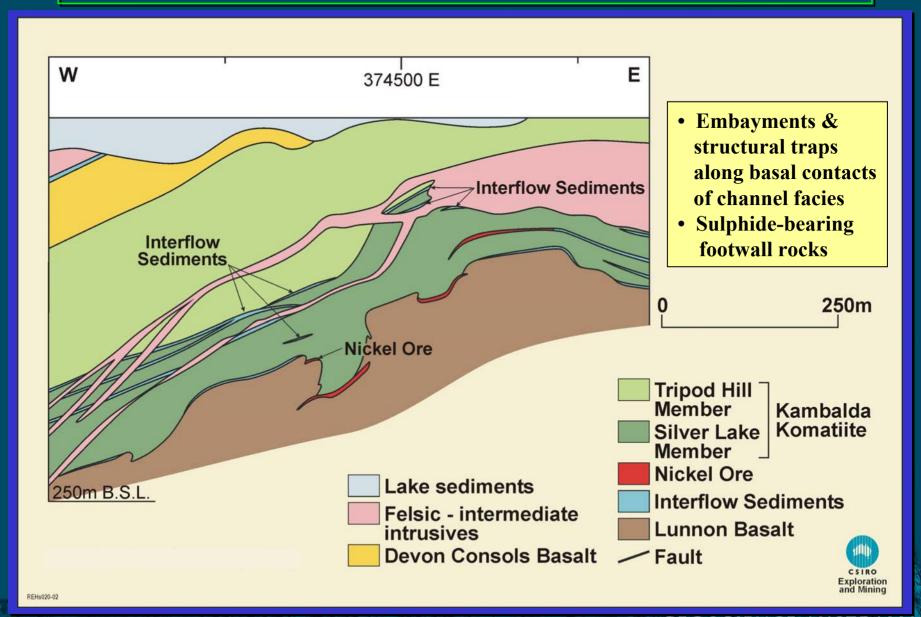








Typical Mineralised Environment – Kambalda Deposits





Preliminary Findings from Archean Study

- Twenty-six major Archean Magmatic Events (AME): range ~3730 Ma (AME 1) to ~2520 Ma (AME 26); restricted to Yilgarn, Pilbara, and Gawler cratons, Sylvania Inlier, Hamersley Basin
- Sequential crustal development: commences ~3730 Ma in NW Yilgarn Craton; followed by Pilbara Craton; more widespread from Yilgarn and Pilbara cratons, Hamersley Basin, Sylvania Inlier; concludes with two late Archean events in Gawler Craton
- Three AME have significant mineralisation: AME 8 ~2925 Ma Munni Munni-Radio Hill (PGE-Ni-Cu); AME 11 ~2800 Ma Windimurra (Ti-V); AME 19 ~2705 Ma Kambalda (Ni-Cu: coeval with Abitibi Belt, Canada); no coeval analogues with ~2585 Ma Great Dyke of Zimbabwe; Archean is poorly mineralised relative to Proterozoic



Critical Questions for Explorers... Revisited

Where are the Archean mafic-ultramafic magmatic systems?

• Continent- and province-wide spatial & temporal correlations

Which Archean Magmatic Events have ultramafic associations, i.e., fertility for Ni, Cr, PGE systems?

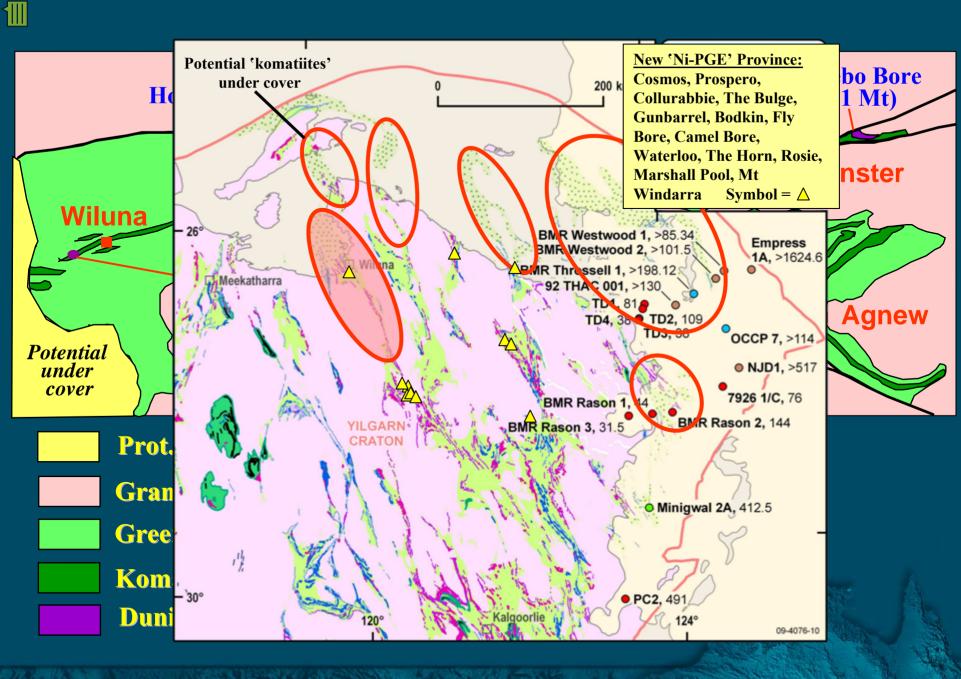
• 16 of 26 AME contain ultramafic rocks....7 of which (AME 4, 5, 6, 8, 18, 19, 26) have komatiitic rocks

Can we correlate Archean Magmatic Events that are known to be mineralised especially under cover?

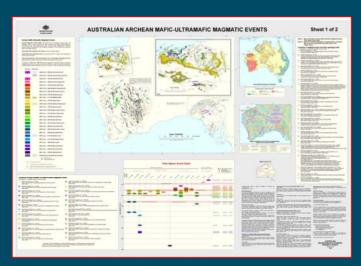
- Three AME (8, 11, 19) contain significant mineralisation
- Potential for extending fertile komatiitic magmatic systems under shallow cover in N and NE Yilgarn Craton

Most Important Messages

- Komatiites and tholeiitic layered intrusions are favourable Archean targets (hydrothermal & Cr deposits rare)
- Exploration interest for large, fractionated tholeiitic mafic-ultramafic intrusions (Windimurra & Munni Munni-type)
- Most prospective komatiitic sequences (Kalgoorlie Terrane):
 - emplaced at ~2.7 Ga
 - volumetrically large magmatic systems
 - sulphidic basement sediments
 - dynamic high-magma-flux environments
 - Al-undepleted dominant compositions
 - unmineralised Pilbara komatiites are older (~3.1-3.4 Ga),
 thinner (10's of m), and mostly Al-depleted
- Map delineates large prospective areas of komatiites under shallow cover in the Yilgarn Craton

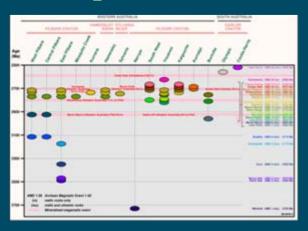


GA Products Available On Line:

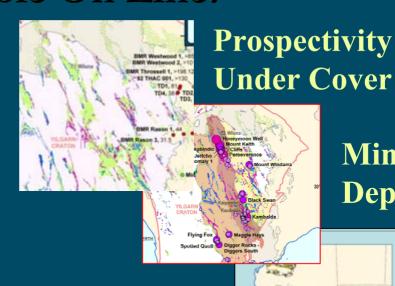




Time-Space-Event Chart



Download Archean & Proterozoic products at: www.ga.gov.au/resources/maps/minerals/index.jsp





State
Data Tables



Time-Slice Maps

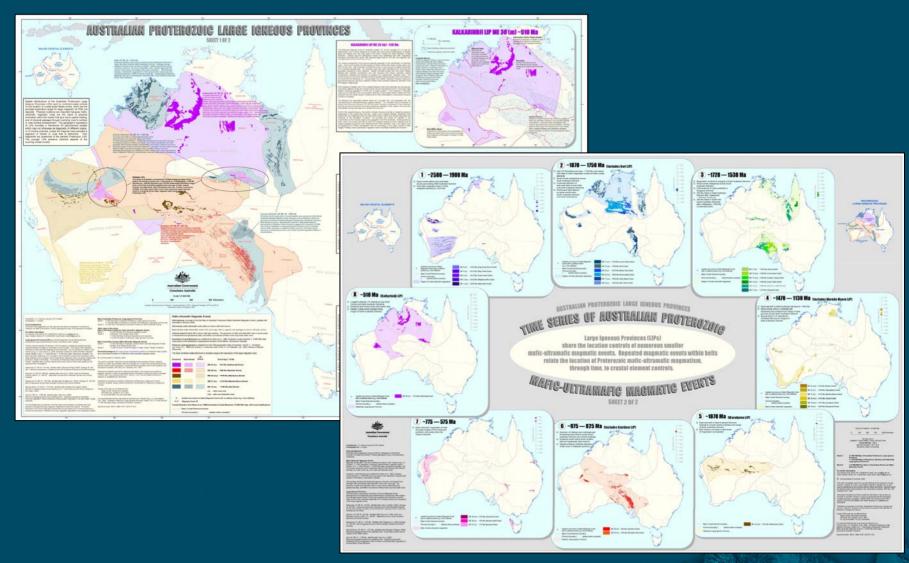
GA Record 2009/41 GeoCat 69935

Mineral

Deposits

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Other Related New Products: LIPs and Time-Series Maps



Download at: www.ga.gov.au/resources/maps/minerals/index.jsp



Thank you



Magmatic Events are even occurring today!

Contact: Dean.Hoatson@ga.gov.au
www.ga.gov.au/resources/maps/minerals/index.jsp