



Key and critical minerals in New South Wales

4 May 2021

Critical minerals in the Australian context



What are critical minerals?

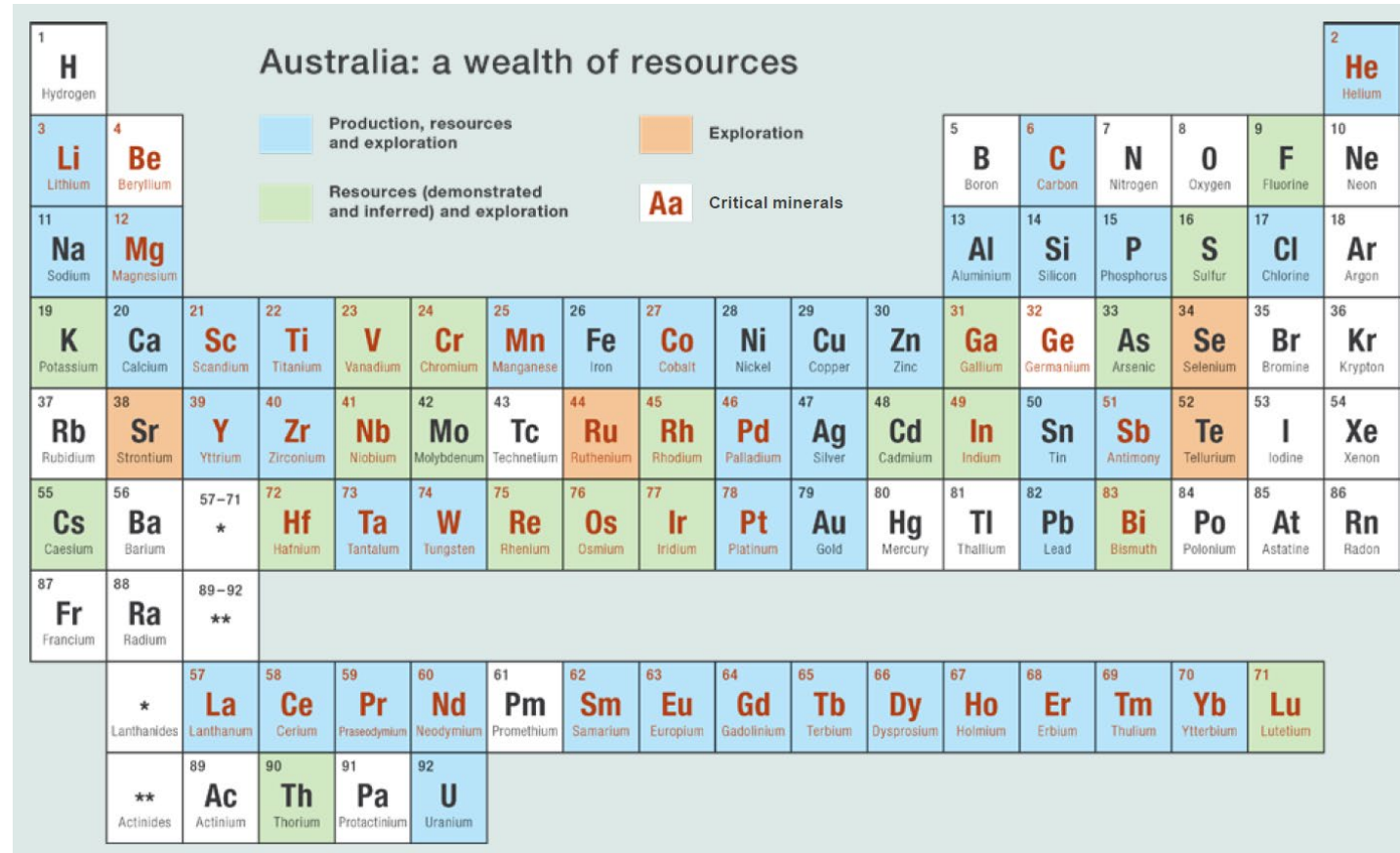
- Essential for the economic and national security
- Potential to become scarce due to geological, political, or technical factors
- Important high-tech applications and few effective substitutes
- Criticality is subject to change



Australian critical minerals

- 24 critical minerals in Australia
- Balancing the future mineral needs of strategic and economic partners with Australia’s potential supply
- Currently produced or with potential in Australia

Antimony	Hafnium	REE
Beryllium	Helium	Rhenium
Bismuth	Indium	Scandium
Chromium	Lithium	Tantalum
Cobalt	Magnesium	Titanium
Gallium	Manganese	Tungsten
Germanium	Niobium	Vanadium
Graphite	PGE	Zirconium



Periodic table of the elements overlain with Australia’s mineral production, resources and exploration activities. Critical minerals are shown in red. (Source: Australian Critical Minerals Prospectus 2020)



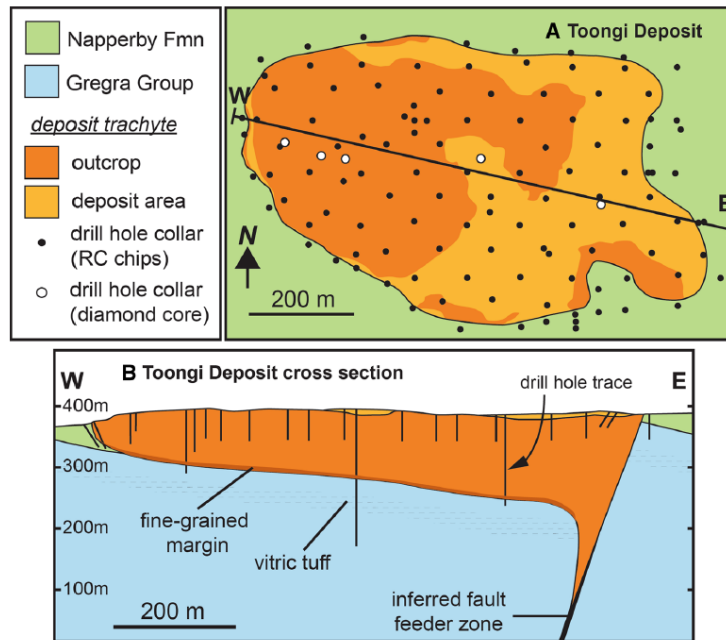
Critical minerals geoscience



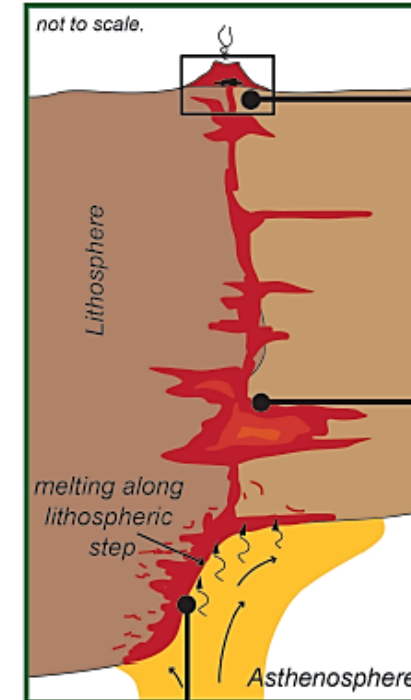
REE – peralkaline/alkaline igneous association

Peralkaline magmatism in NSW

- Mesozoic/Cenozoic volcanism
- Jurassic syenites of ELO
- Devonian Granites (Temora)



Peralkaline volcanic deposits (e.g., Toongi, NSW)



Ore deposition processes

How do ore metals precipitate?
Are hydrothermal fluids important?
Hydrothermal fluid composition?
What is the role of degassing?
What is the role immiscibility?

WORKPLAN:

magmatic/hydrothermal experiments
studies of natural ore systems

Ore metal enrichment processes

How do ore metals become enriched in magmas?
What is the role of fractionation/replenishment & tapping?
What role do melt volatiles play in enriching ore metals?

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magma evolution modelling

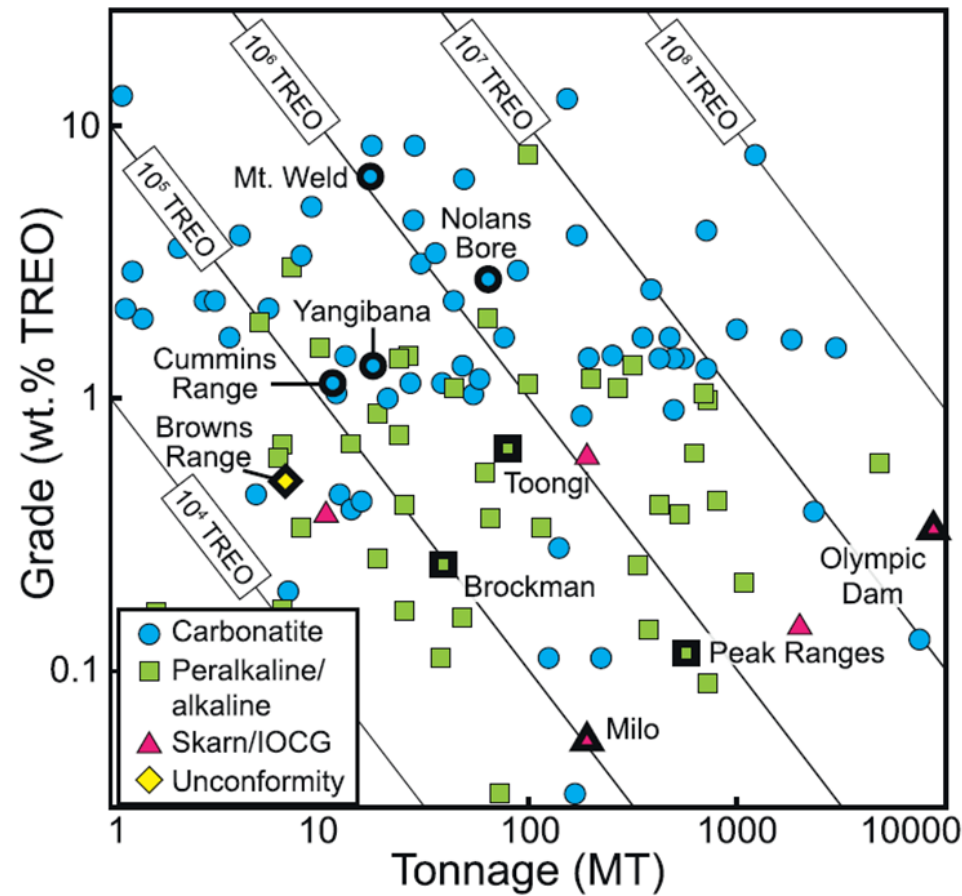
Lithospheric structure controls

Do lithospheric steps allow production of fertile magmas?
Can lithospheric architecture be used to target for prospective areas for mineralisation?

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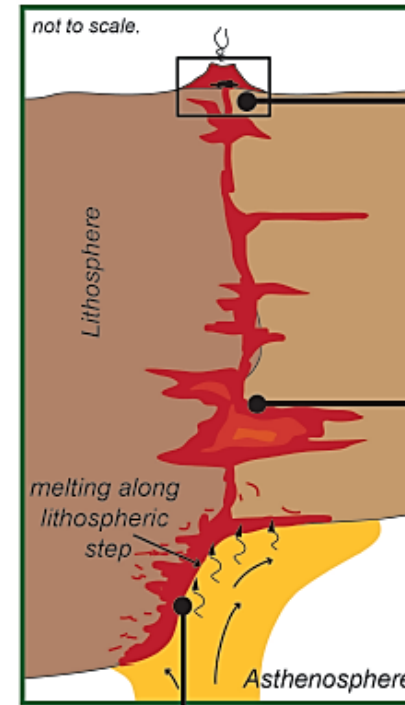
linking field studies with lithospheric architecture analysis

REE – peralkaline/alkaline igneous association



Spandler et al., 2020

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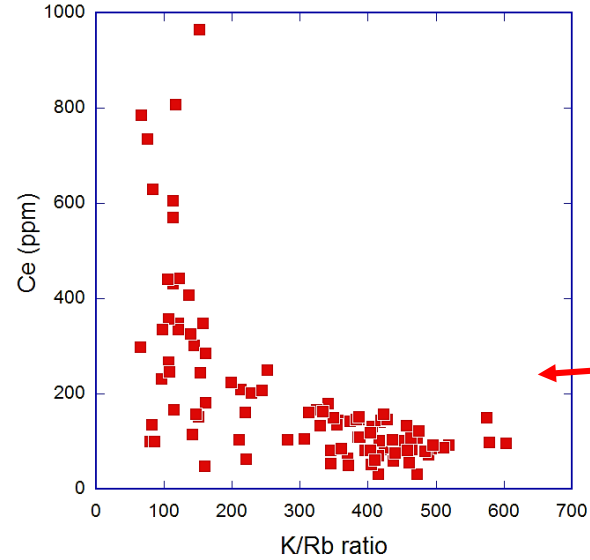
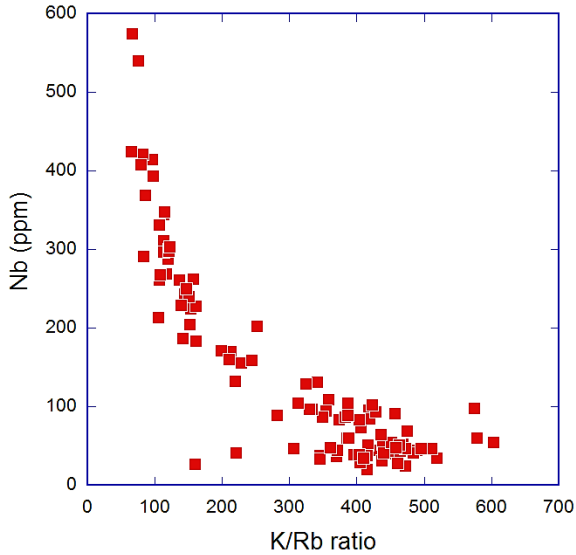
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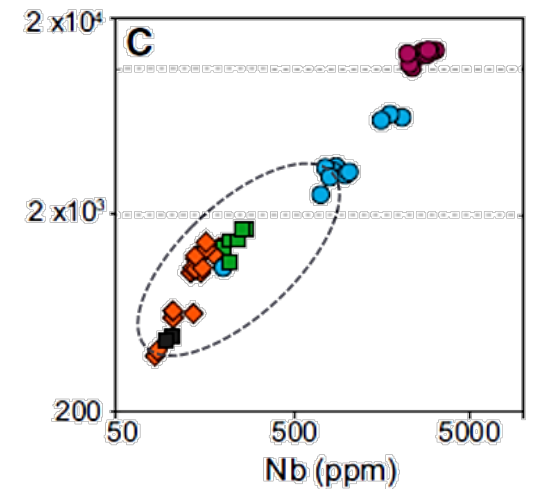
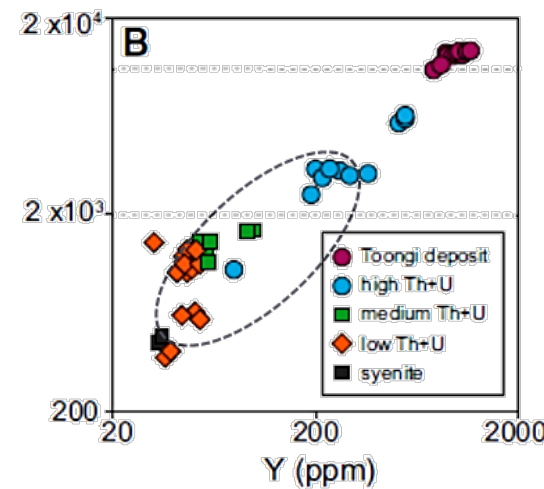
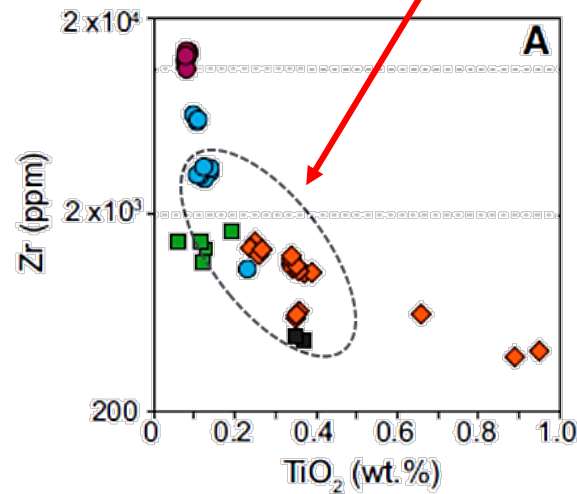
Geochemical enrichment trends in volcanic suites emplaced in NSW are very similar over a wide time range.



Cenozoic volcanic trends

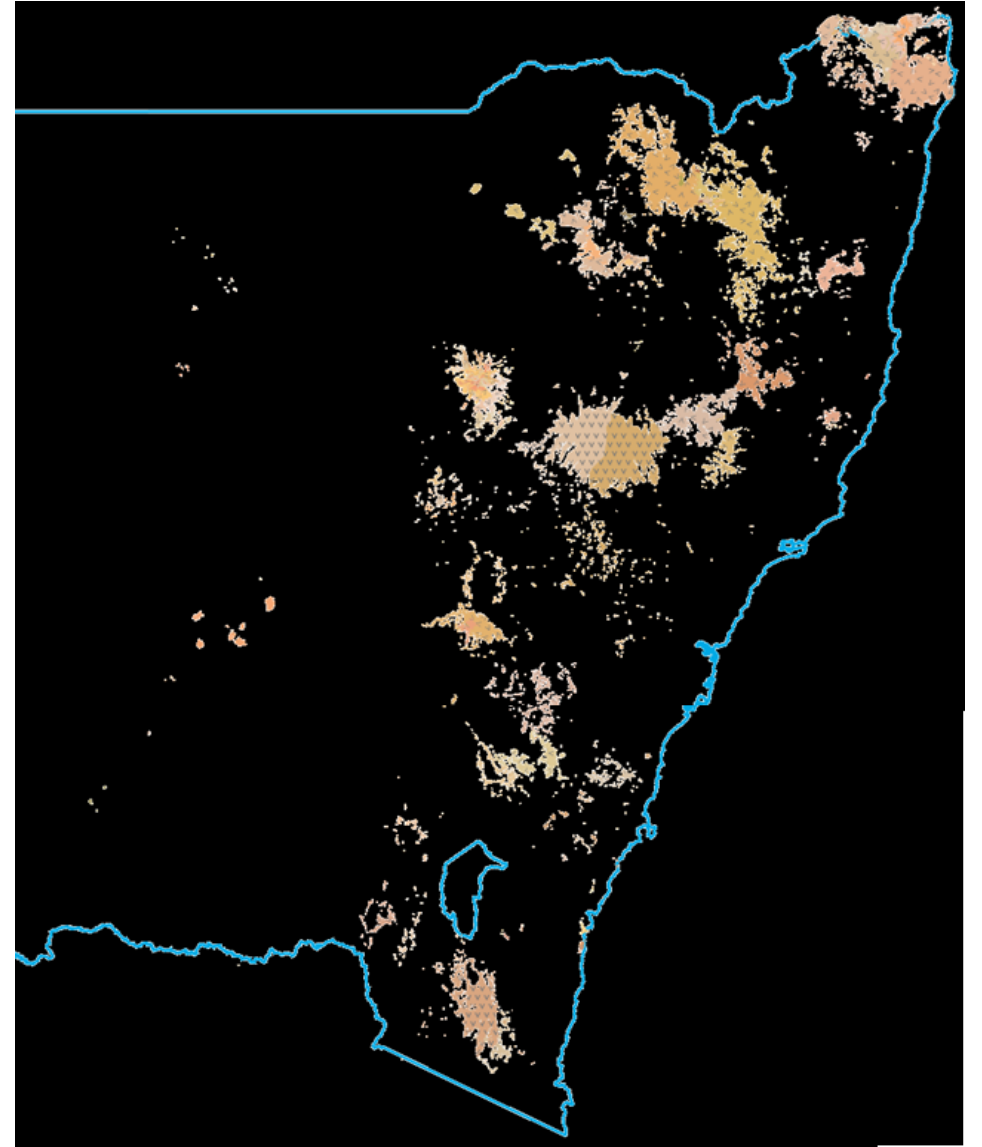
Compared with Mesozoic Toongi

Source: Spandler and Morris, 2016

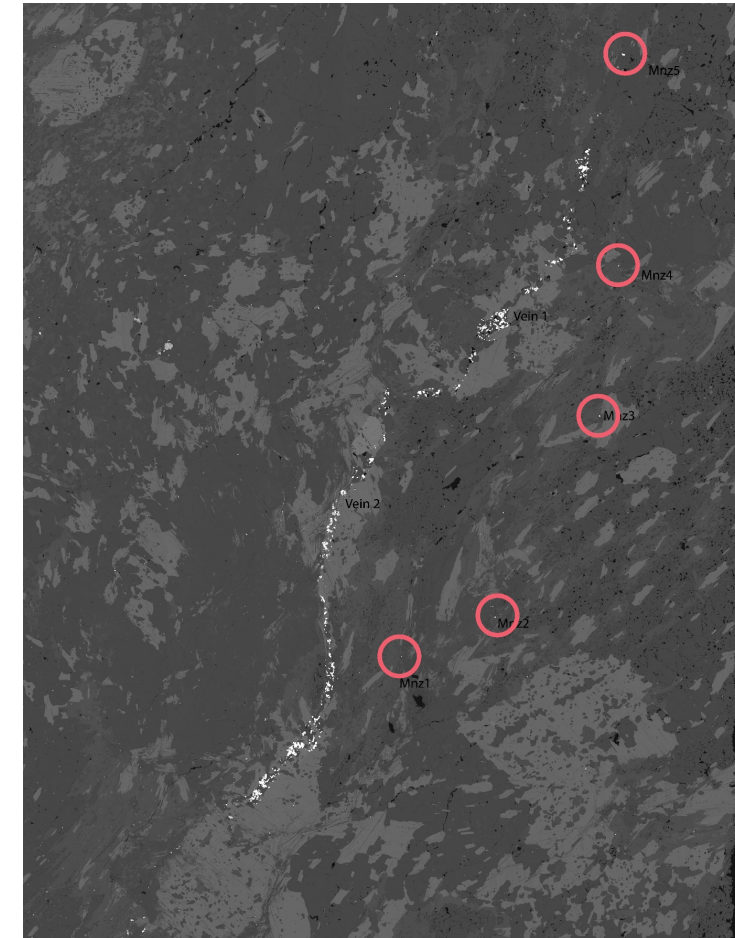
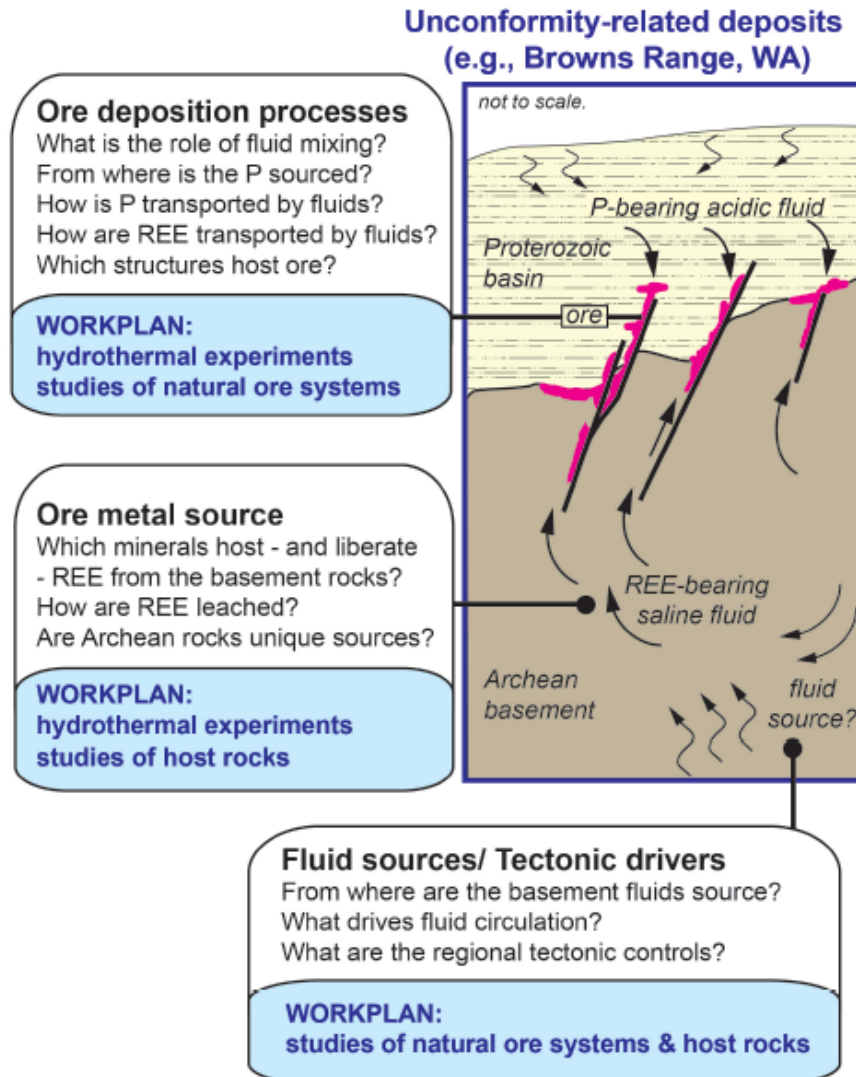


REE – peralkaline/alkaline igneous association

- Updated Cenozoic layer in MinView
- Paper on volcanism in Quarterly Notes
- Updated geochemical database
- Mineral system model on REE–Zr–Nb
- Comparative geochemical studies
- ARC linkage on REE mineralisation

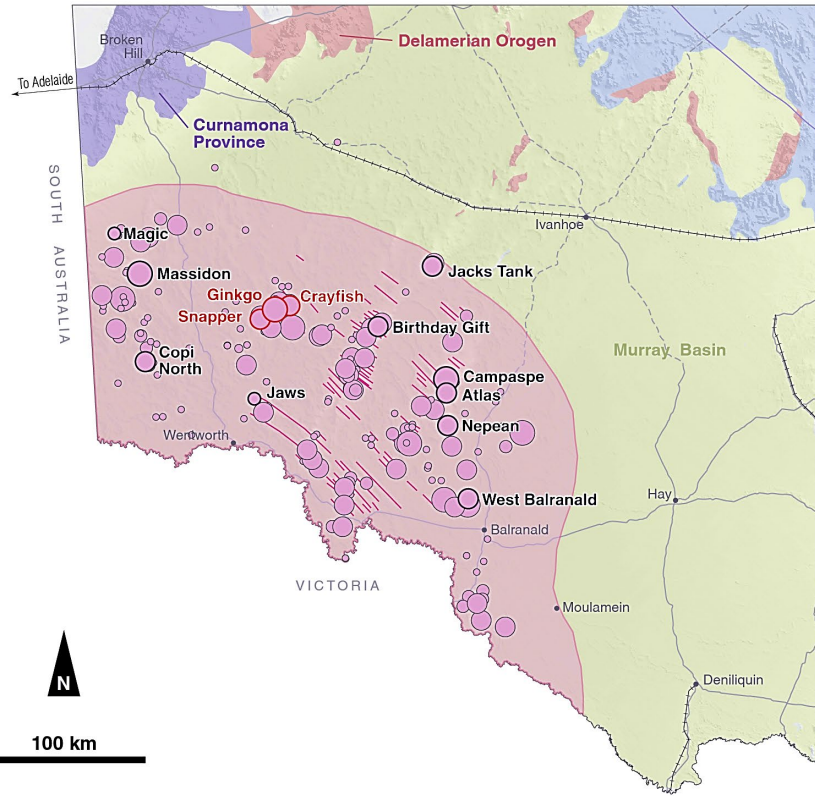


REE – Proterozoic monazite



Back Scattered Electron image of a narrow monazite/xenotime vein in Paragon Group metasedimentary rocks. Image is approximately 0.5 cm wide.

Heavy Mineral Sands – titanium, zirconium

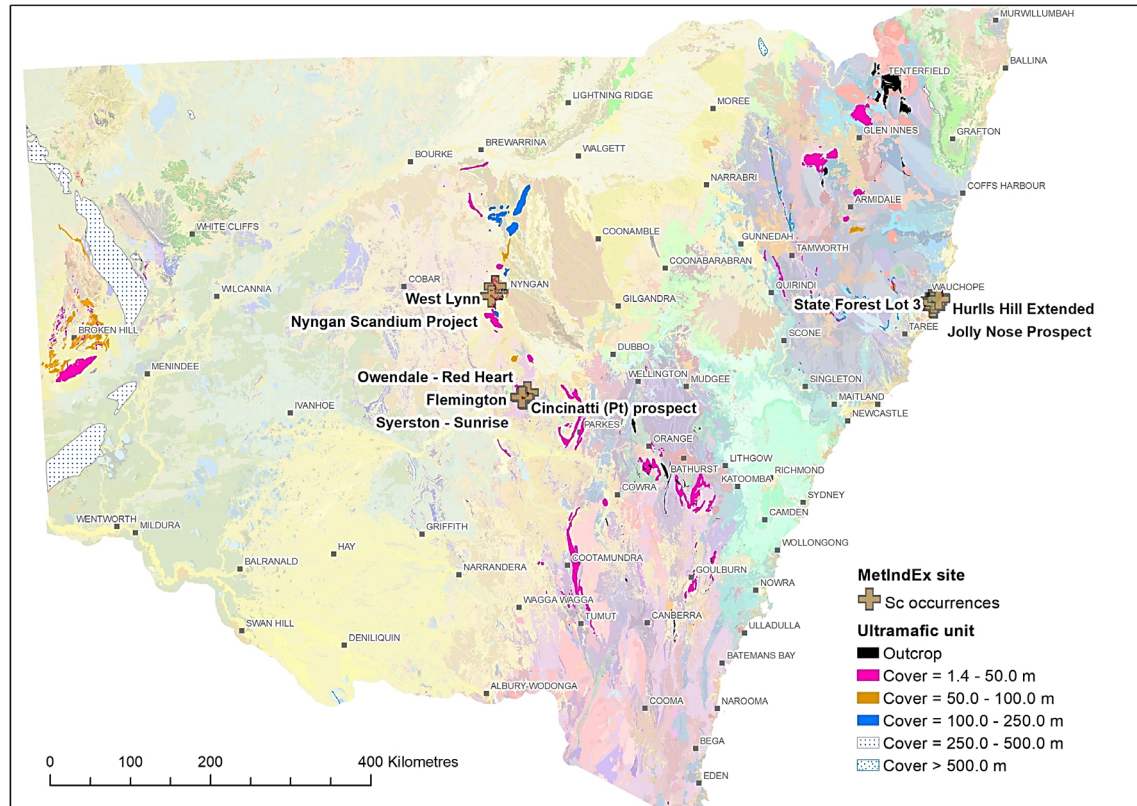


- REFERENCE
- Heavy mineral sand occurrence
 - Small
 - Medium
 - Large
 - Very large
 - Ginkgo ○ Operating mine
 - Atlas ○ Deposit
 - Strand line deposit
 - Approximate extent of Loxton-Parilla Sands
 - +++ Railway
 - Major road, sealed
 - - - Major road, unsealed
 - Gas pipeline

- World class mining operations
- Also potential for REE-bearing heavy mineral sands
- Murray Basin potential now highlighted in new MinView ‘Critical Minerals View’

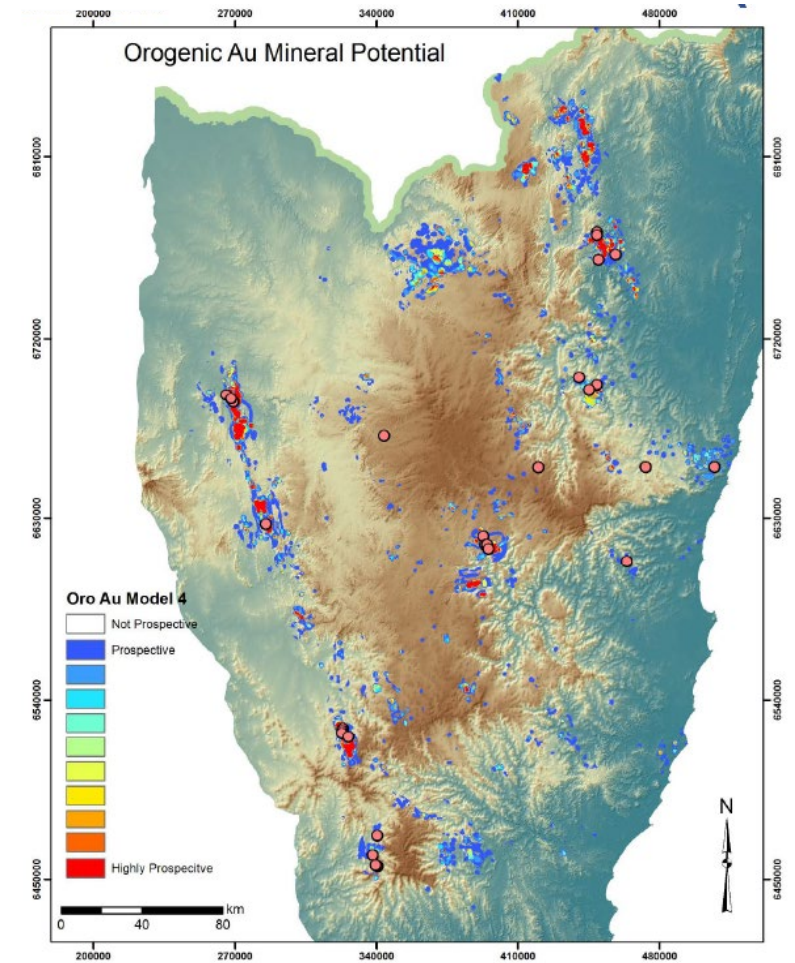
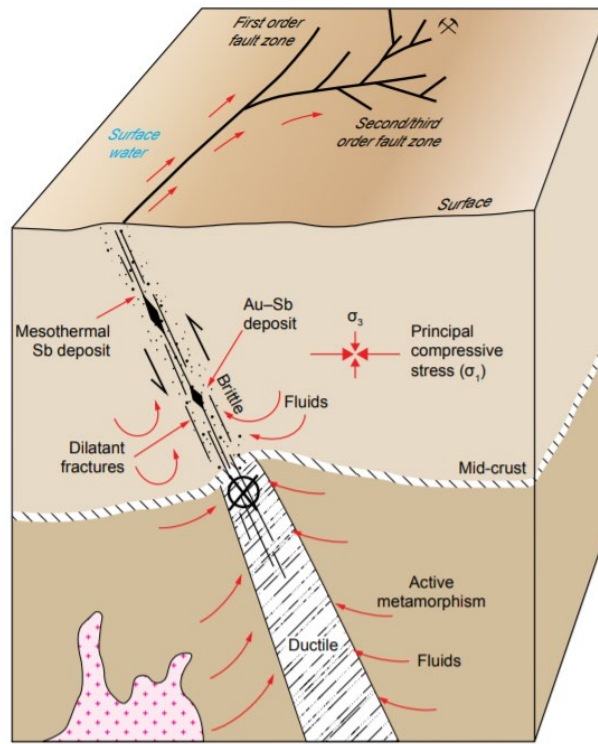
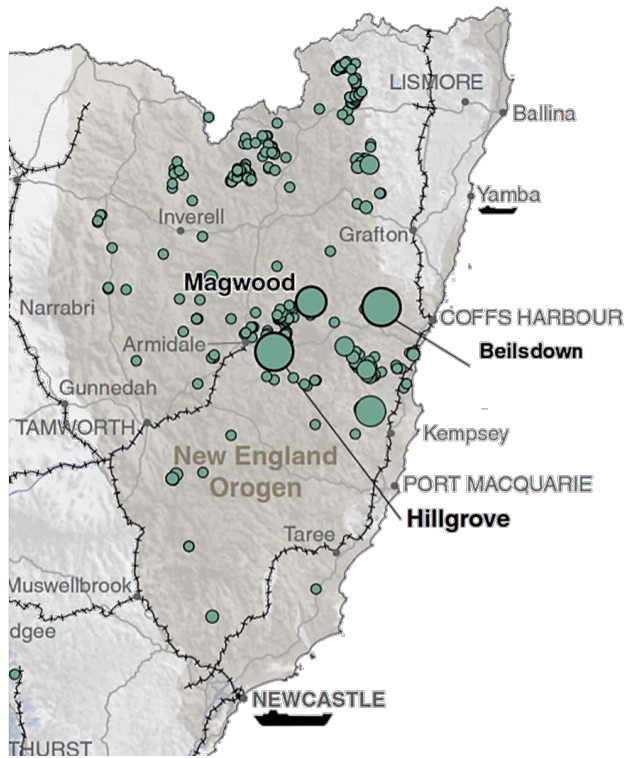


Scandium-enriched regolith-hosted deposits



- Sc-enriched parent-rock composition is a necessary precondition.
- Clinopyroxene is the dominant rock-forming mineral enriched in Sc. Ni and Co are mainly contained in olivine.
- Mafic–ultramafic intrusions have undergone a prolonged weathering history.
- Associated with deeply weathered Ordovician to earliest Silurian Alaskan-type mafic–ultramafic complexes located in the Central Lachlan Orogen.
- Other areas with potential remain untested.
- Potential host rocks are highlighted in the new MinView ‘Critical Minerals View’.

Antimony – New England Orogen



Key minerals for a connected future



Key minerals – copper and gold

“Friedland sees copper supply as a national security issue”

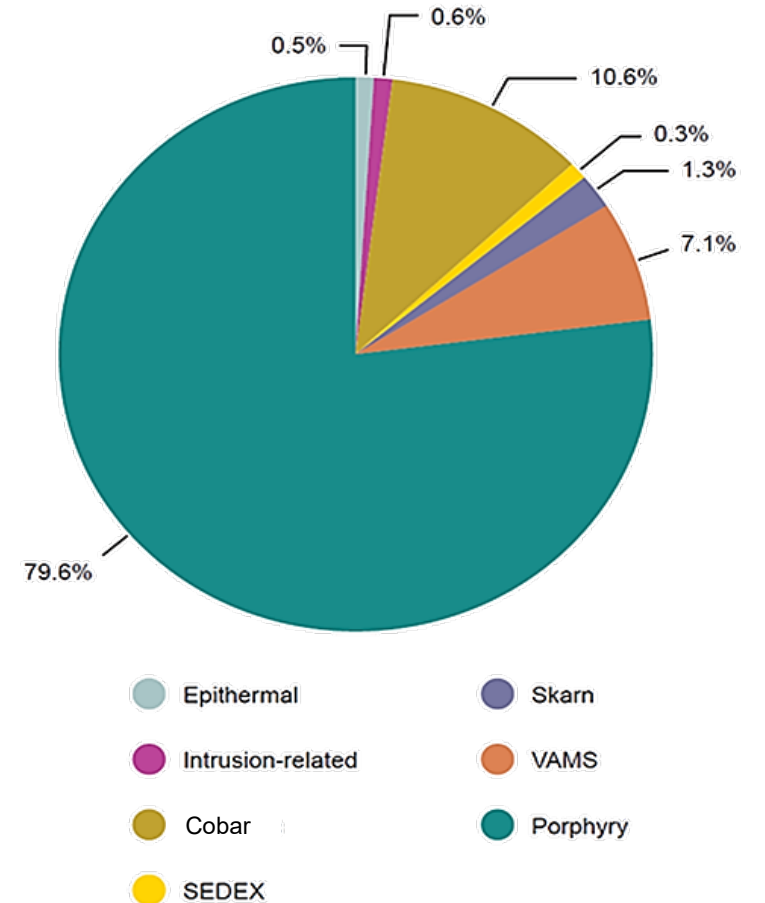
“Copper is the new oil, says Goldman Sachs”

Source: MiningNews.net

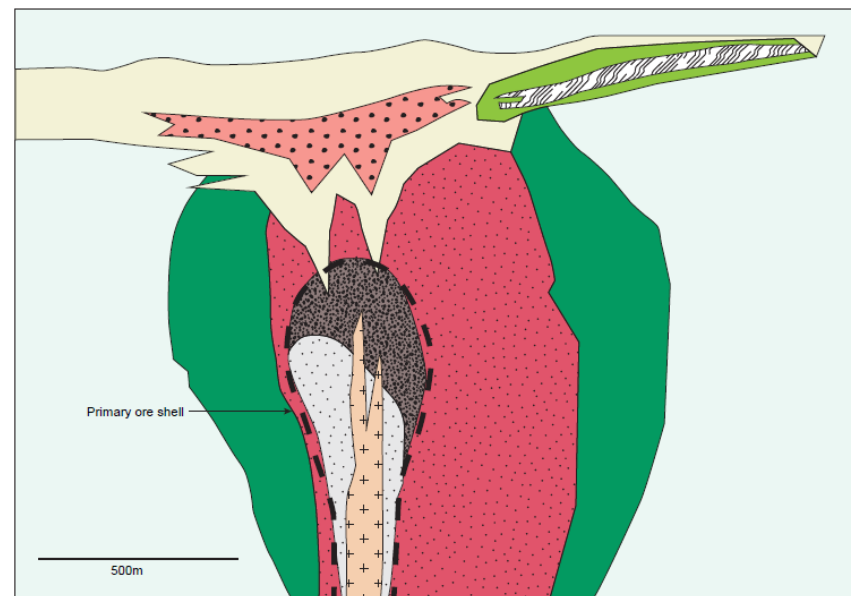


Copper endowment (past production + resources) for NSW, classified by deposit type

Total endowment >19.6 Mt; current resources >17 Mt



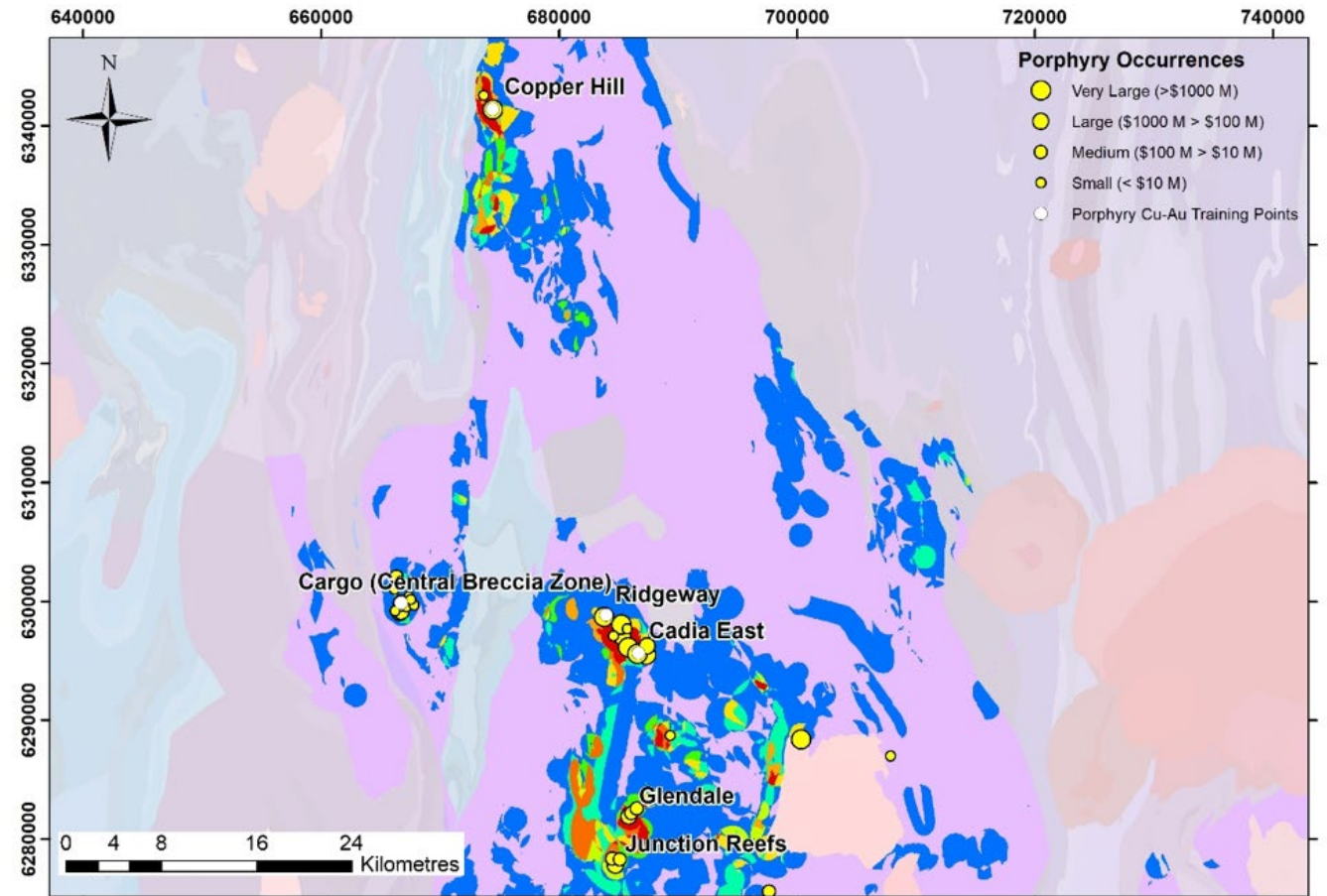
Copper – Macquarie Arc Cu–Au (Mo Re)



Reference

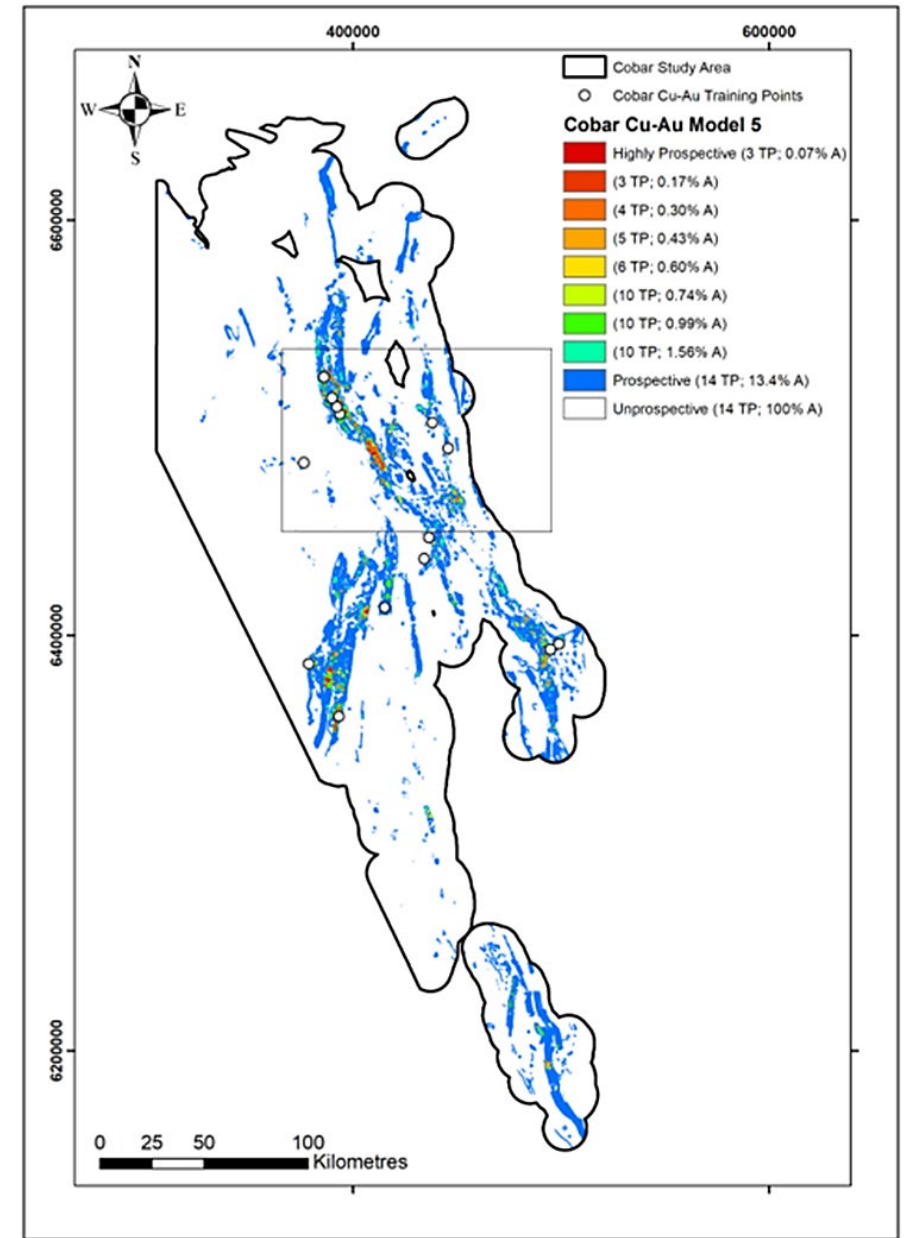
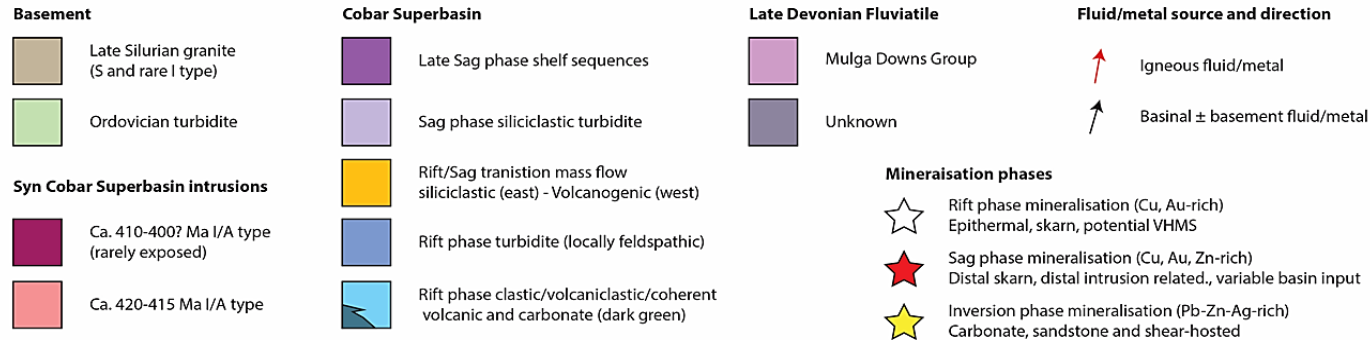
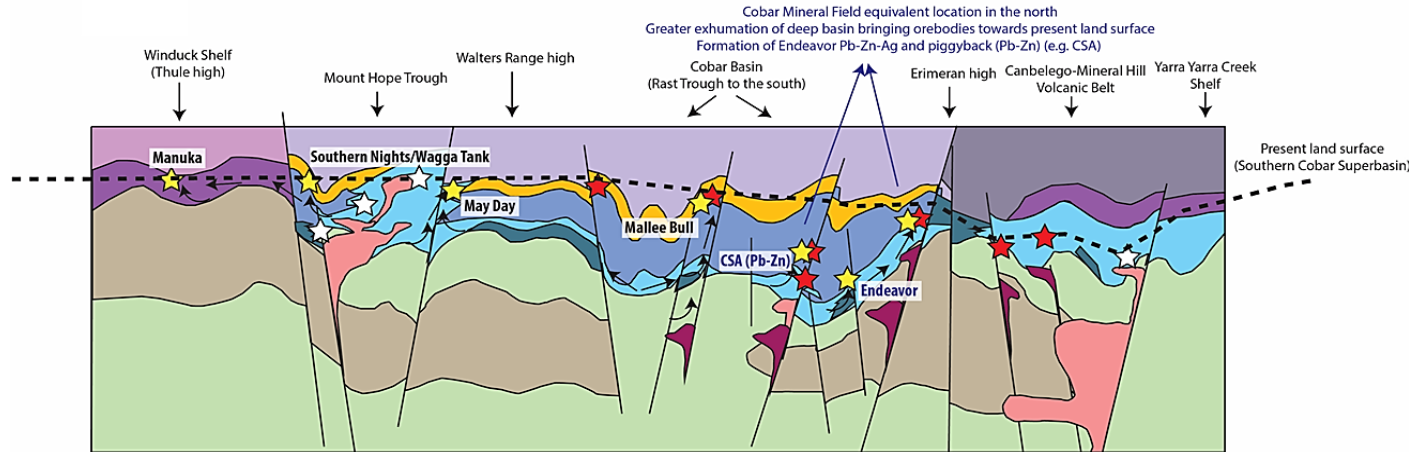
	Distal propylitic (chl-carbzmztpi)		Outer propylitic (ab-act-qz-carb-py)
	Skarn (py-hm-mt-chl-carb-gt)		Inner propylitic (ab-chl-act-epi-hm-qz)
	Skarn propylitic (epi-py)		Outer calc-potassic (Kf-chl-bt-ab-act-qtz-cp)
	Alkalic lithocap (ab-kf-ser-carbv-py-tm)		Inner calc-potassic (bt-act-mt-kf-ab-qtz-bn)
	Sodic (ab-qz-hm)		Monzonite intrusion

2020_062



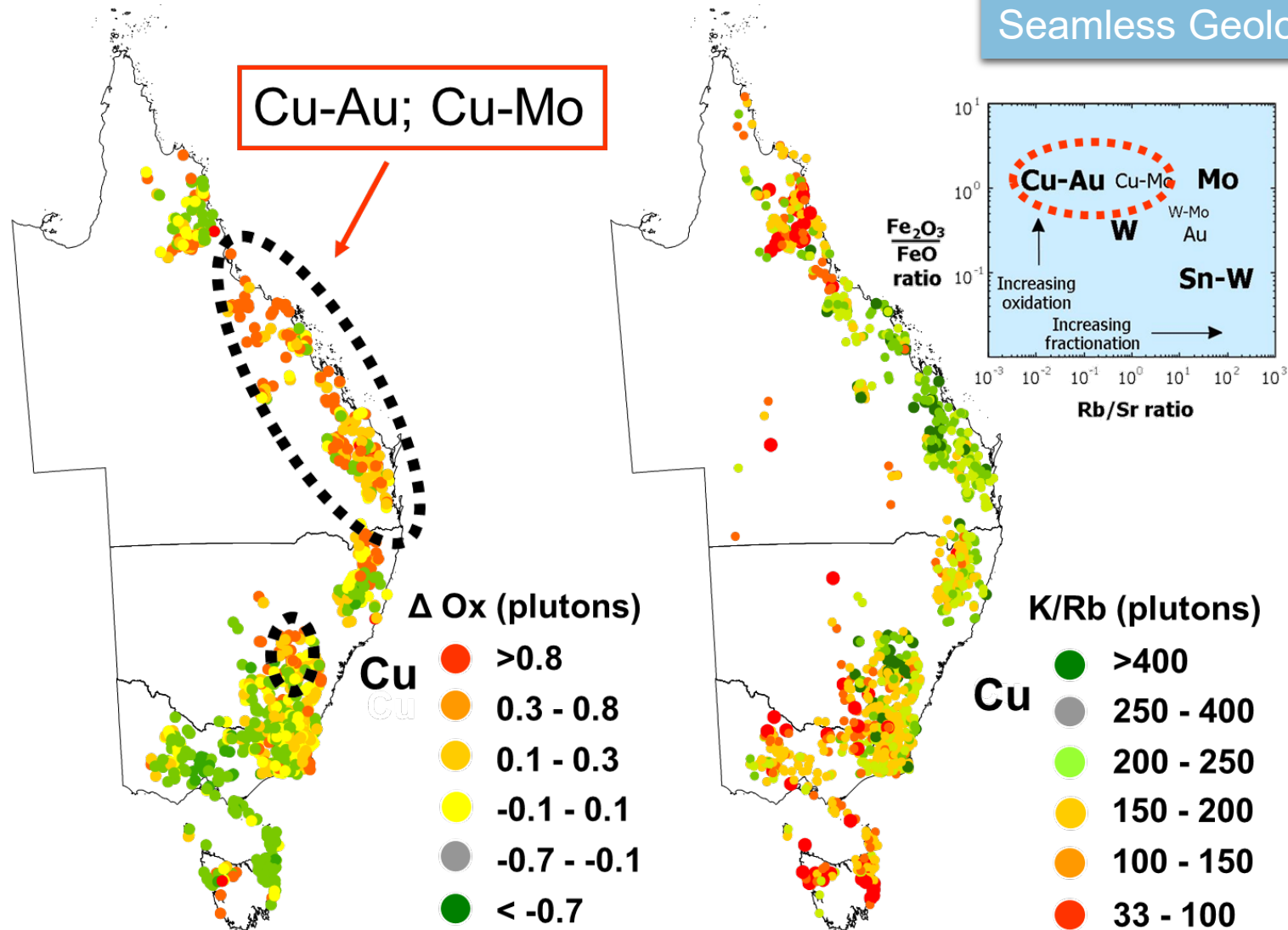
Copper – Cobar Cu Au

Southern Cobar Superbasin ca. 390-380 Ma
(Inversion phase)



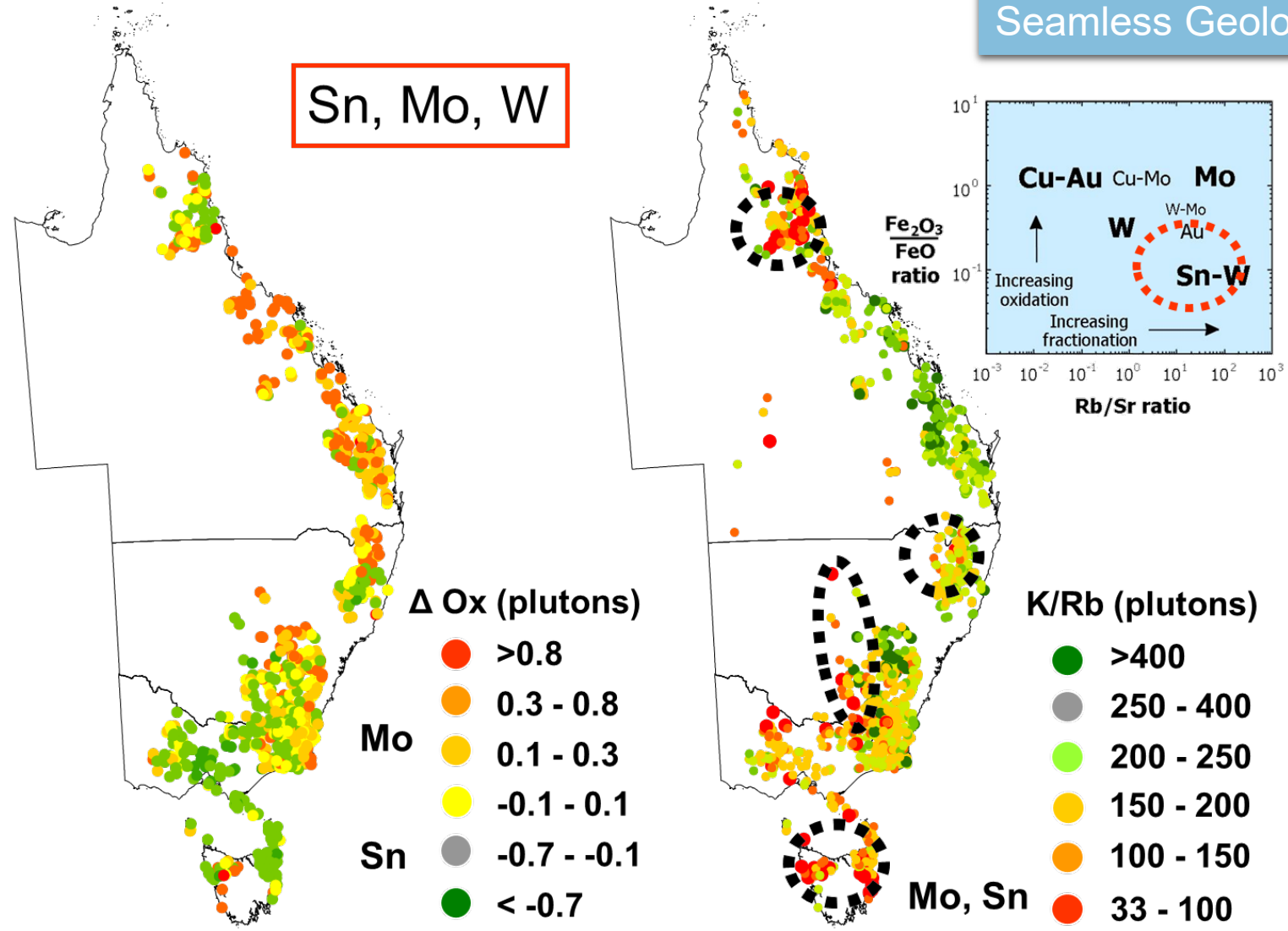
Magmatic fertility studies

New magmatic fertility parameters now available for western Lachlan magmatic rocks in the latest NSW Seamless Geology release (V2.1).

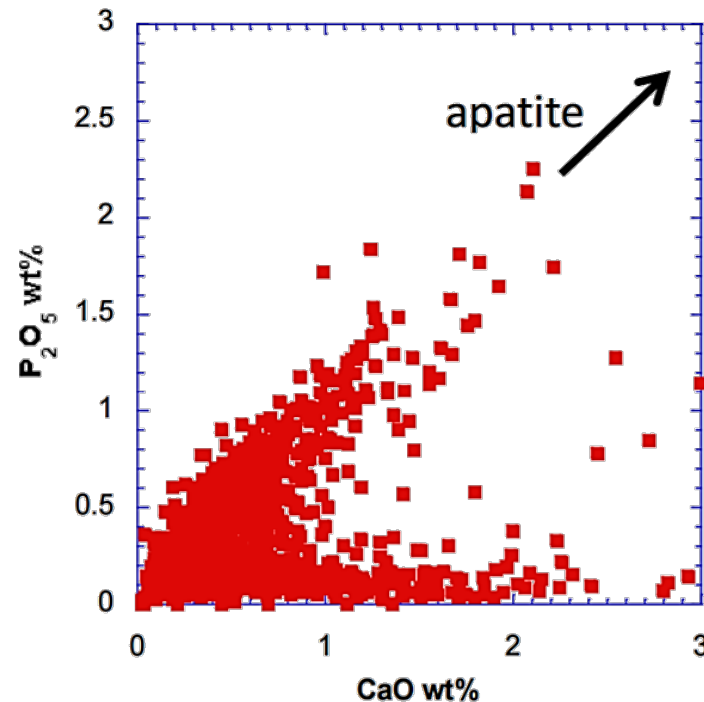
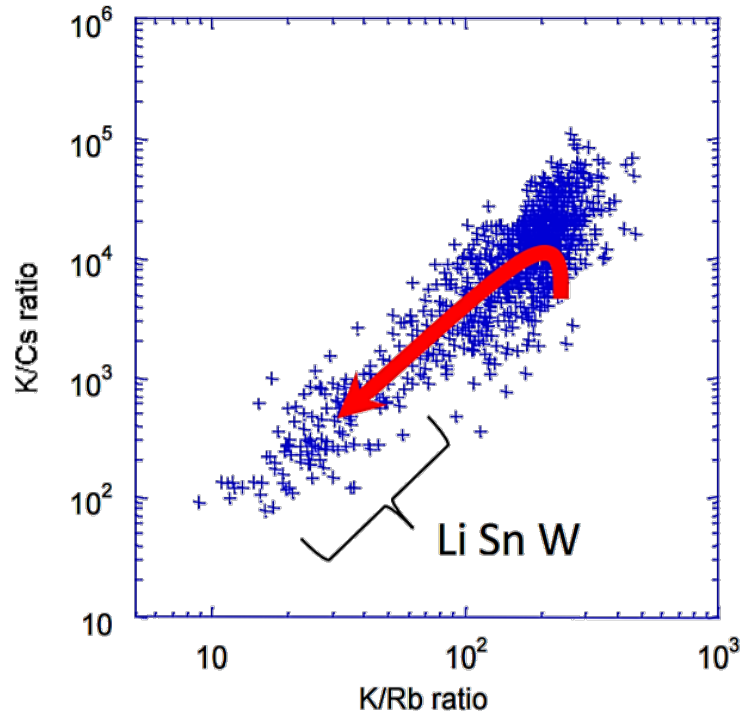


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Magmatic fertility studies e.g. Broken Hill pegmatites



- Petrology and geochemistry establish strongly peraluminous trends.
- Fractionate to extreme compositions with very low REE contents.
- Sn, Nb, W and Ta are strongly enriched.
- REE potential is very low due to geochemical constraints.

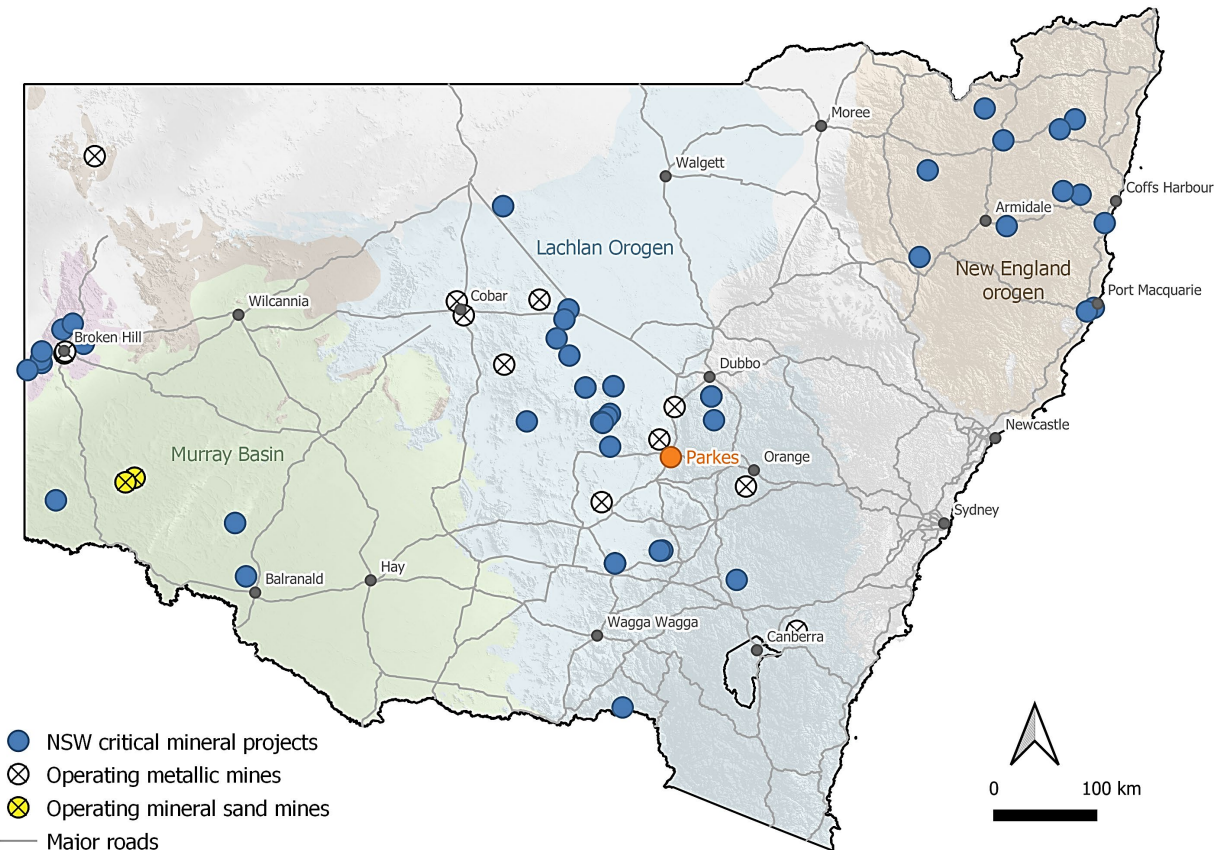
Critical mineral prospects and projects



Critical minerals priority projects shortlist

- 10 advanced critical mineral projects
- 7 project summaries included in the Australian Critical Minerals Prospectus 2020 (in red)

Project	Critical Minerals
Dubbo	REE (+ Zr, Nb, Hf, Ta)
Narraburra	REE (+ Zr, Nb, Hf, Th, Ga, Li)
Broken Hill Cobalt (Thackaringa)	Co
Nyngan Scandium	Sc
Platina Scandium (Owendale)	Sc
Sunrise	Co, Sc
Hillgrove	Sb
Atlas-Campaspe	Minerals sands (Ti, Zr)
Balranald	Minerals sands (Ti, Zr)
Copi	Minerals sands (Ti, Zr)



GSNSW critical mineral projects



GSNSW critical minerals projects

- MinView 'Critical Minerals View' showing Critical Mineral projects, prospects and potential
- Industry-focused NSW Critical Minerals Prospectus
- Baseline data: EFTF Mine Tailings Project and in-house analyses
- Magmatic fertility mapping: new release for central Lachlan in NSW Seamless Geology 2.1
- Hyperspectral mapping of prospective host rocks
- Expanded Mineral System Model folio
- ARC REE linkage (Carl Spandler – University of Adelaide)



Commodity flyers

Cobalt and scandium

Opportunities in New South Wales, Australia

A small image showing a mineral sample with the text 'Co & Sc' overlaid in white.

Antimony

Opportunities in New South Wales, Australia

A small image showing a mineral sample with the text 'Sb' overlaid in white.

Tin and tungsten

Opportunities in New South Wales, Australia

A small image showing a mineral sample with the text 'Sn & W' overlaid in white.

Rare earth elements

Opportunities in New South Wales, Australia



Heavy mineral sands

Opportunities in New South Wales, Australia





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