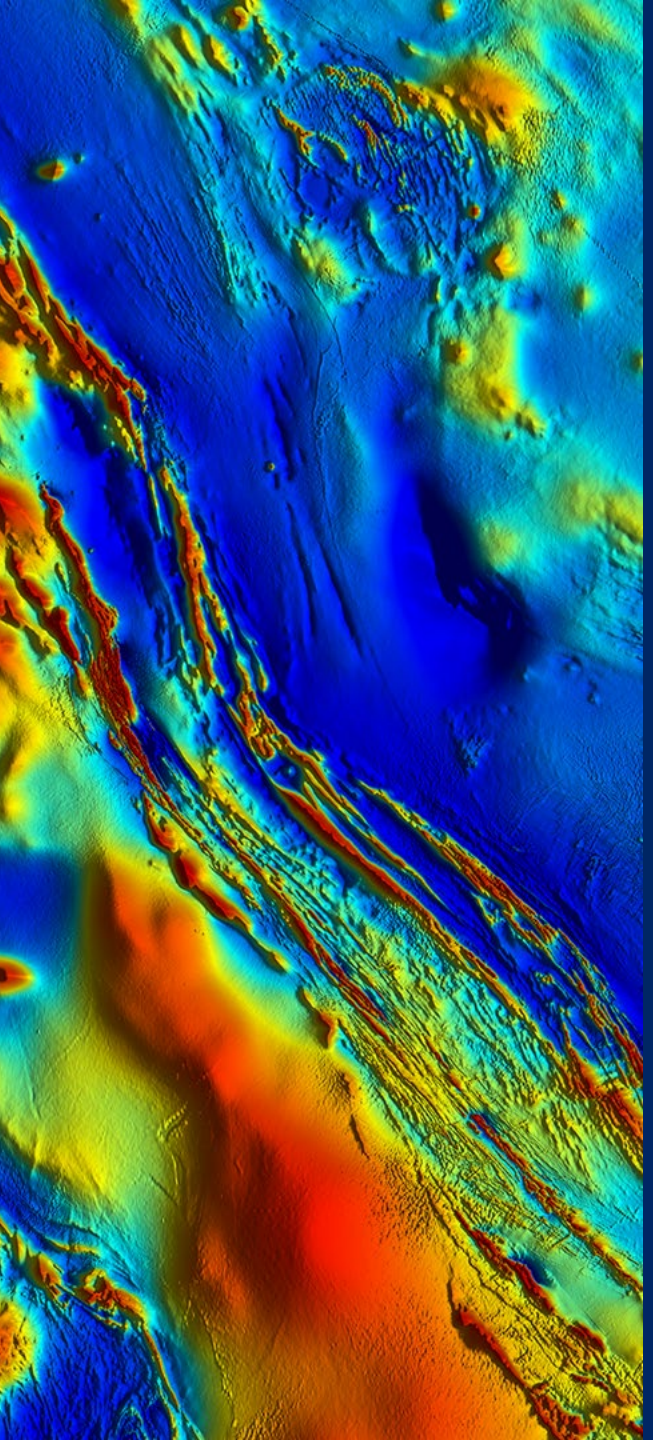

Peralkaline volcanic-hosted critical metal resources in NSW

What they are, why they form, and how to find them

Brenainn Simpson
Senior Geoscientist (Mineral Systems)

10 May 2024

NSW GOVERNMENT

Acknowledgements

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- Our partners:

THE UNIVERSITY of ADELAIDE

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

THE AUSTRALIAN NATIONAL UNIVERSITY

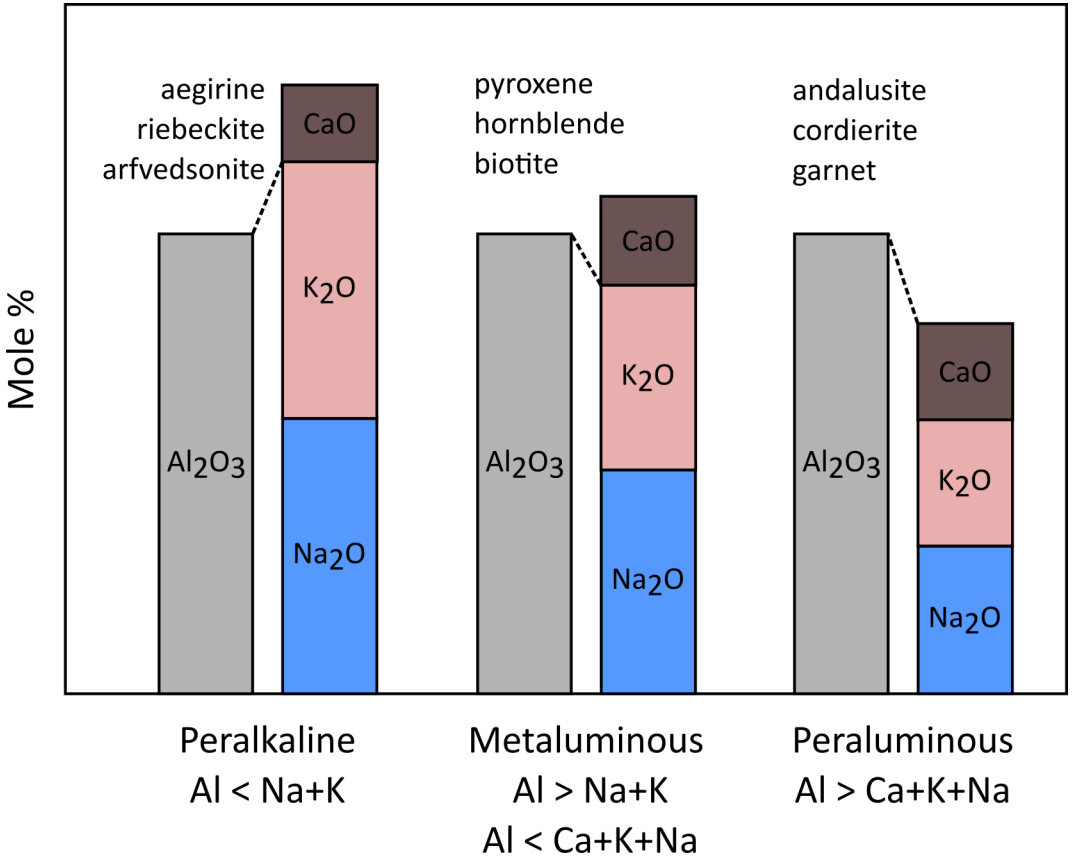
ASM Australian Strategic Materials

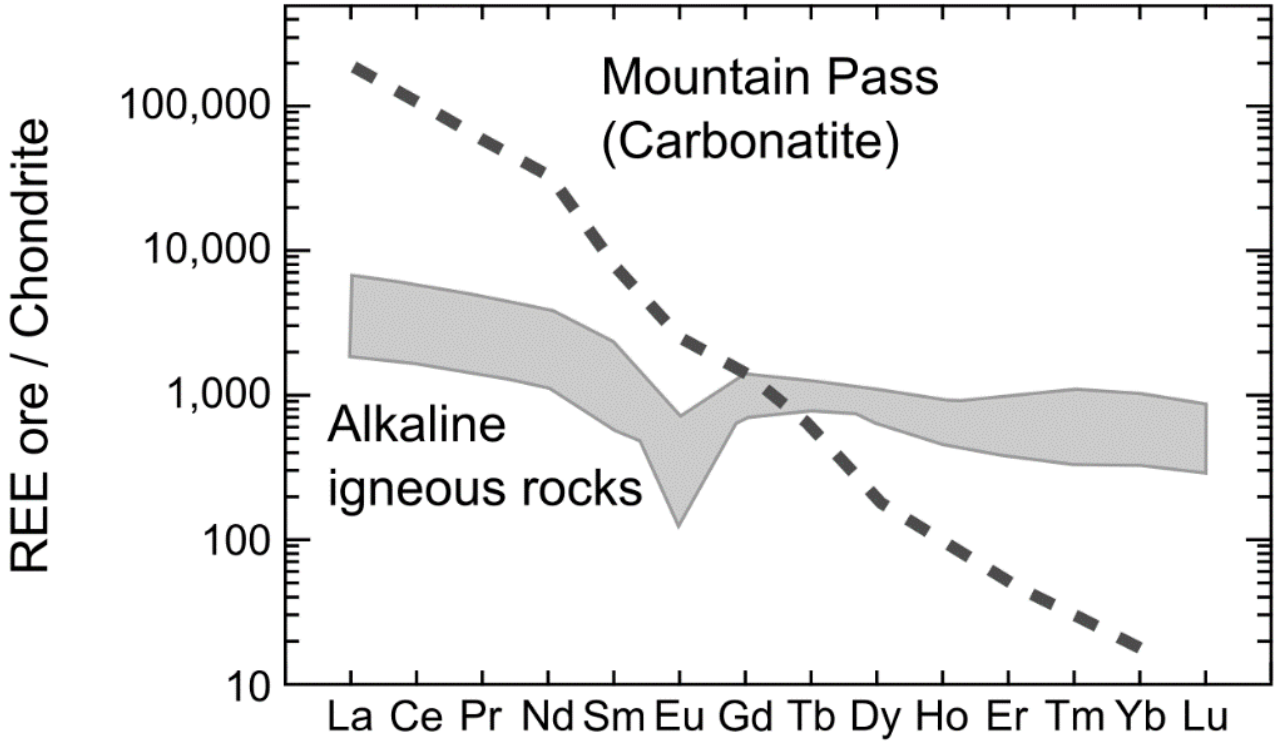
Low-grade bulk-tonnage critical metal resources

Alkaline igneous rocks as a critical metals resource

1

Peralkaline magmas – what are they?

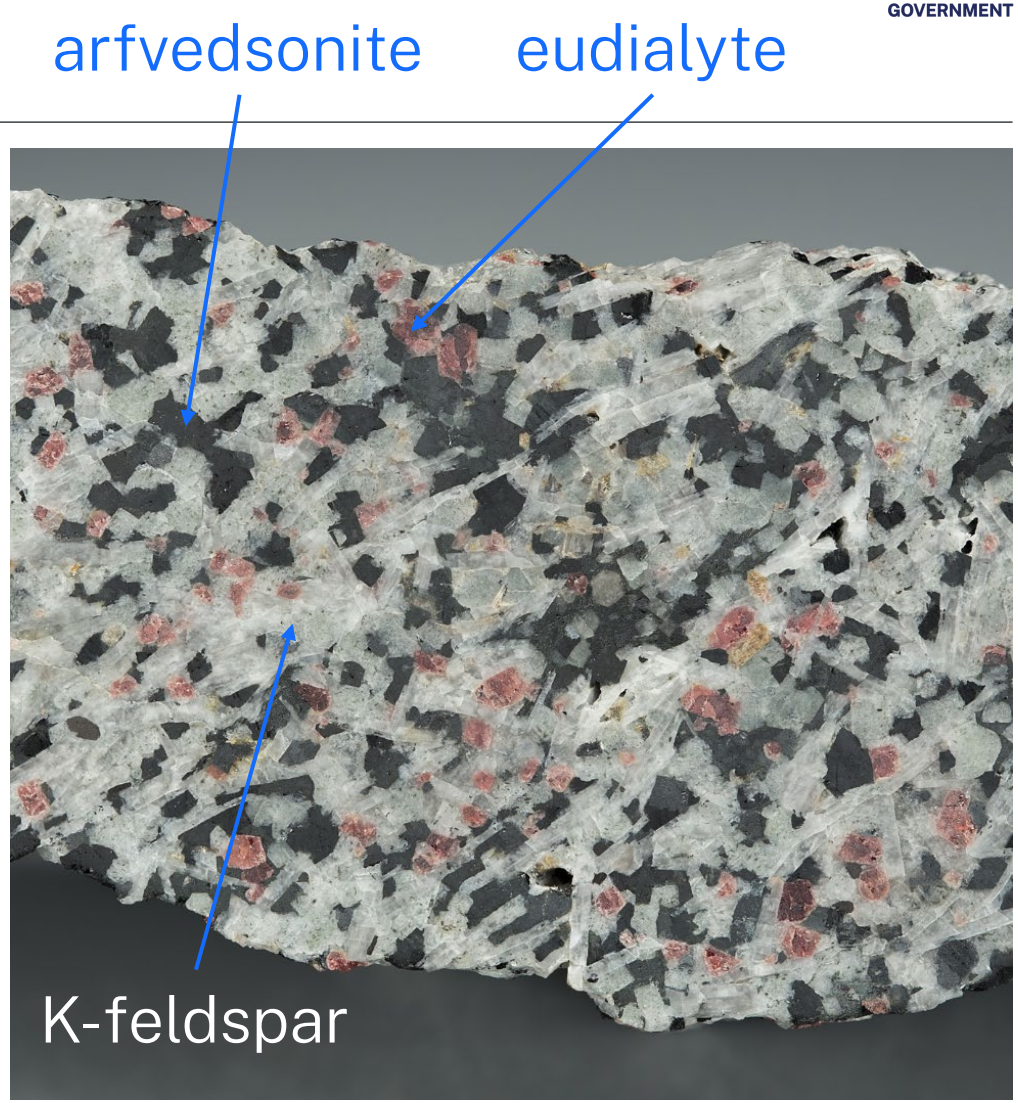




Peralkaline magmas – what are they?

Mineralogy

- Dominated by feldspathoids, feldspars, or a combination of feldspars and quartz
- Na-rich amphiboles and pyroxenes
- Ore minerals
  - Primary igneous minerals: zircon, baddeleyite, eudialyte group minerals (EGMs), apatite, monazite, xenotime, pyrochlore, niobite
  - Secondary (alteration) minerals: REE carbonates, REE bearing clays
  - Weathering can be good for recovery
  - ANSTO have done a lot in recent years!



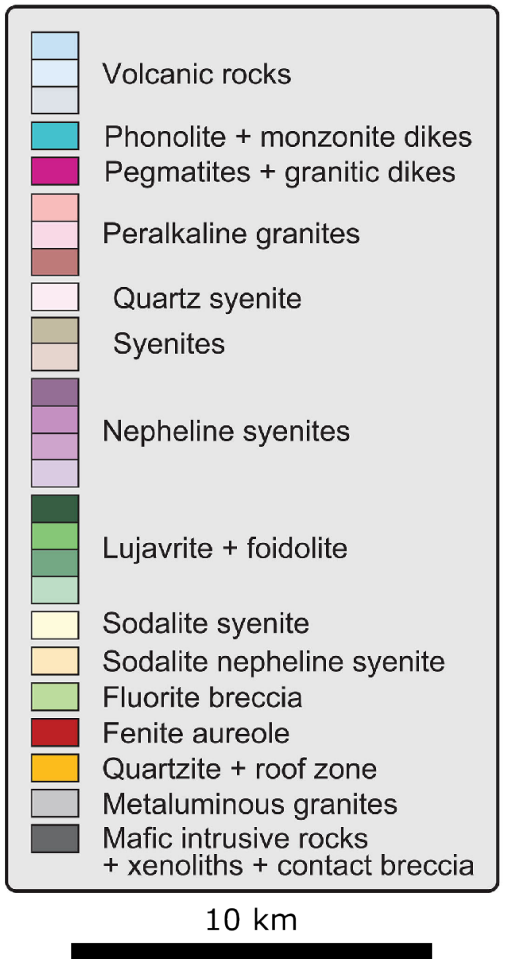
Peralkaline syenite

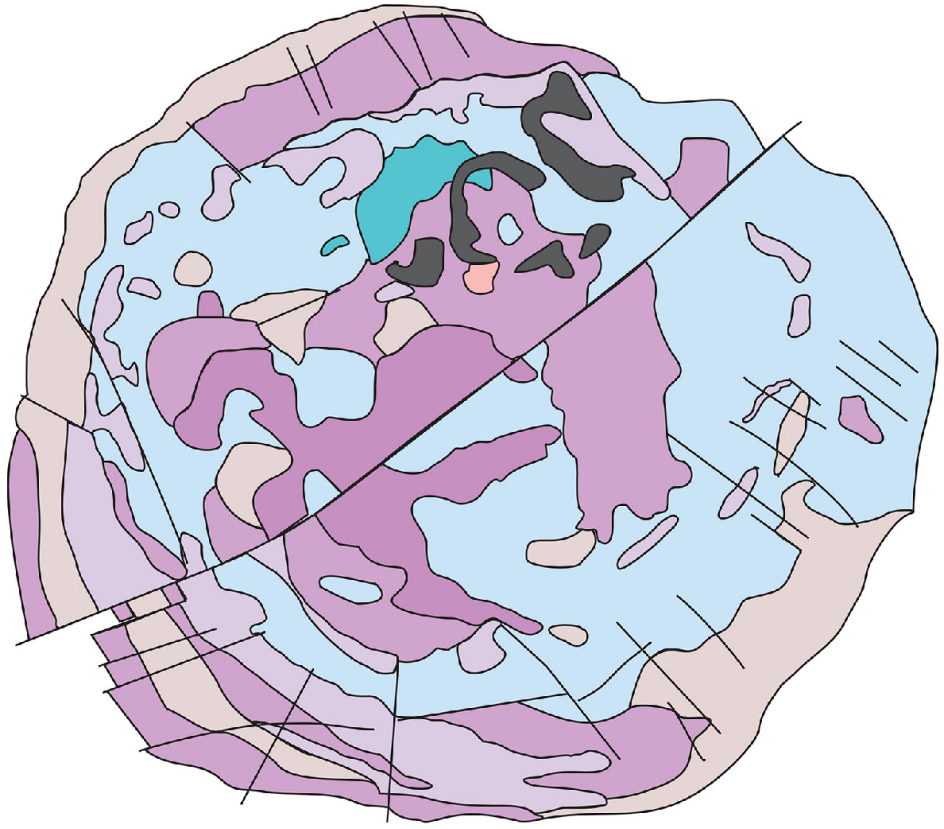
Peralkaline magmas – what are they?

Can be intrusive (plutonic) or extrusive (volcanic)

Intrusions are often zoned and complex!

Volcanic equivalents are homogeneous





Pilanesberg Complex, Pilanesberg Alkaline Province, South Africa

Mesozoic peralkaline volcanism

A new mineral system model for NSW

2

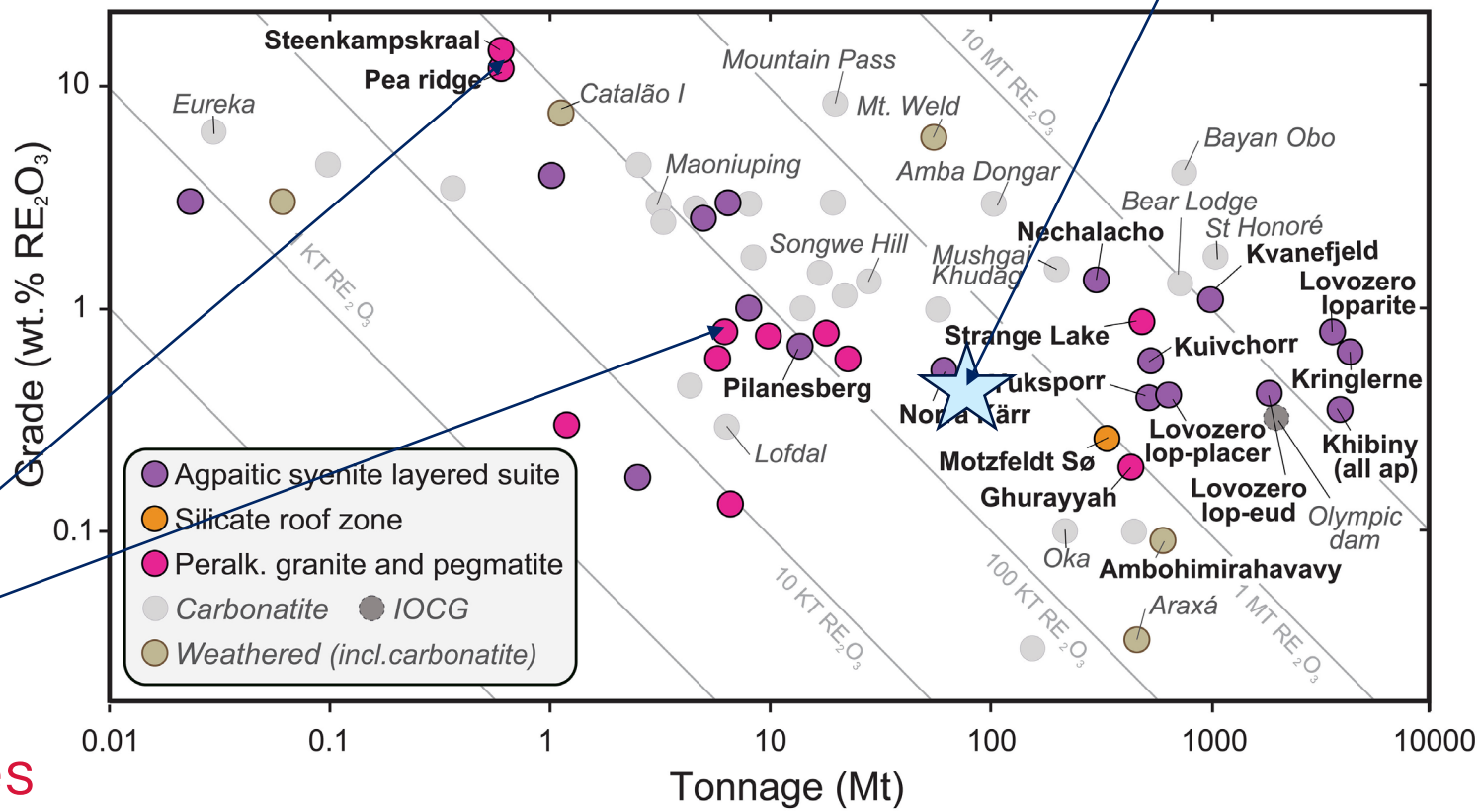
Alkaline-hosted resources in NSW

Toongi (Dubbo)

Alkaline (A-type) magmatism occurs in the Lachlan and New England from the Silurian to the Cenozoic

- Best example is Toongi
- Mesozoic volcanics

Other global peralkaline resources

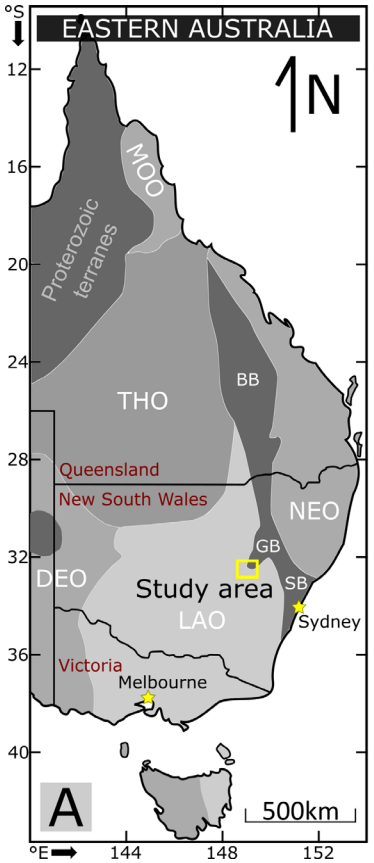


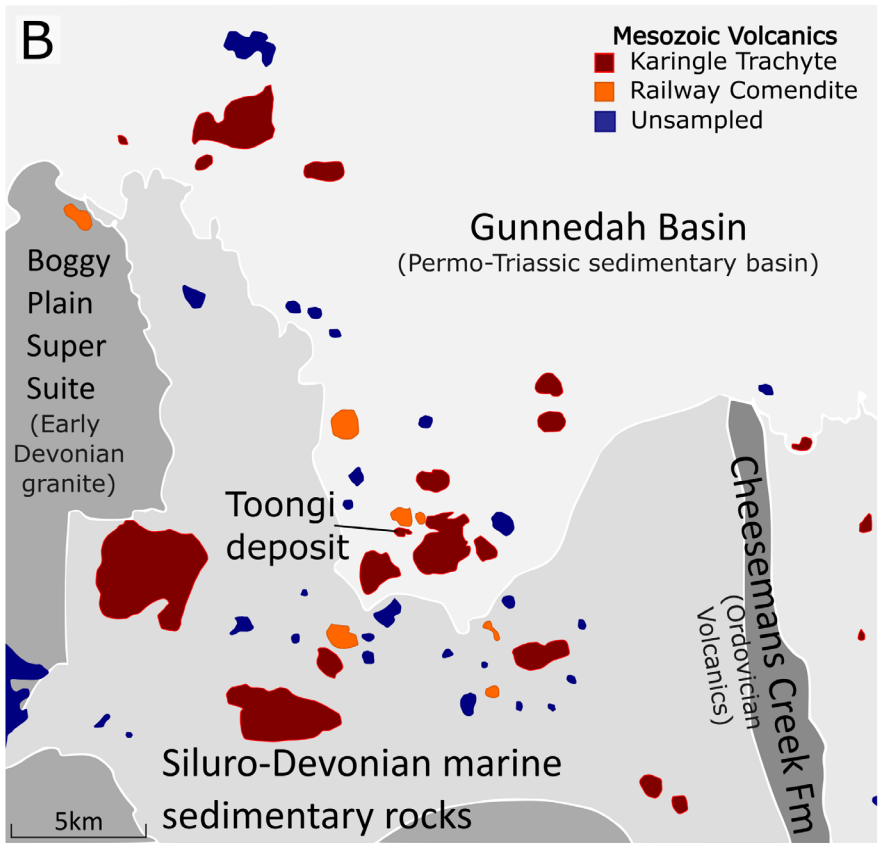
Toongi deposit

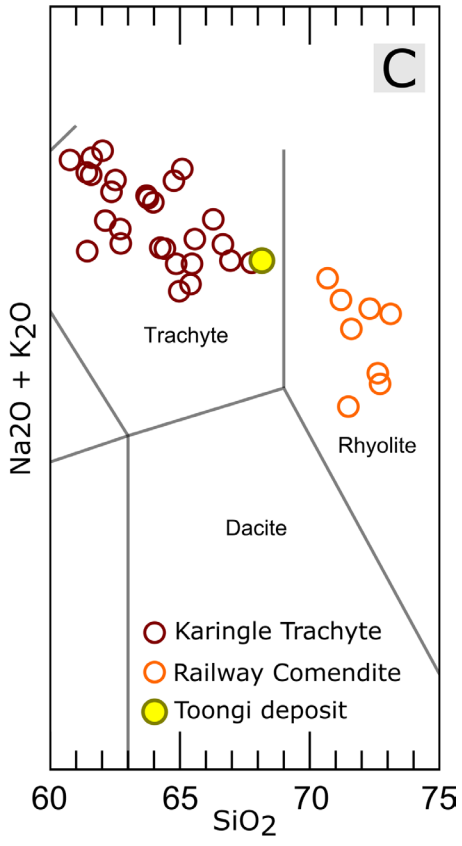
Suite of petrogenetically related peralkaline trachytes and rhyolites (comendite)

Previously ungrouped, now formalised

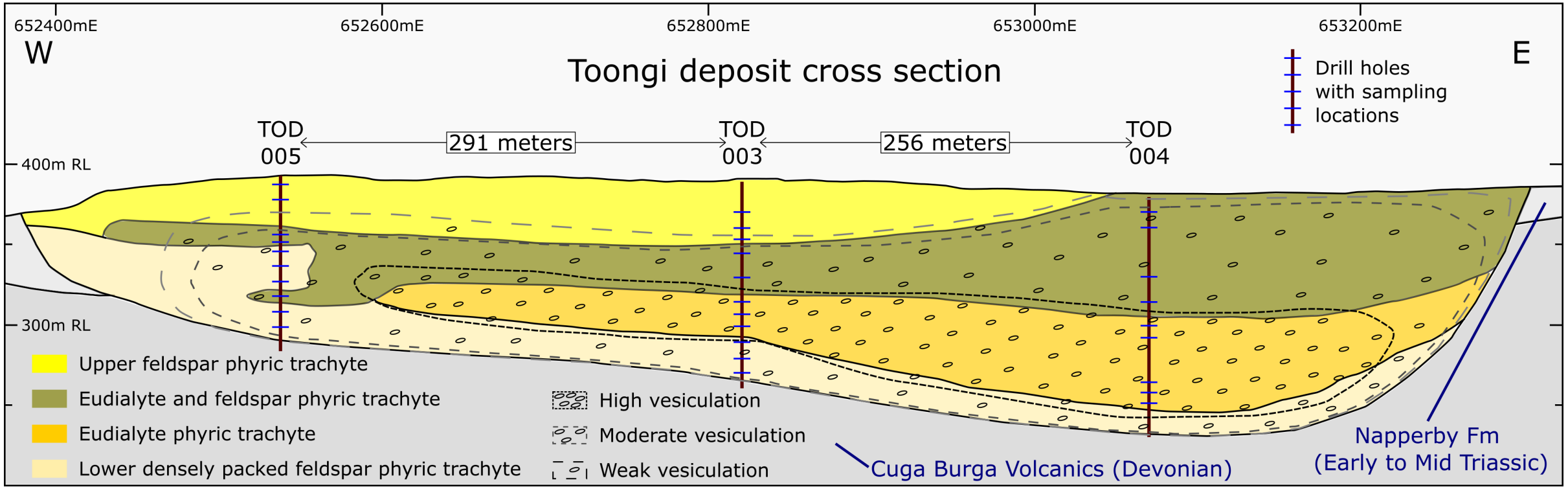
- **Benolong Volcanic Suite**
- **Karingle Trachyte Fm**
- **Railway Comendite Fm**







Toongi deposit

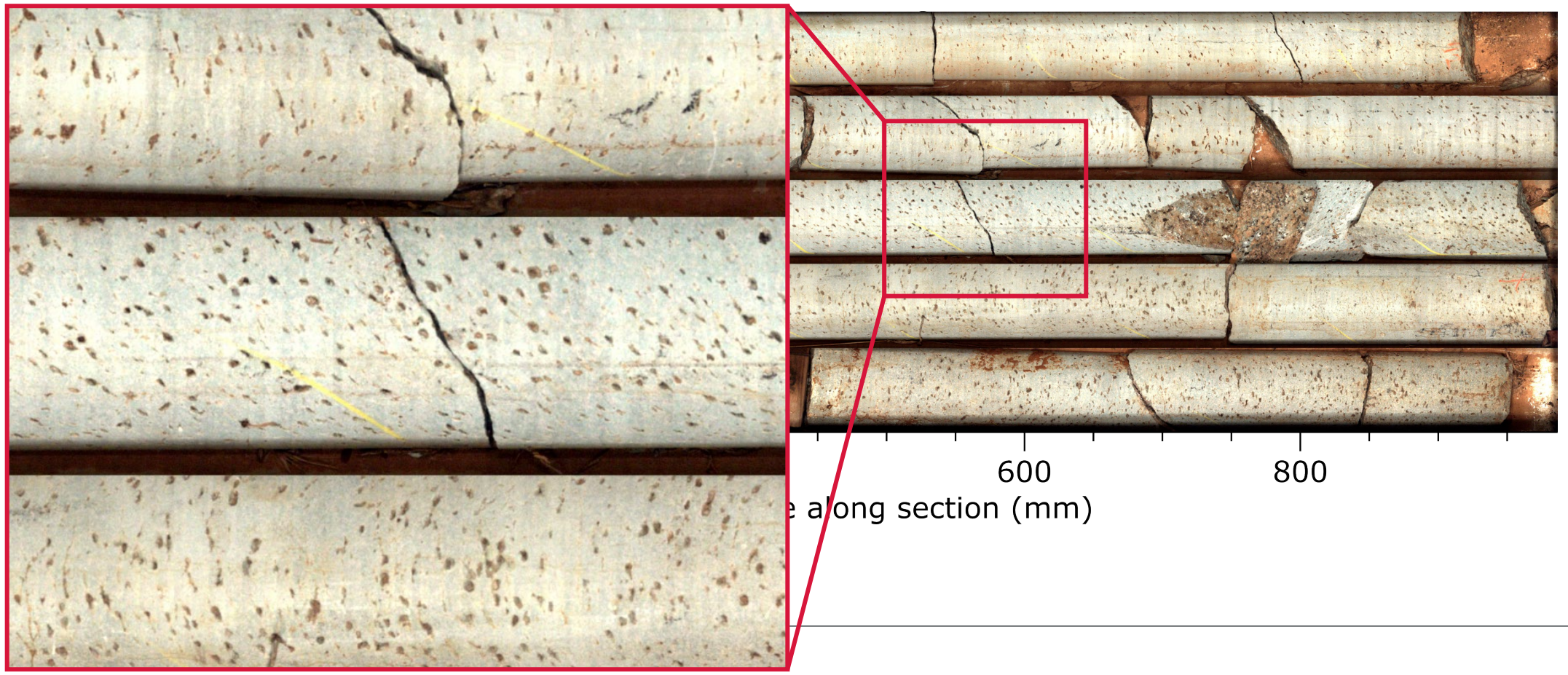


- Becomes intensely vesiculated towards the centre
- Corresponds with size of eudialyte phenocrysts

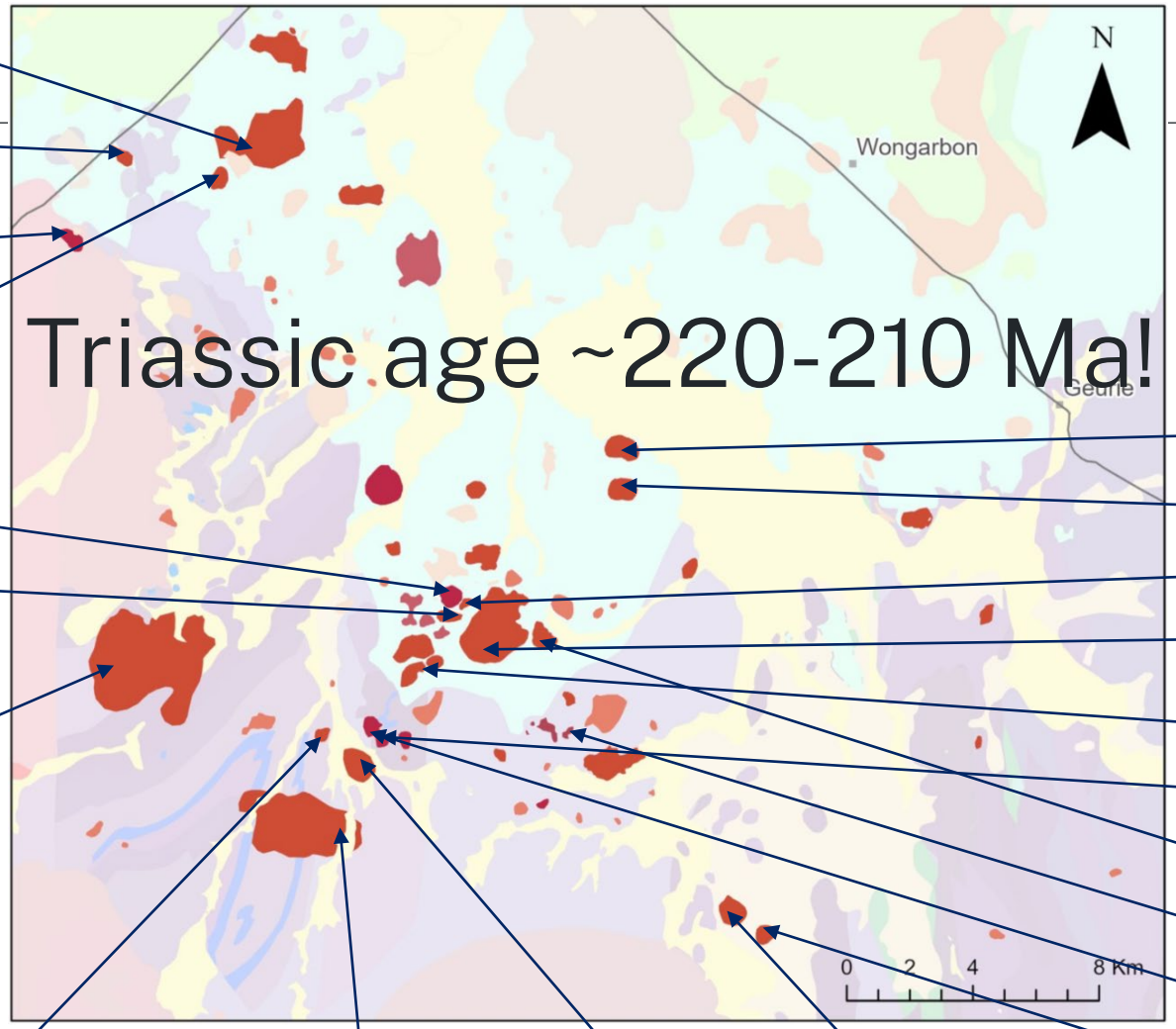
Toongi deposit

Evidence for latest stage volatile retention

Important for metallogenic potential



Geochronology



Triassic age ~220-210 Ma!

Apatite U-Pb
Zircon U-Pb
K-feldspar Ar-Ar

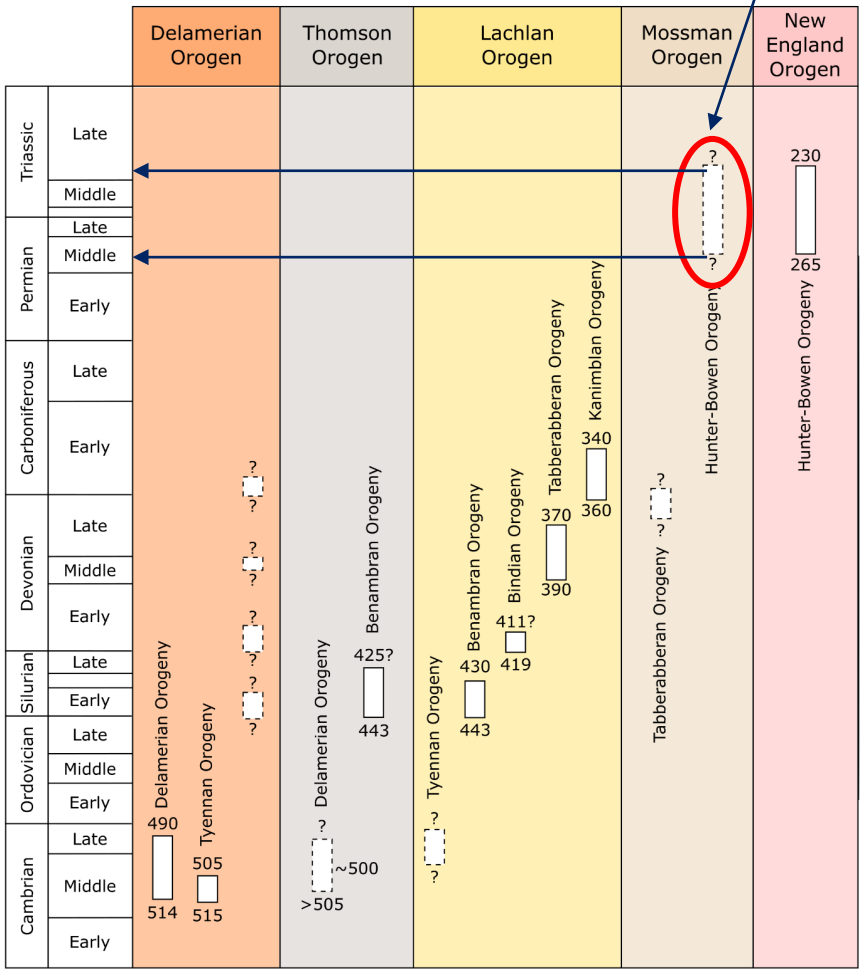
220.1±0.2
219.9±0.2
217.6±0.2
217.6±0.2
205.8±0.2
212.52±4.99
208.5±0.3
214.68±7.40
208.43±7.70
208.9±0.2
210.26±6.70
217.55±2.04
220.56±3.02
219.98±4.57
220.61±4.05 215.2±0.2
207.6±0.2
215.8±0.2
213.2±0.2
210.2±0.2, 210.0
207.6±0.2
216.0
211.0

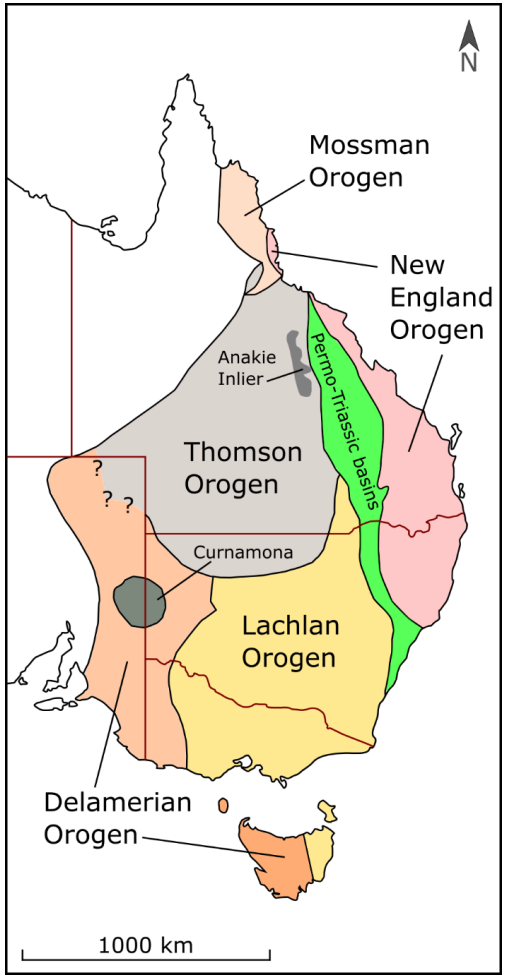
Some Ar-Ar ages will be a bit young due to Ar loss

Tectonic significance

Late Triassic volcanism

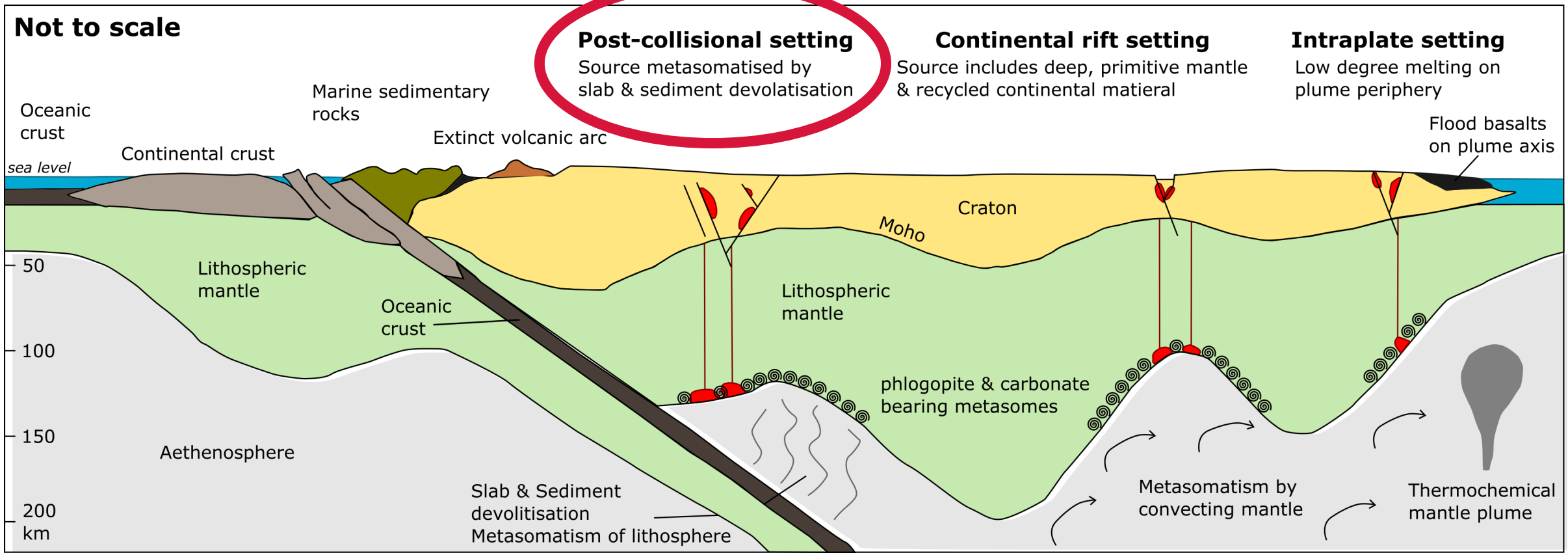
Geochronology consistent with post-orogenic relaxation after the Hunter–Bowen Orogeny





Tectonic significance

Analogue for the Lachlan–New England suture?

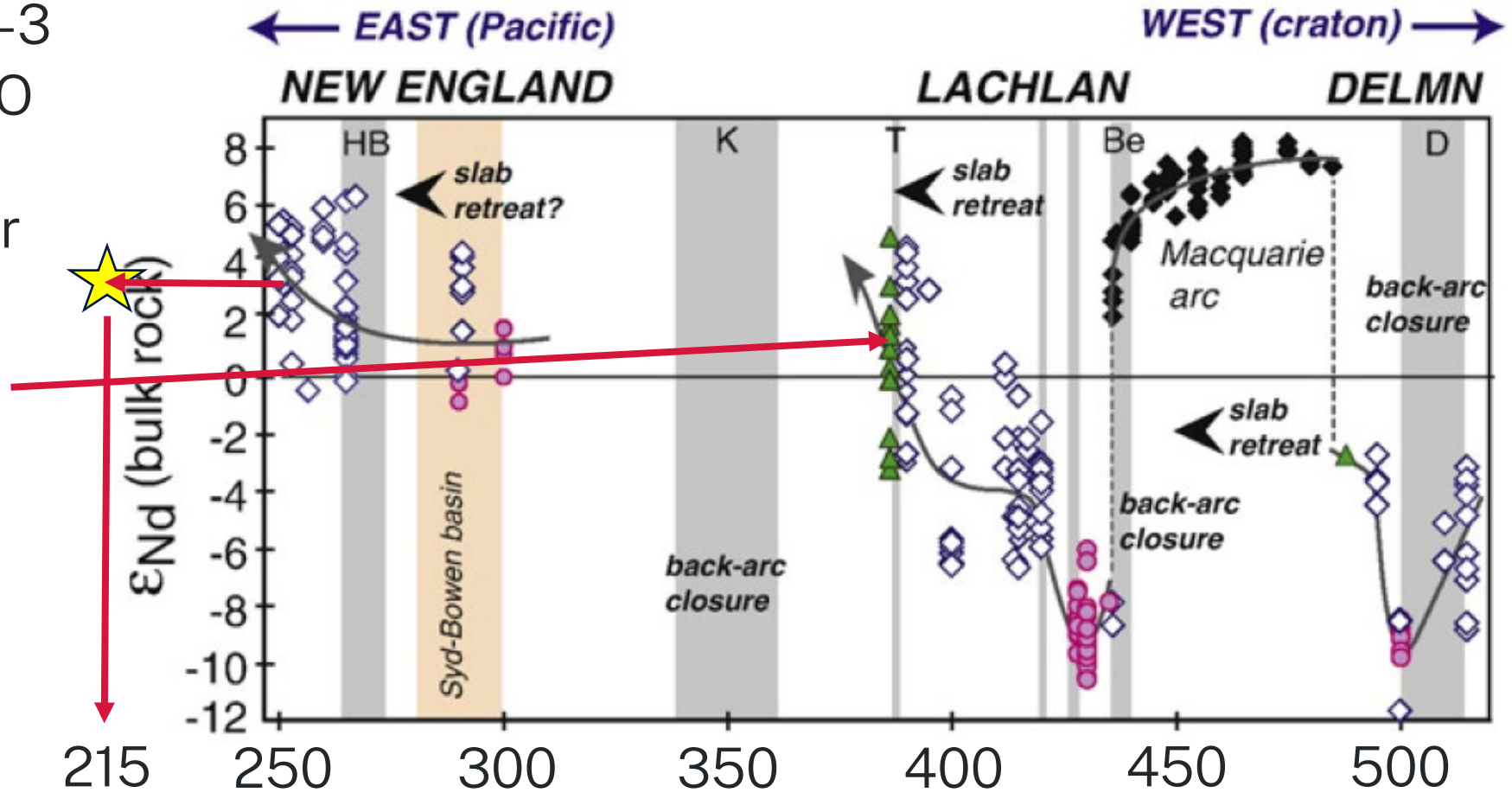


Beard et al. 2022 'Alkaline-silicate REE-HFSE Systems'

Tectonic significance

Dubbo εNd values ~2–3

- Absent data for NEO A-types
- Probably too low for NEO
- Not dissimilar from LAO A-types…

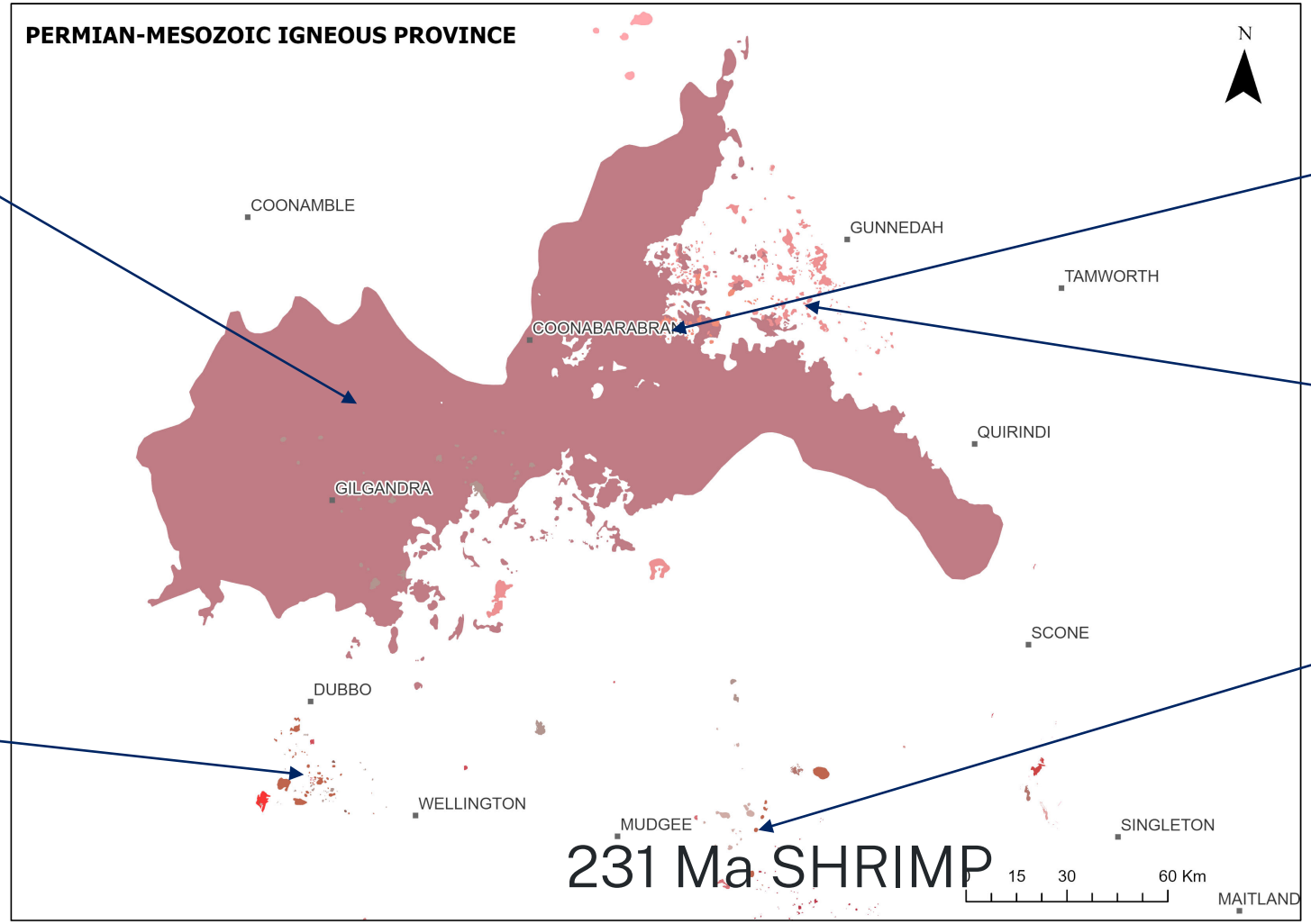


Source: Kemp et al. 2009 DOI: 10.1016/j.epsl.2009.05.011

Synthesis

- Pre-fertilisation of the SCLM under the LAO occurred during the accretion of the NEO in the Carboniferous
- Post-Kanimblan relaxation triggers extension and formation of Permo-Triassic Basins
- Hunter-Bowen orogeny (~265 Ma) compression followed by relaxation and A-type magmatism in the NEO (235–210 Ma)
- Post-HBO relaxation triggers low-degree partial melts of metasomatically enriched SCLM under the LAO-producing enriched parental magmas
- Extensive differentiation in the crust results in peralkaline volcanism at surface (or as subvolcanic intrusions)
- The Toongi trachyte is a sub-volcanic sill that represents a highly fractionated ‘sweat’ from a batholith at depth

Where else in NSW?



Garrawilla Volcanics

Bulga Complex

Glenrowan Intrusives

Ungrouped Mesozoic volcanics

Benolong Volcanic Suite

Alkaline-hosted resources in NSW

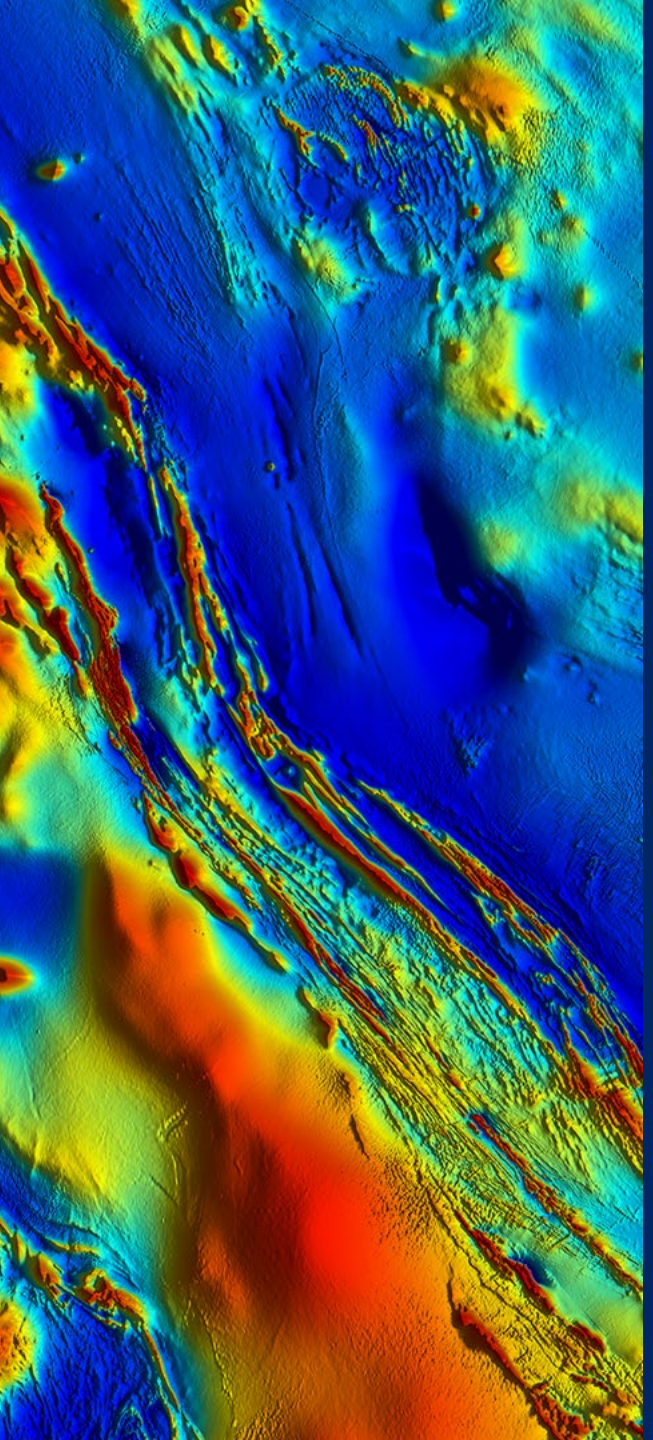
Reports

Petrographic character of variably peralkaline Mesozoic Volcanics, Dubbo 1:250,000 Geological Sheet SI/55-4

B.P. Simpson and J.A. Fitzherbert *30 November 2023*
GS2023/004
DOI: 10.13140/RG.2.2.27762.58568

Petrography of the Zr+REE enriched Toongi and Railway trachytes

B.P. Simpson and J.A. Fitzherbert *29 September 2022*
GS2023/003
DOI: 10.13140/RG.2.2.21051.69921



Thank you

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