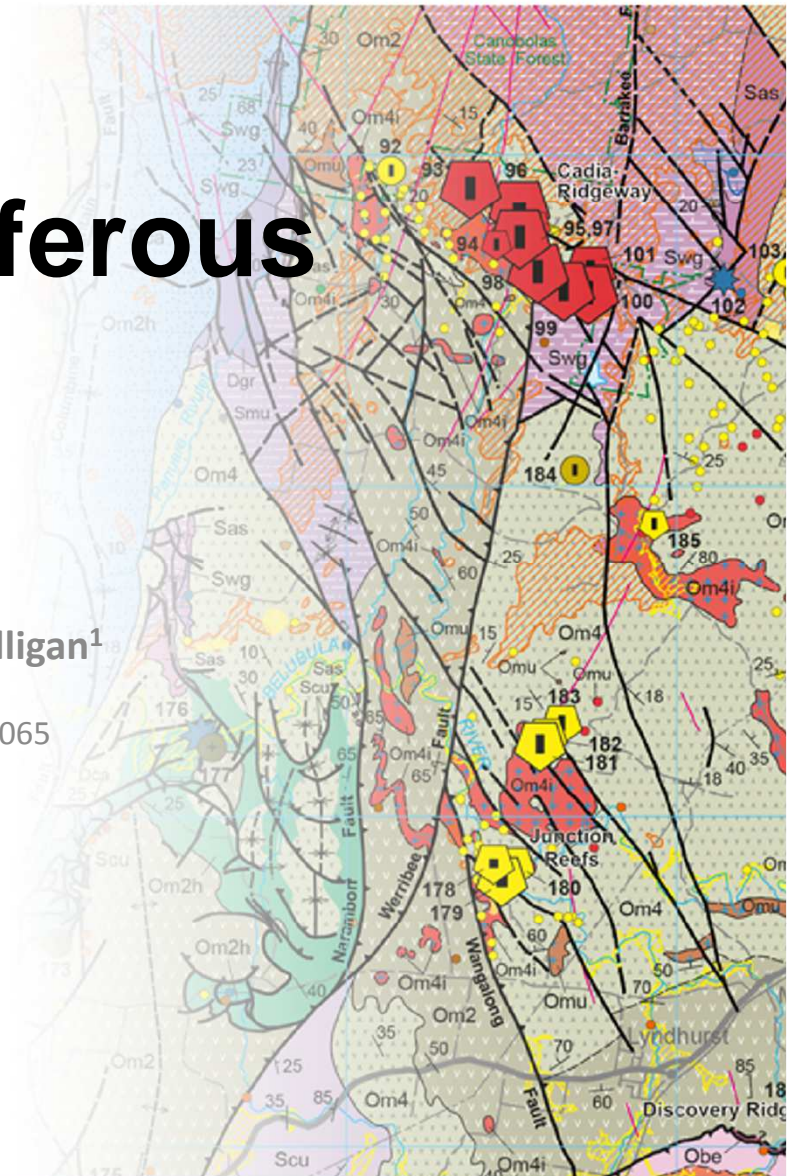


A Review of Metalliferous Basins in NSW

John Greenfield, Phil Gilmore, Peter Downes, Joel Fitzherbert, Cameron Perks, Liann Deyssing, Lindsay Gilligan¹

Geological Survey of NSW

¹Thomson Resources, Level 1, 80 Chandos Street, St Leonards NSW 2065



Introduction

How significant are basin-related Pb-Zn-Ag-Cu-Au deposits in NSW?

What are the basin-scale characteristics of endowment?

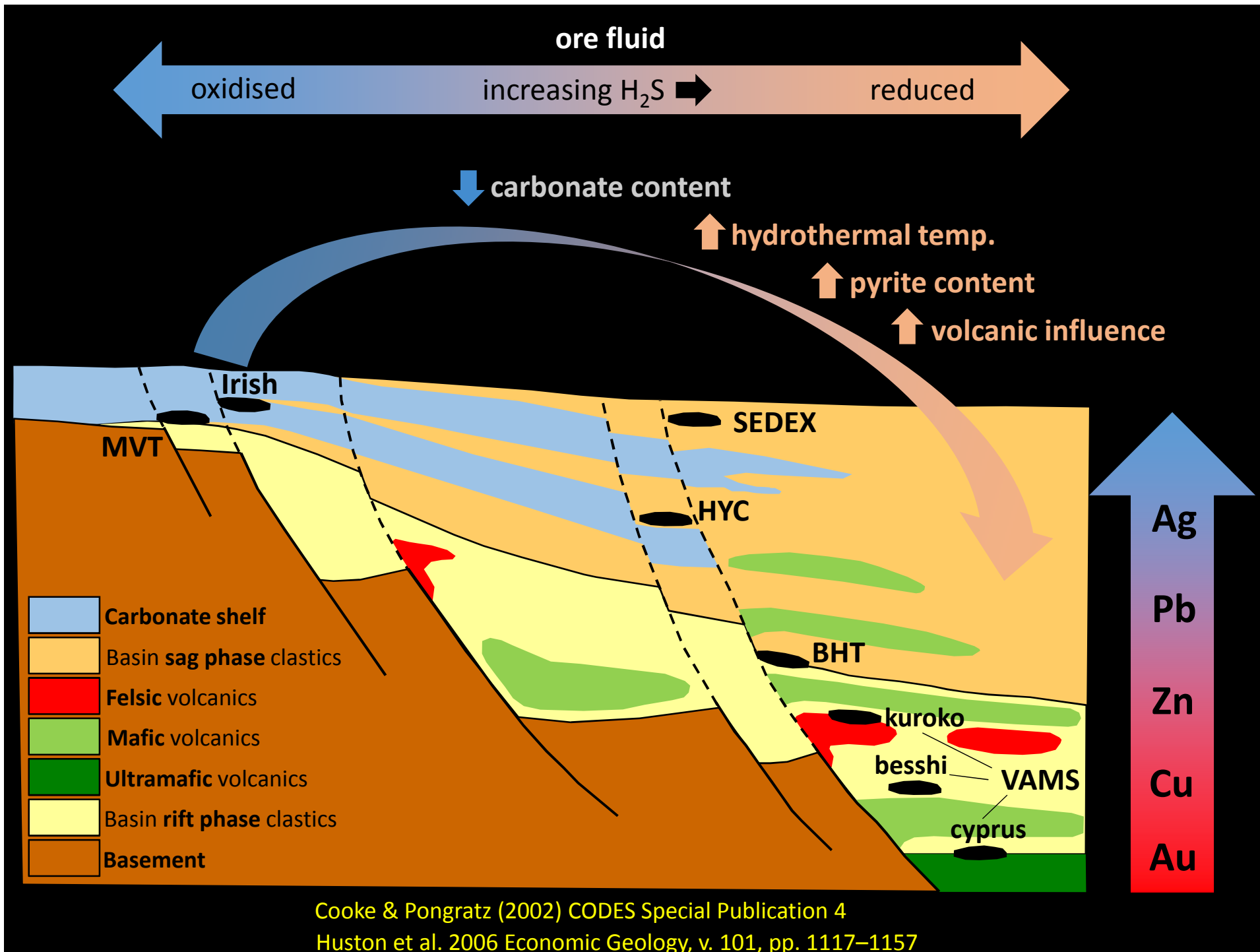
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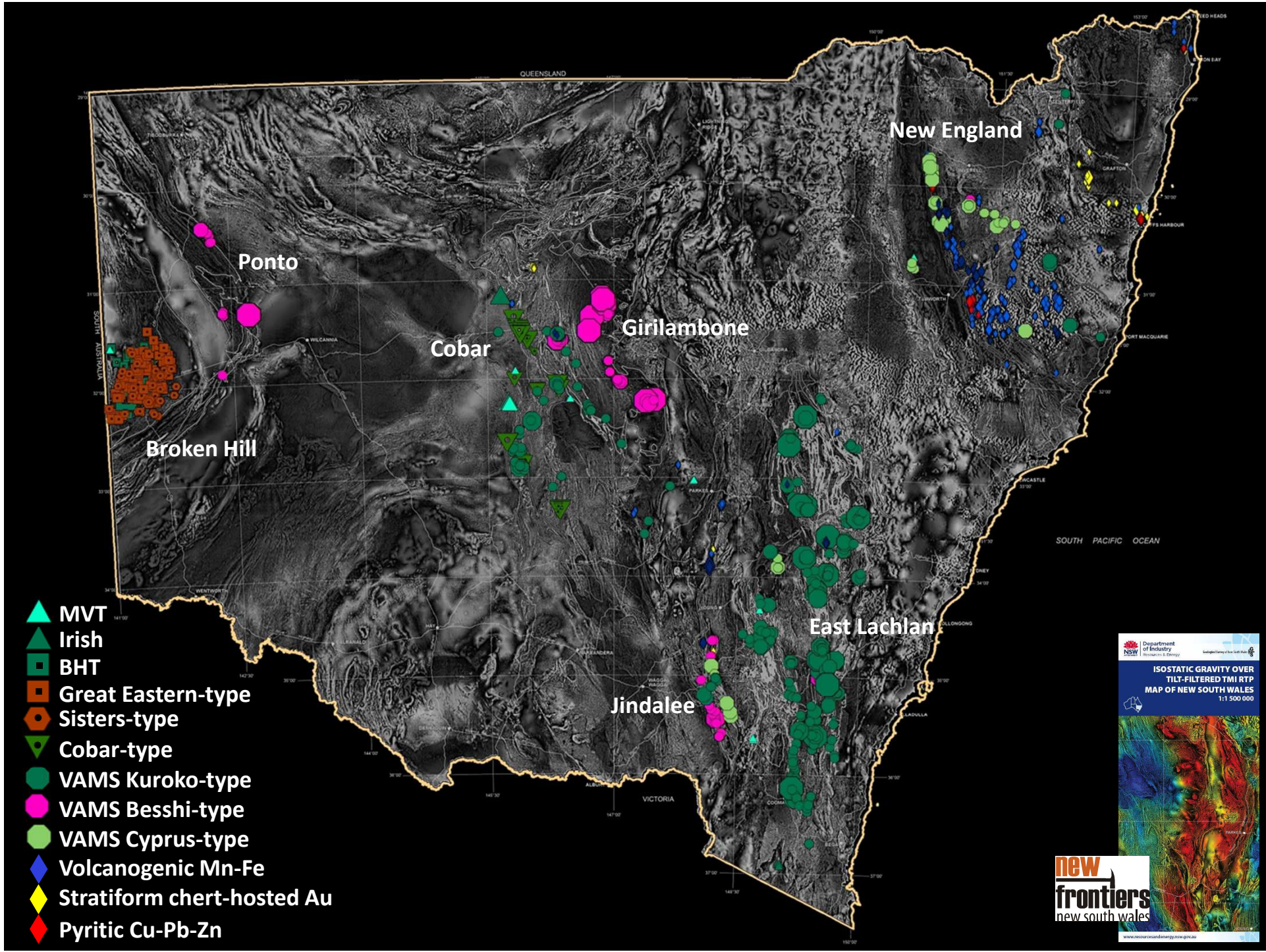
- revised **MetIndEx** (wisdom of 50 years metallogenic mapping)
- 2014-15 GSNSW mapping and mineral system studies
- Years of studies: GSNSW, industry, GA, CSIRO, CODES/unis etc....

Revised **MetIndEx** available free from




14 new  product placements in 30 minutes!






- ▲ MVT
- ▲ Irish
- BHT
- Great Eastern-type
- Sisters-type
- ▼ Cobar-type
- VAMS Kuroko-type
- VAMS Besshi-type
- VAMS Cyprus-type
- ◆ Volcanogenic Mn-Fe
- ◆ Stratiform chert-hosted Au
- ◆ Pyritic Cu-Pb-Zn

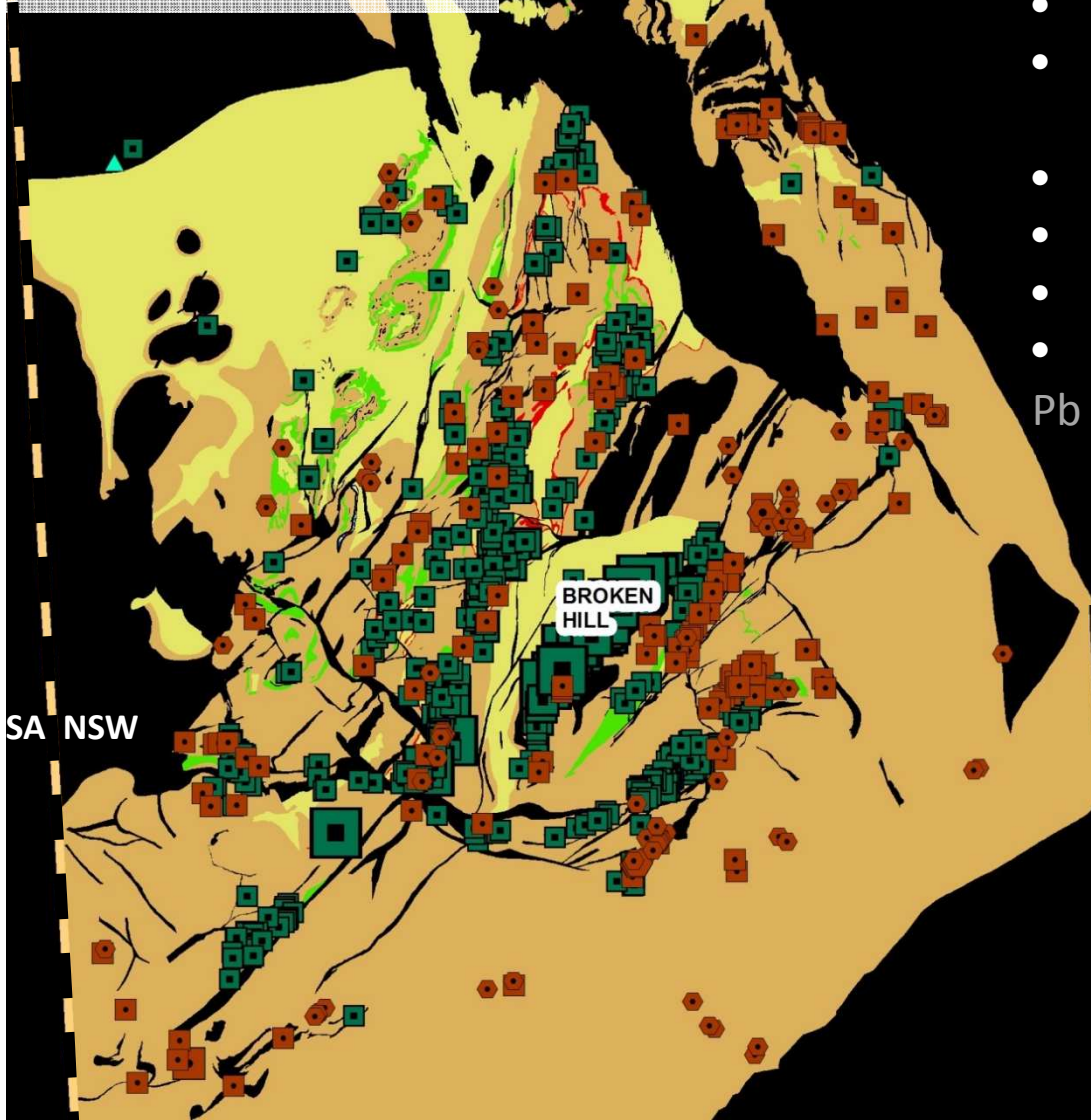
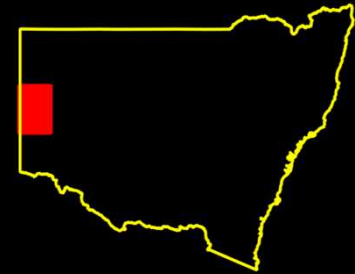


 ISOSTATIC GRAVITY OVER
 TILT-FILTERED TMI RTP
 MAP OF NEW SOUTH WALES
 1:1 500 000



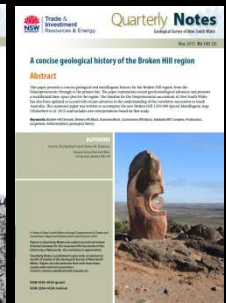
www.nswenergy.gov.au

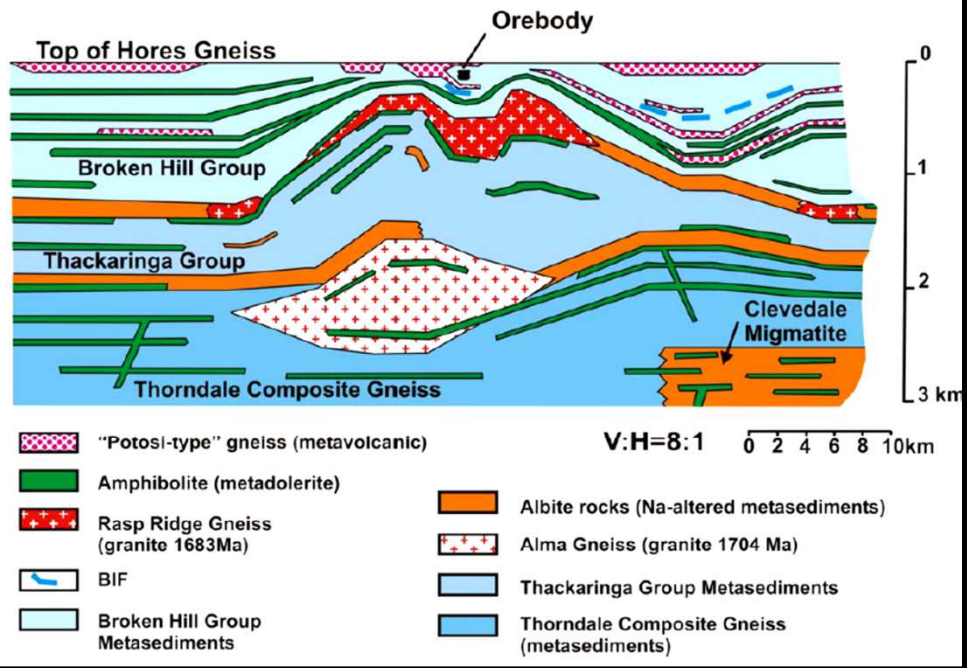
Broken Hill



- Late Palaeoproterozoic basin
- ensialic continental rift setting
(Red Sea? Lake Baikal? Distal back-arc?)
- half-graben basin configuration
- Extensive exhalative mineralisation
- world class Broken Hill Pb-Zn-Ag deposit
- Basin endowment:
Pb 19.3Mt Zn 17.4Mt Ag 26.8kt Cu 14kt Au 29t

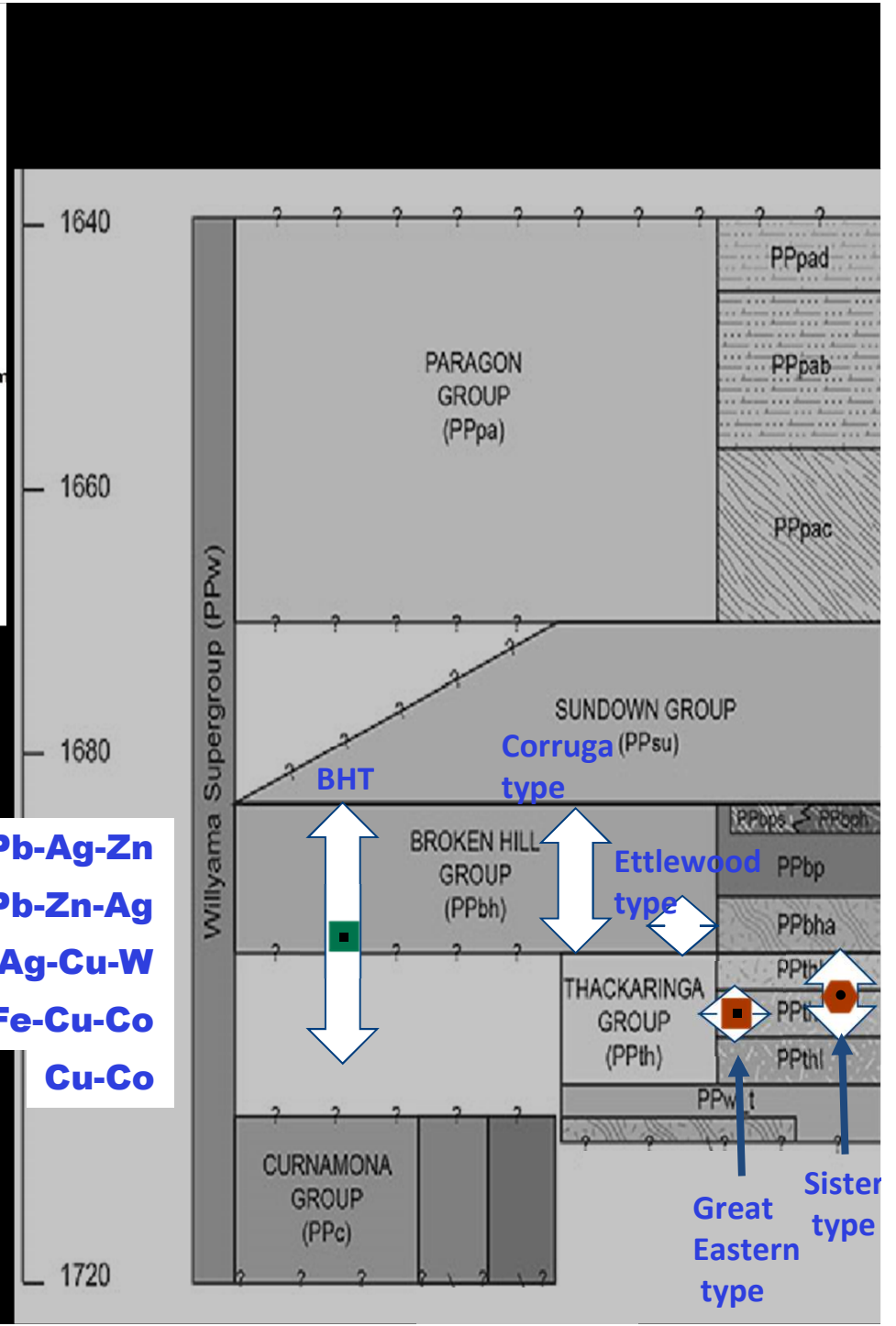
- Broken Hill type
- ⬡ Fe-Cu-Co Sisters type
- Pyritic Cu-Co Great Eastern type



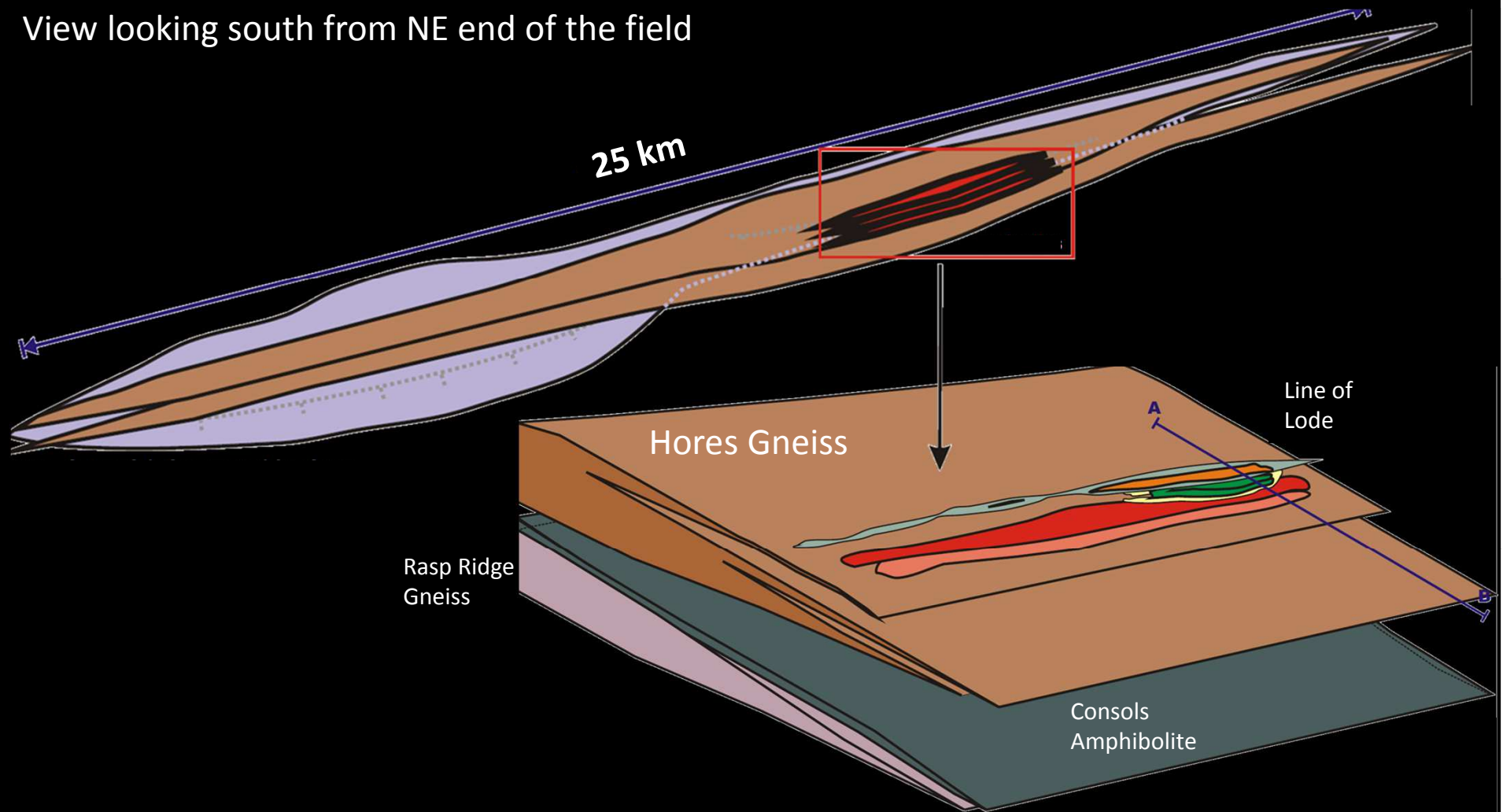


Stevens BPJ, 2003. BHEI Geoscience Australia Record 2003/13

Pb-Ag-Zn
W-Cu-Pb-Zn-Ag
Zn-Pb-Ag-Cu-W
Fe-Cu-Co
Cu-Co



View looking south from NE end of the field



Webster AE 2006, CODES Monograph No. 1

Keys to Broken Hill basin character

- extensional rift setting with elevated geotherm (distal back-arc?)
- rift-stage bimodal volcanics (including Fe-rich tholeiite)
- master growth faults controlling major fluid discharge conduits
- Mineralisation at transition from basin rift to sag depositional phase

Mt Arrowsmith

(Koonenberry Belt)

Neoproterozoic

Shallow marine shelf

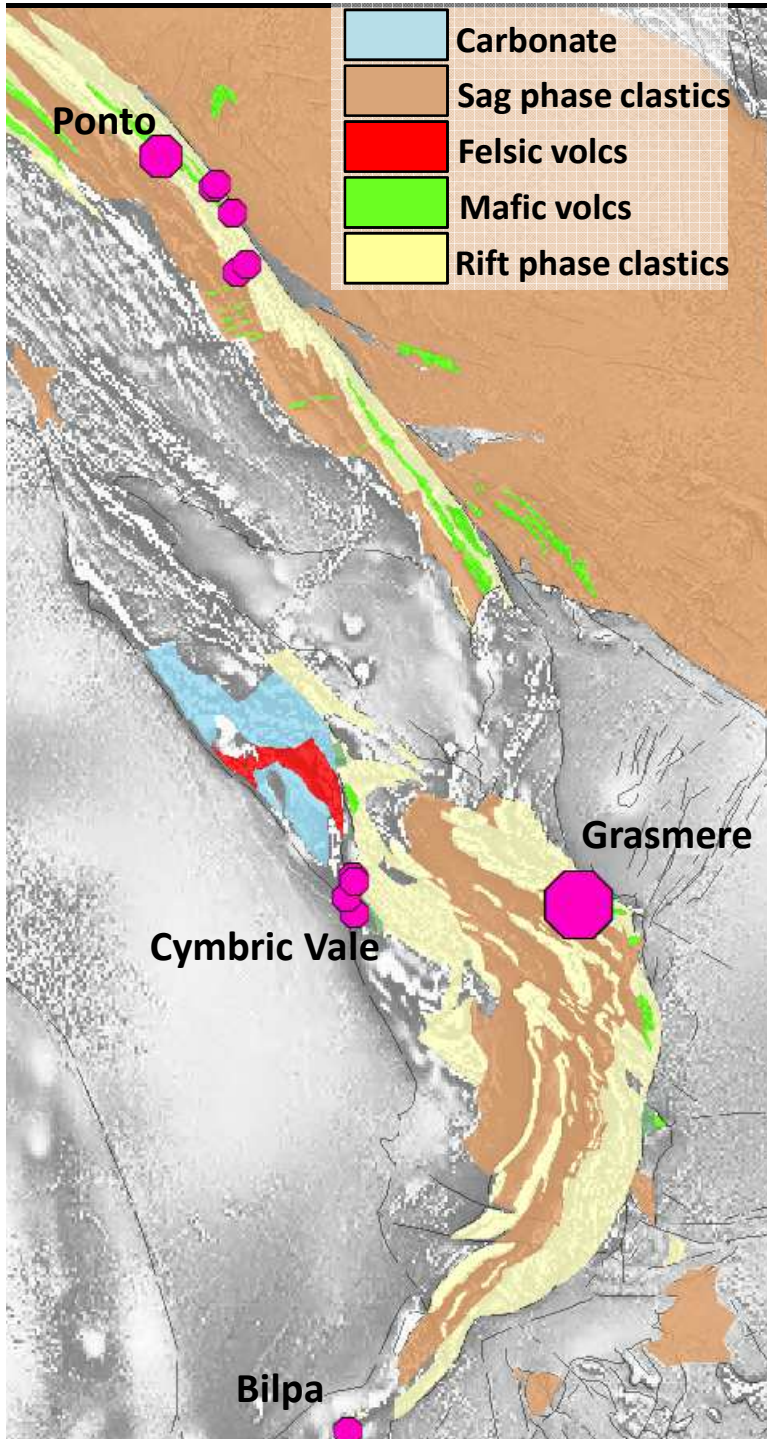
Alkaline Volcanics

Intracratonic rift

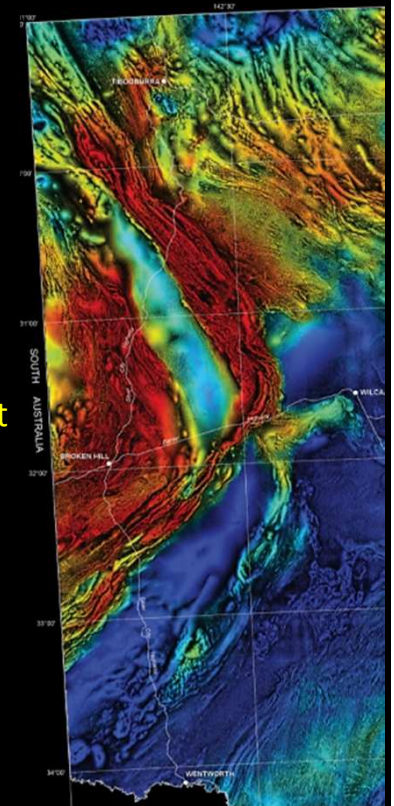


Ponto Group

Koonenberry Belt

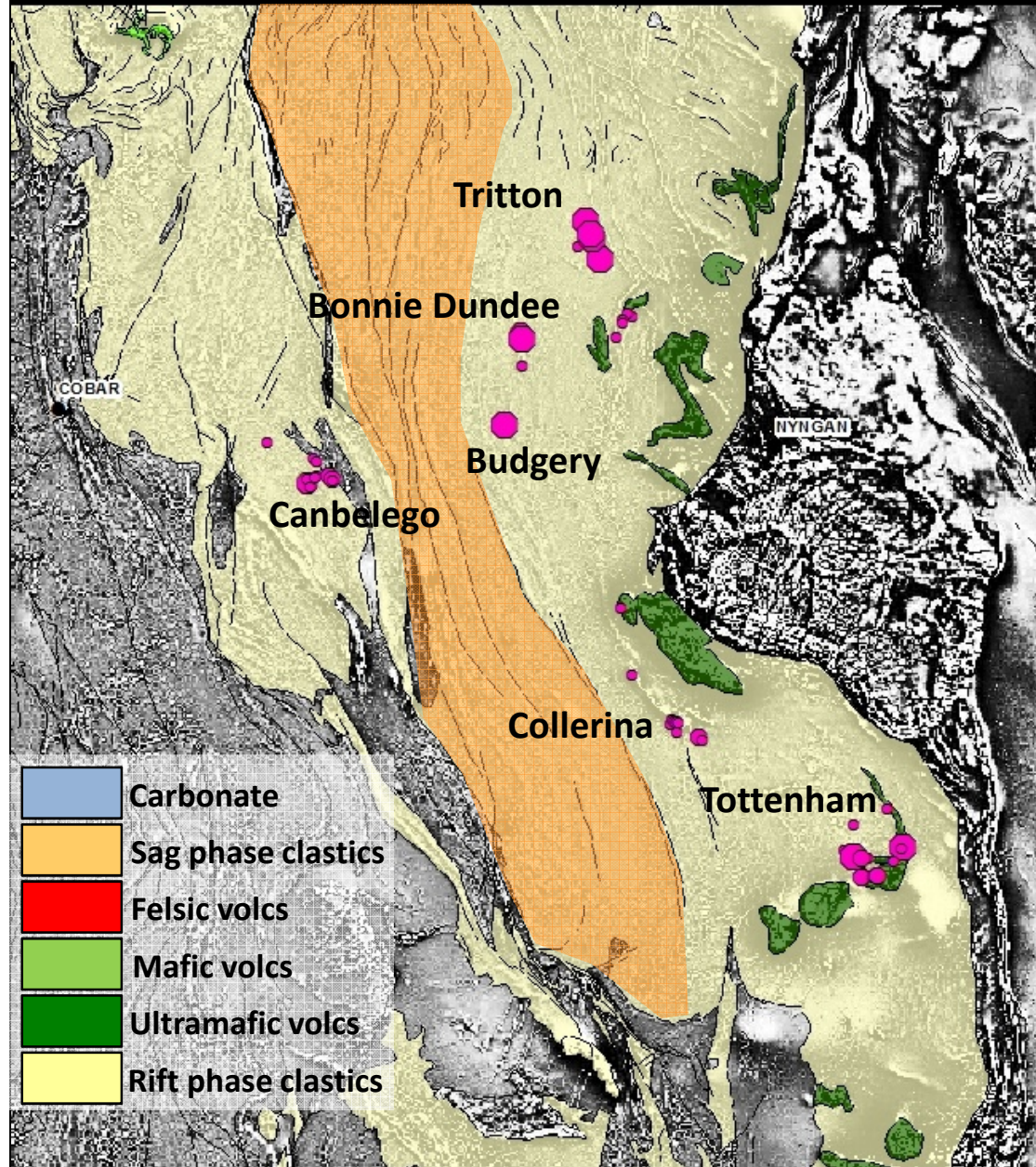
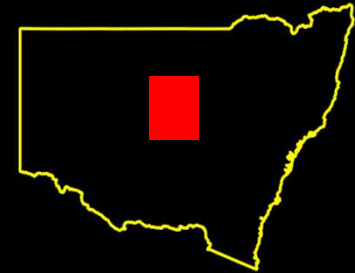


- Mid-Cambrian oceanic basin
- Fore-arc basin to Mt Wright Arc
- Imbricate thrust package
- Narrow, strike extensive- 300km
- quartz-magnetite exhalatives
- tholeiitic mafic lavas, sills
- Besshi-type deposit endowment:
Zn 20.1kt Ag 13.2t Cu 60.2Kt Au 0.29t



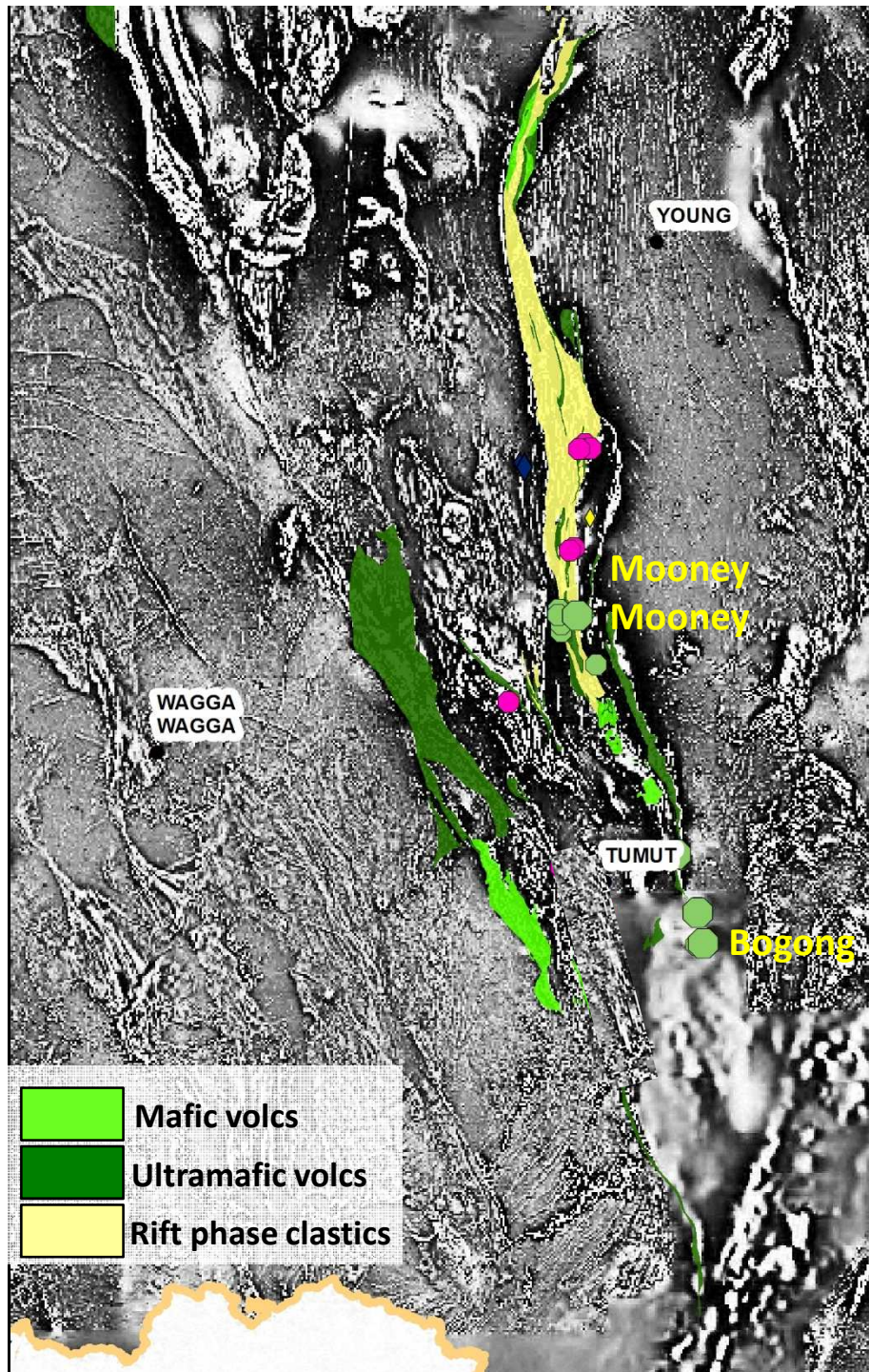
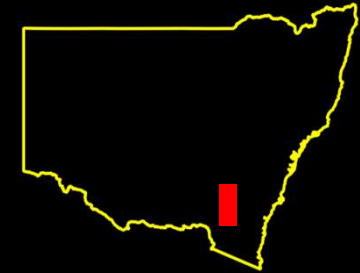
new
frontiers
 new south wales

Girilambone District



- Early to Middle Ordovician
- oceanic basin
- back-arc basin to Macquarie Arc
- siliclastic turbidite, chert, quartzite
- quartz-magnetite exhalatives
- tholeiitic mafic/ultramafic sills
- Early Ord. Narrama Fm hosts Qtz-Mgt units and Besshi type deposits
- Besshi-type deposit endowment:
Ag 18.5t **Cu 1.1Mt** **Au 0.45t**

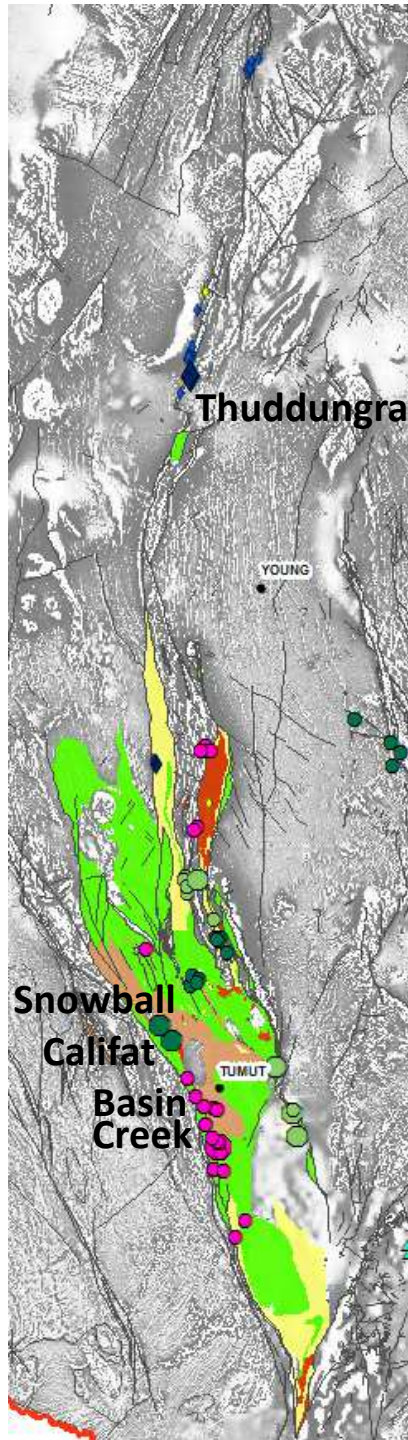
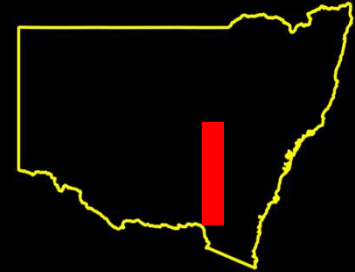
Jindalee Group



- early- to mid-Late Ordovician
- strongly sheared
- equivalent of the Girilambone Group?
- Siliciclastic turbidite with interbedded slate, Mn-bearing chert, quartzite, qtz-mag units
- tholeiitic mafic to ultramafic rocks
- Three small VAMS Cyprus types associated with mafic and ultramafic (Coolac Serpentinite) rocks
- Underexplored, strongly deformed rock package that has been overlain by the Siluro-Devonian Tumut Trough

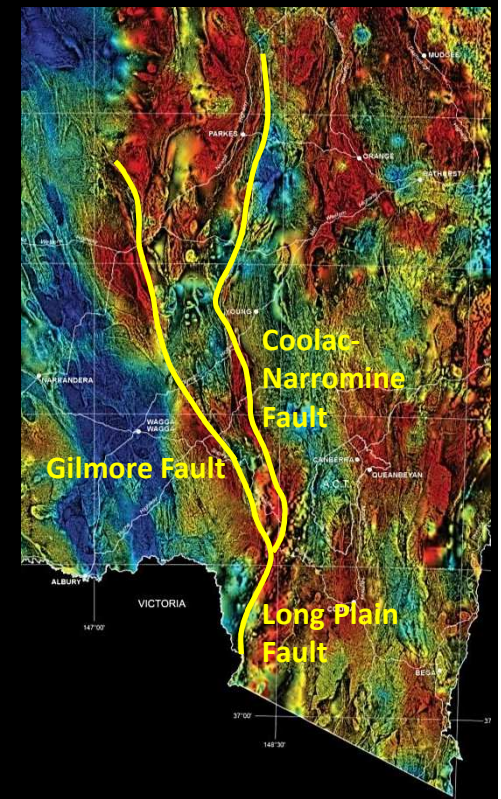
- VAMS pelitic–mafic-hosted (Besshi-type)
- VAMS mafic setting-hosted (Cyprus-type)
- ◆ Volcanogenic Mn–Fe

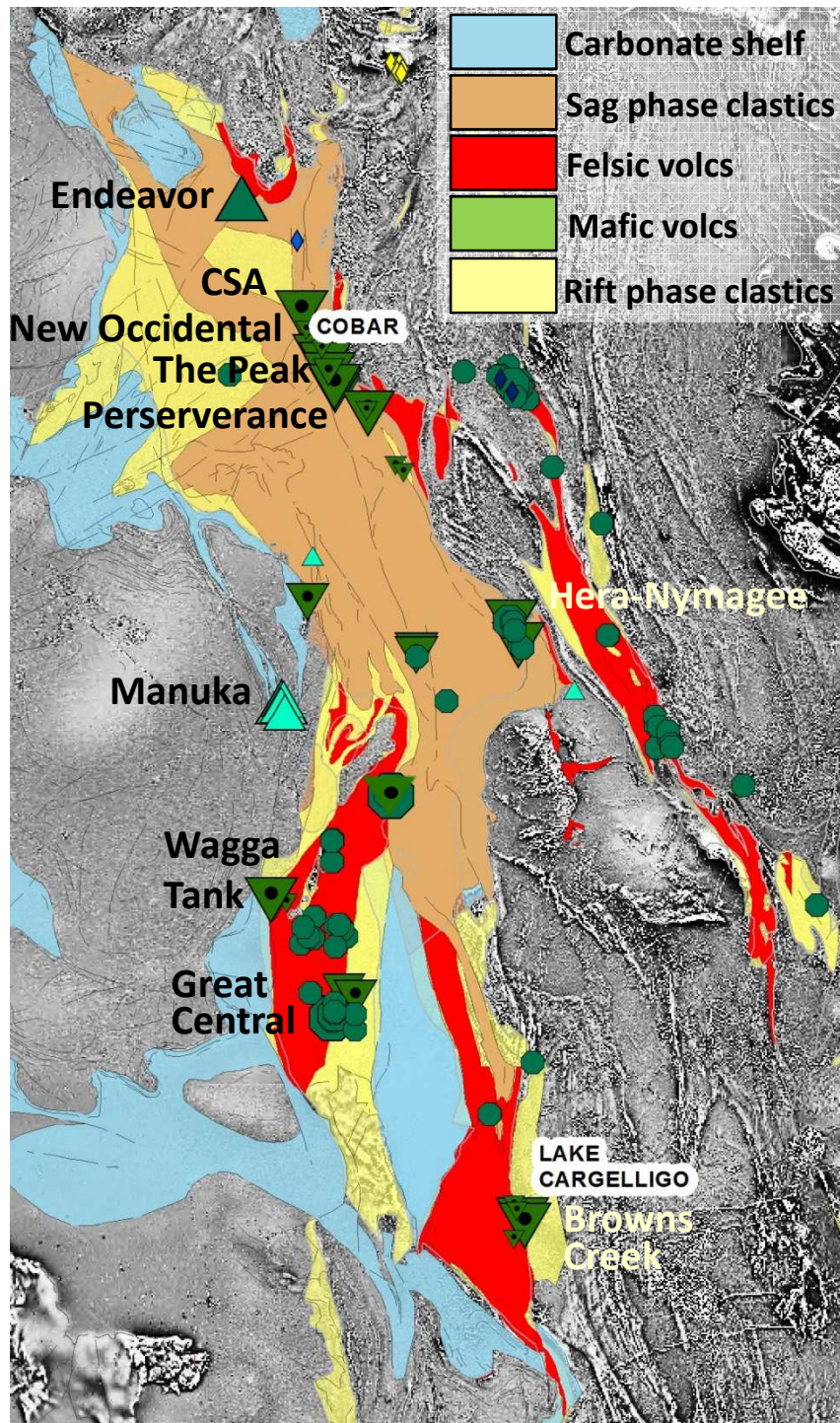
Tumut Trough



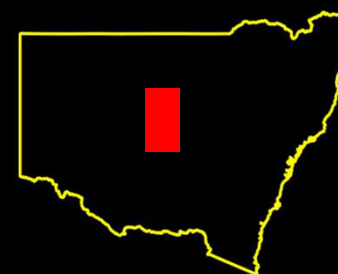
- Siluro-Devonian transtensional rift basin
- Key units- sag phase siliciclastic turbidite (Bumbole Fm) overlying rift phase andesitic volcanics and volcanoclastics (Jackalass Slate)
- strongly sheared
- a line of Mn–Fe occurrences extend along Coolac-Narromine Fault
- Minor endowment: 120Kt @ 4% Cu Basin Creek deposit – main resource

- VAMS Kuroko type
- VAMS Besshi-type
- VAMS Cyprus-type
- ◆ Volcanogenic Mn–Fe



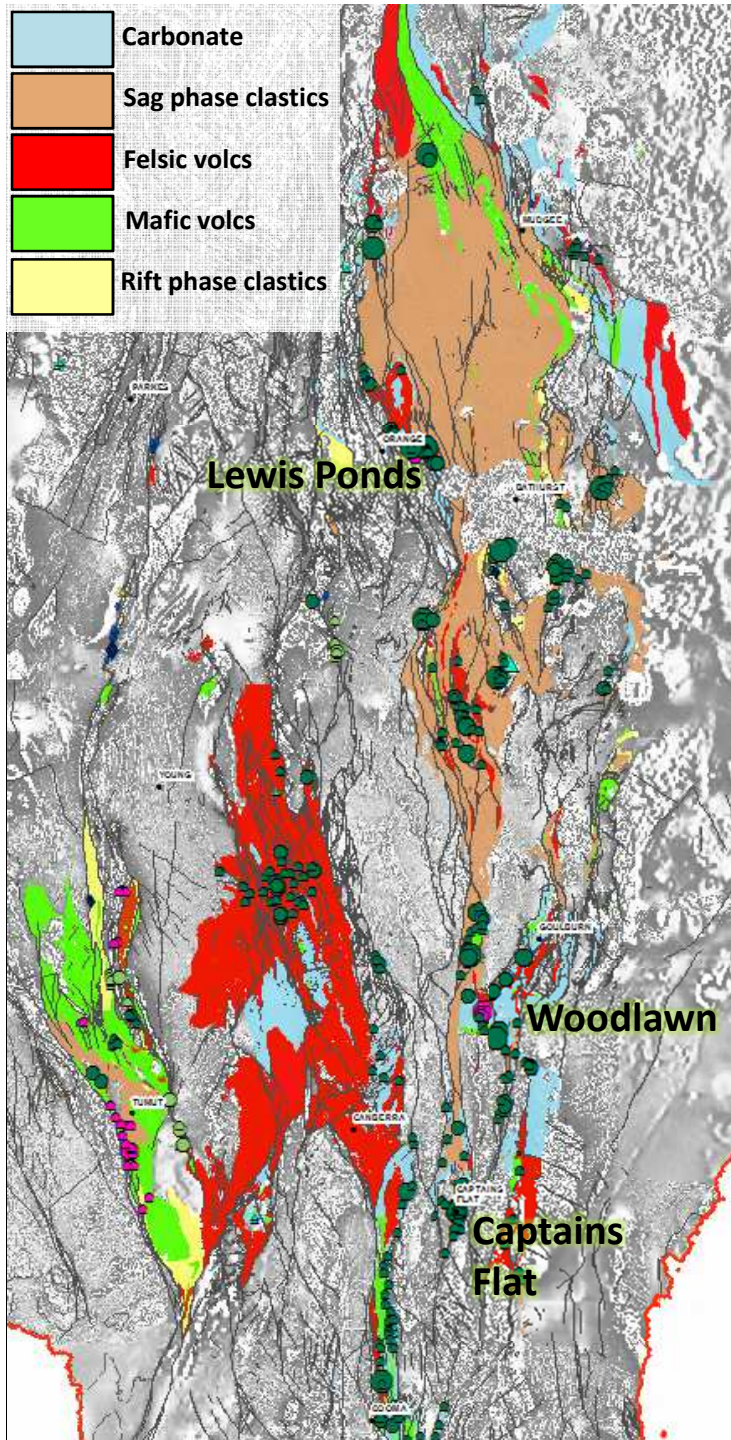


Cobar Basin

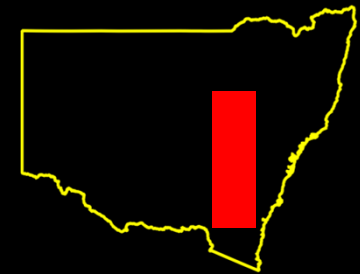


- Latest Silurian to Early Devonian transtensional rift basin – new GSNSW dating
- Rift-phase siliciclastic turbidite and high-K calc-alkaline volcanics, sag-phase silt-rich turbidite
- Deposits concentrated in rift phase with MVTs on carbonate shelves
- Main endowment from structurally-controlled Cobar type deposits, esp. along Rookery Fault
- remobilisation of VAMS and Irish/SEDEX style is inferred for some deposits
- isotope data suggest ore fluid derived from a combination of basin and basement sources
- Basin endowment:
Pb 2.7Mt Zn 4.5Mt Ag 6.2Kt Cu 2.0Mt Au 196t

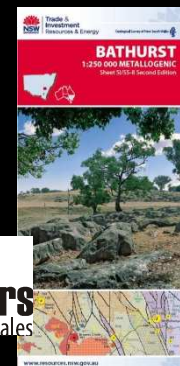
- ▼ Structurally-controlled high-sulfide (Cobar type)
- VAMS Kuroko-Iberian type?
- ▲ MVT
- ▲ Irish/SEDEX? type



Eastern Lachlan

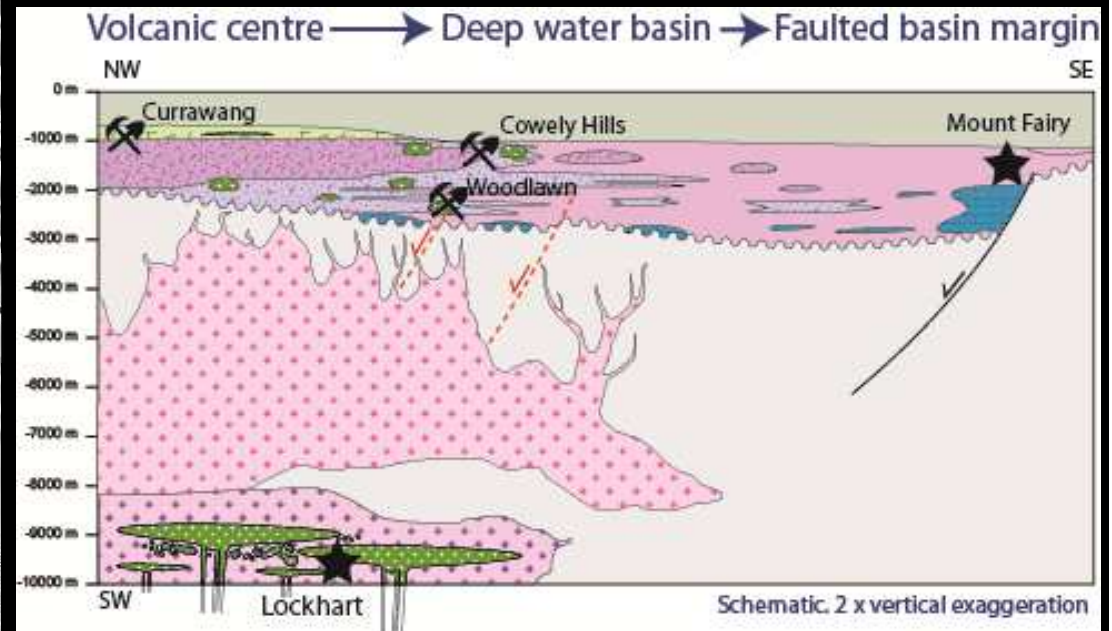
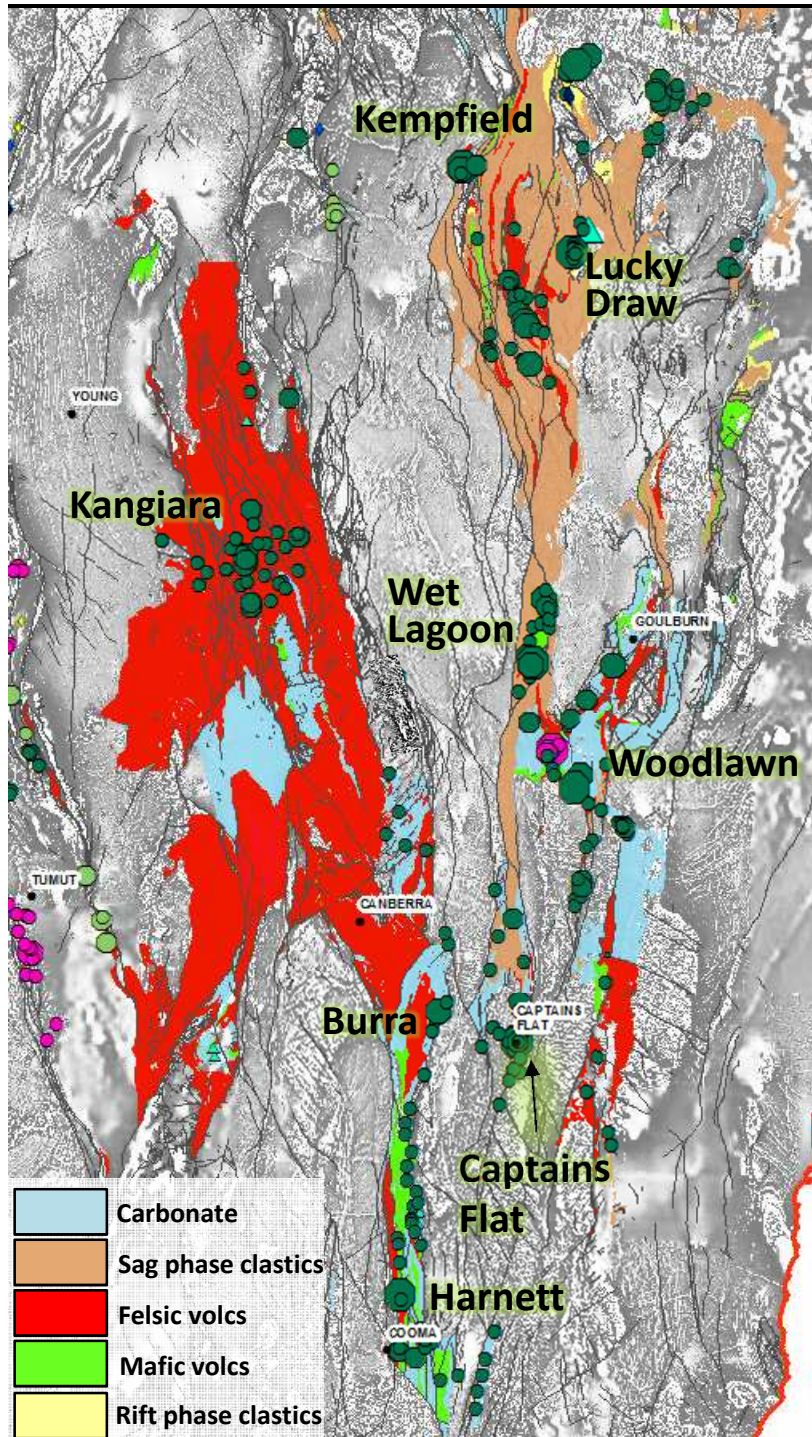


- Silurian to Early Devonian distal back-arc marine basins developed on rifted Cambro-Ordovician continental crust
- Mainly bimodal felsic-dominated Kuroko-type and siliciclastic–felsic-hosted Iberian-type
- 95 small to large VAMS deposits, clustered adjacent to growth/discharge faults, on the margins of volcanic centres
- three very large deposits (Woodlawn, Captains Flat, Lewis Ponds)
- minor carbonate-hosted stratabound (MVT and Irish types) located on carbonate shelf regions
- Basin endowment:
Pb 1.5Mt Zn 2.5Mt Ag 3.7Kt Cu 516kt Au 48t



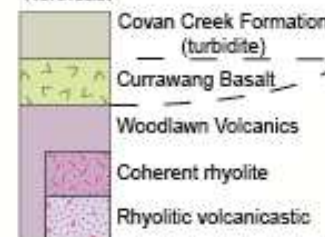
Goulburn Basin/ Canberra-Yass Shelf

Silurian I-type magmas intruded thinned Ordovician basement beneath basins (e.g. Thurrally Suite under Goulburn Basin)



MOUNT FAIRY GROUP

Northeast



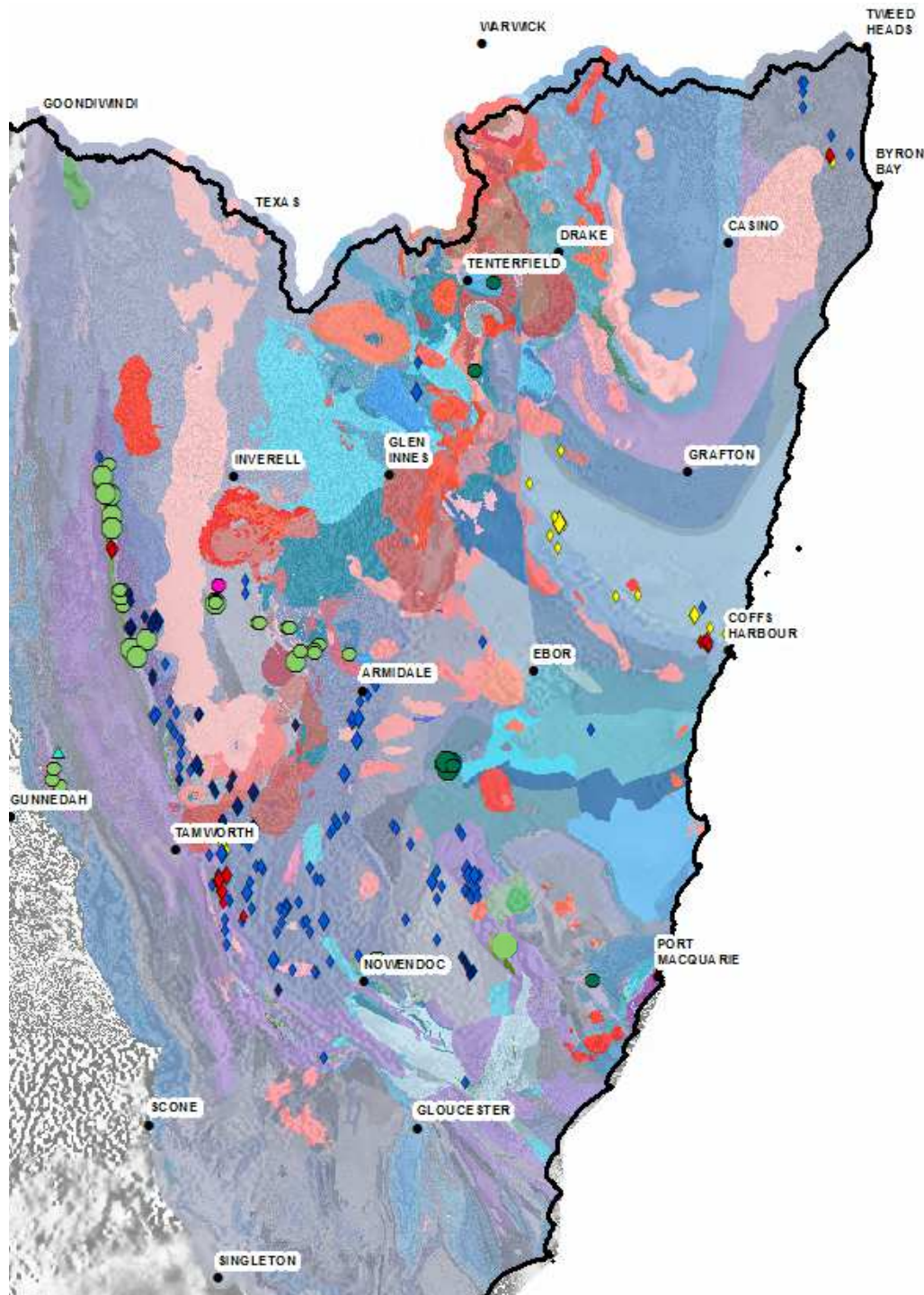
Southeast



THURRALILLY SUITE

Southwest



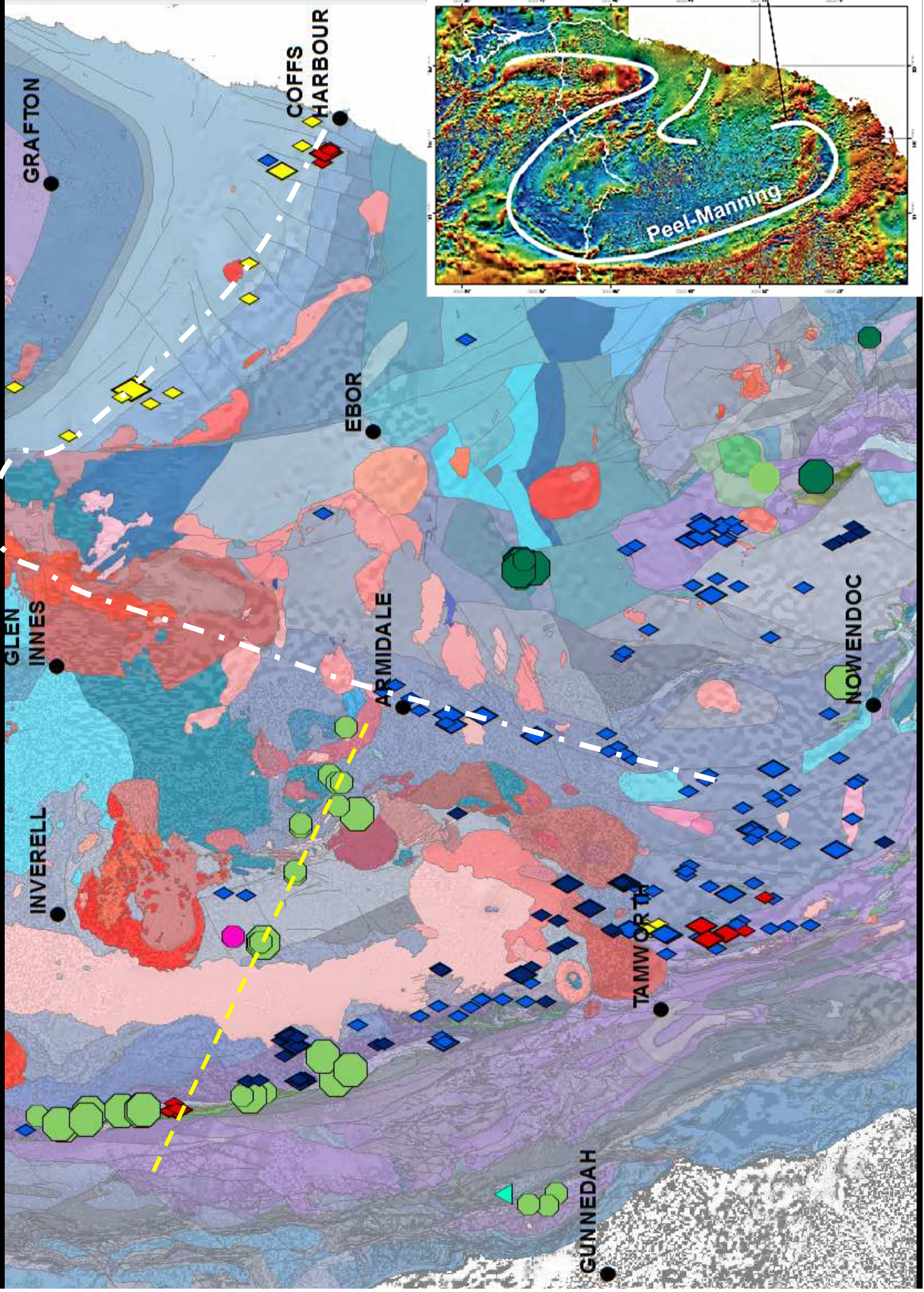
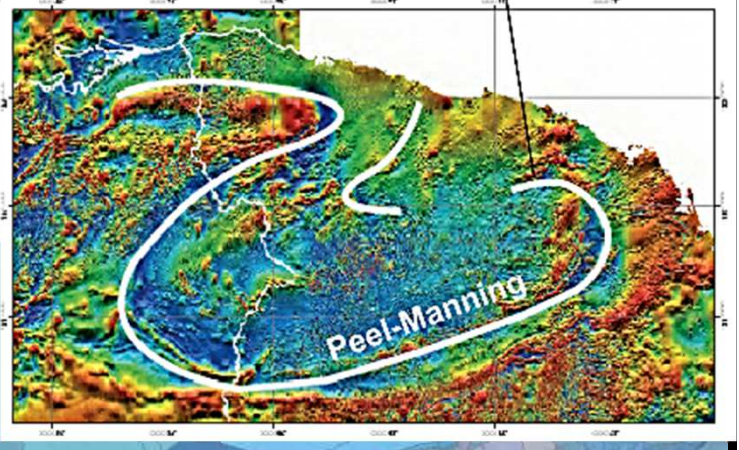


New England

Most volcano-sedimentary mineralisation occurs in:

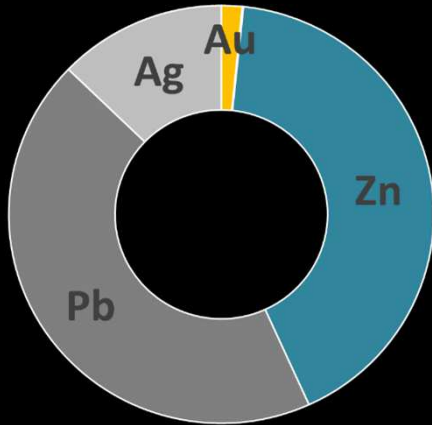
- Silurian-Carboniferous accretionary complex (Cyprus type deposits, Mn-Fe/pyritic Cu-Zn-Au exhalites)
- Early Permian back-arc basin VAMS Kuroko type deposits
- Volcano-sedimentary endowment:
Pb 556t Zn 670t Ag 1.4t Cu 2.9Kt Au 0.77t

- VAMS Kuroko-type
- VAMS Besshi-type
- VAMS Cyprus-type
- ◆ Volcanogenic Mn-Fe
- ◆ Stratiform chert-hosted Au
- ◆ Stratiform pyritic Cu-Pb-Zn

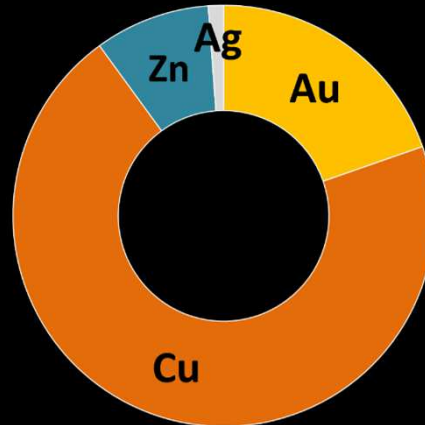


Basin Metal Tenor (\$ values)

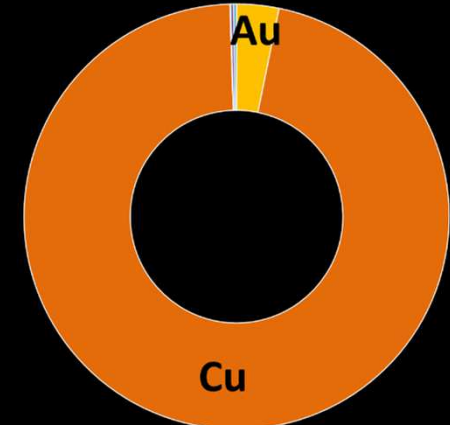
Broken Hill



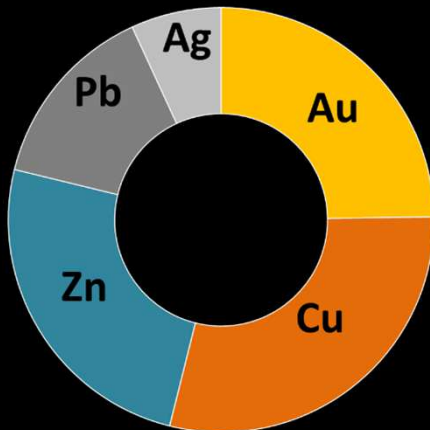
Koonenberry



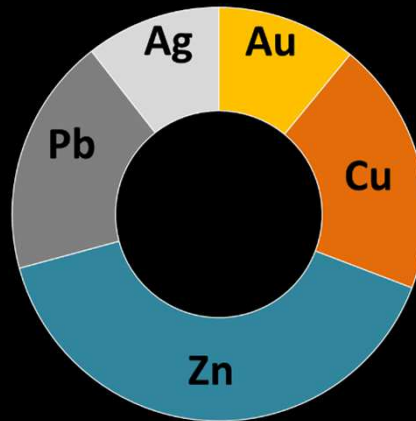
Ordovician Basement



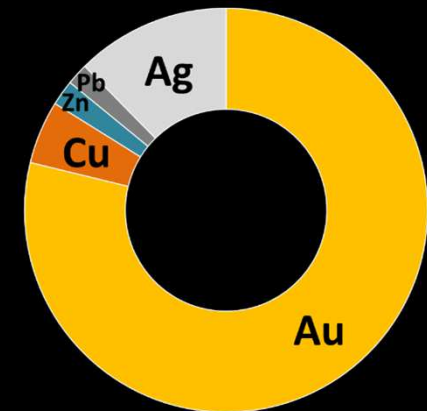
Cobar Basin



Eastern Lachlan Basins



New England Orogen



Basin Metal value (AUD\$ 2009)

AUD\$ (2009)

\$80b

\$70b

\$60b

\$50b

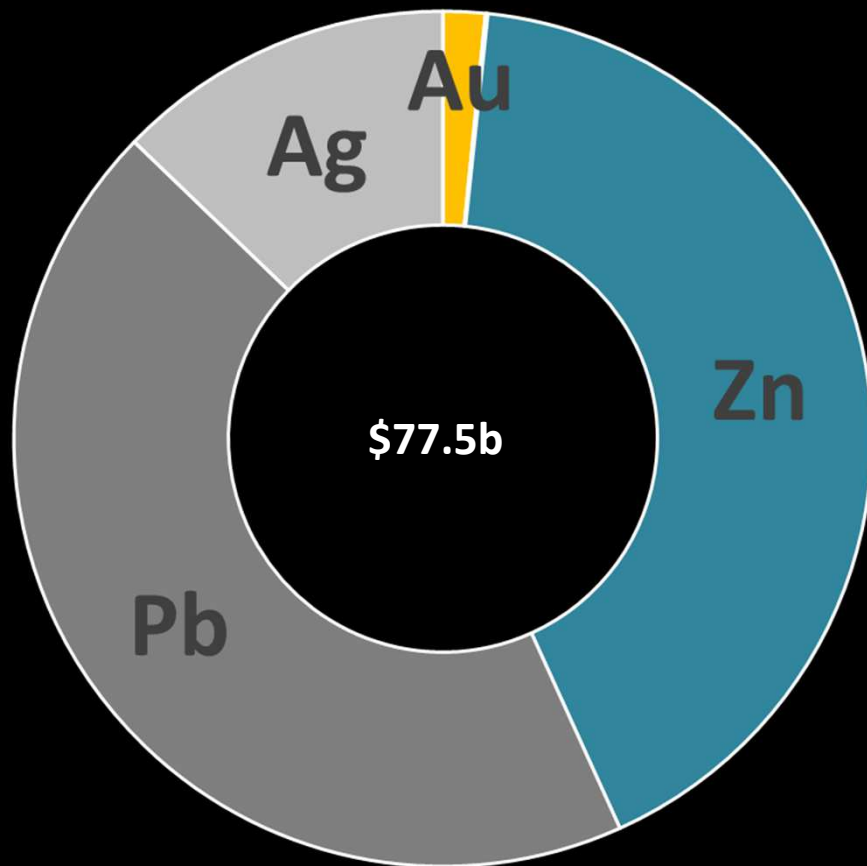
\$40b

\$30b

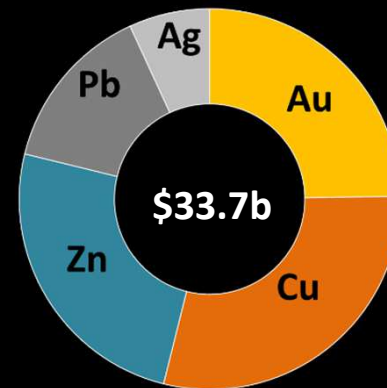
\$20b

\$10b

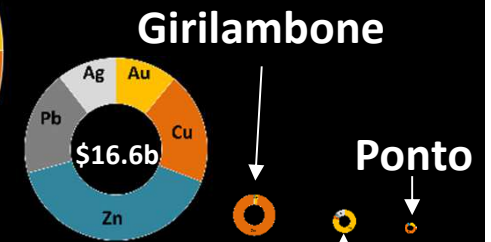
\$0



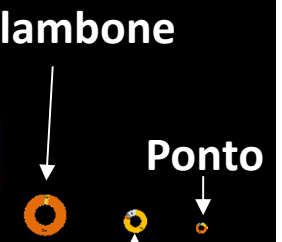
Broken Hill



Cobar Basin

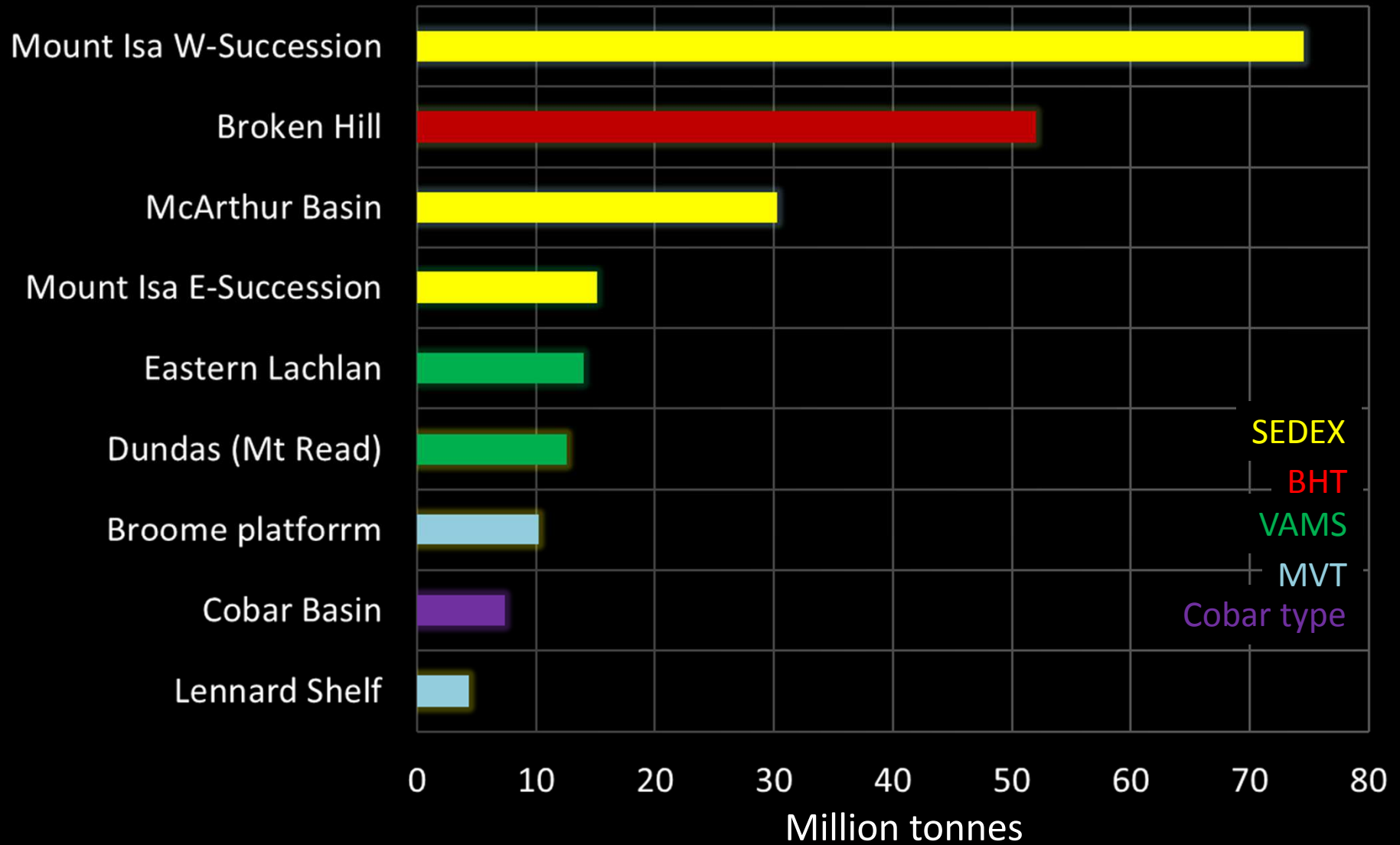


E. Lachlan



NEO

Pb-Zn-Ag endowment (Mt)



Summary

- NSW metalliferous basins host a spectrum of volcano-sedimentary deposits, with world-class endowment in the Broken Hill, Cobar, and East Lachlan basins.
- The majority of volcano-sedimentary mineralisation in NSW occurred during extension associated with trench-distal back-arc basins
- Key deposits are BHT (VAMS), VAMS, Cobar type
- Distinct lack of SEDEX and Irish types – dynamic basin development?
- Lack of MVT style deposits- no stable craton available for large platforms in the Tasmanides?
- The key ingredients for Pb–Zn±Ag±Cu±Au endowment in NSW are:
 - Active margin- even if distal to subduction trench
 - Rift basins built on pre-thickened continental crust substrate
 - Rift phase submarine volcanism