



**Australian Government**

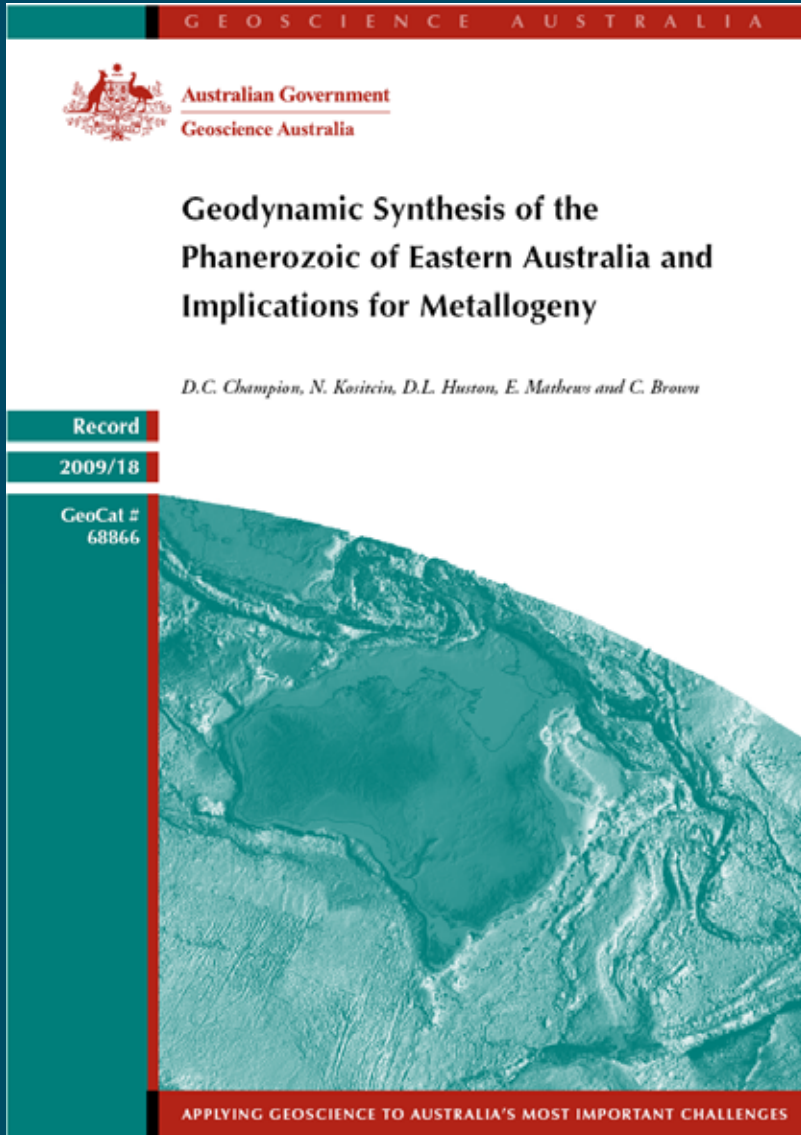
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**Geoscience Australia**

# Metallogenesis of eastern Australia: links to the tectonic evolution of the Tasman Orogen

**David L Huston, David C Champion and Natalie Kositcin**

# Methodology



**Geologic synthesis (orogen based)**  
Lachlan, Thomson, North Queensland & New England

**Tectonic synthesis (cycle based)**  
Delamerian, Benambran, Tabberabberan, Kanimblan & Hunter-Bowen

**Deposit synthesis (cycle based)**  
Description, mineral system, age

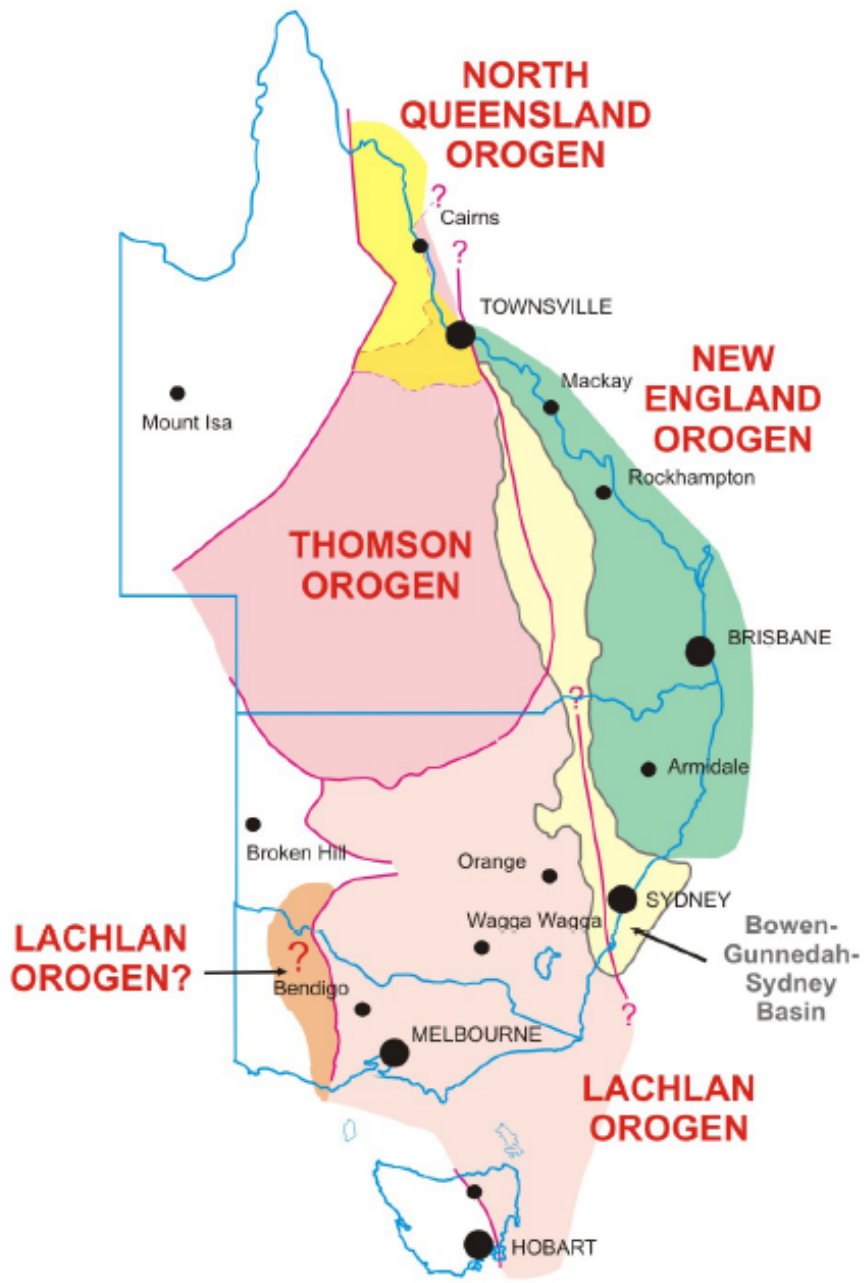
**Mineral potential analysis**  
Known deposits + tectonic environment = mineral potential

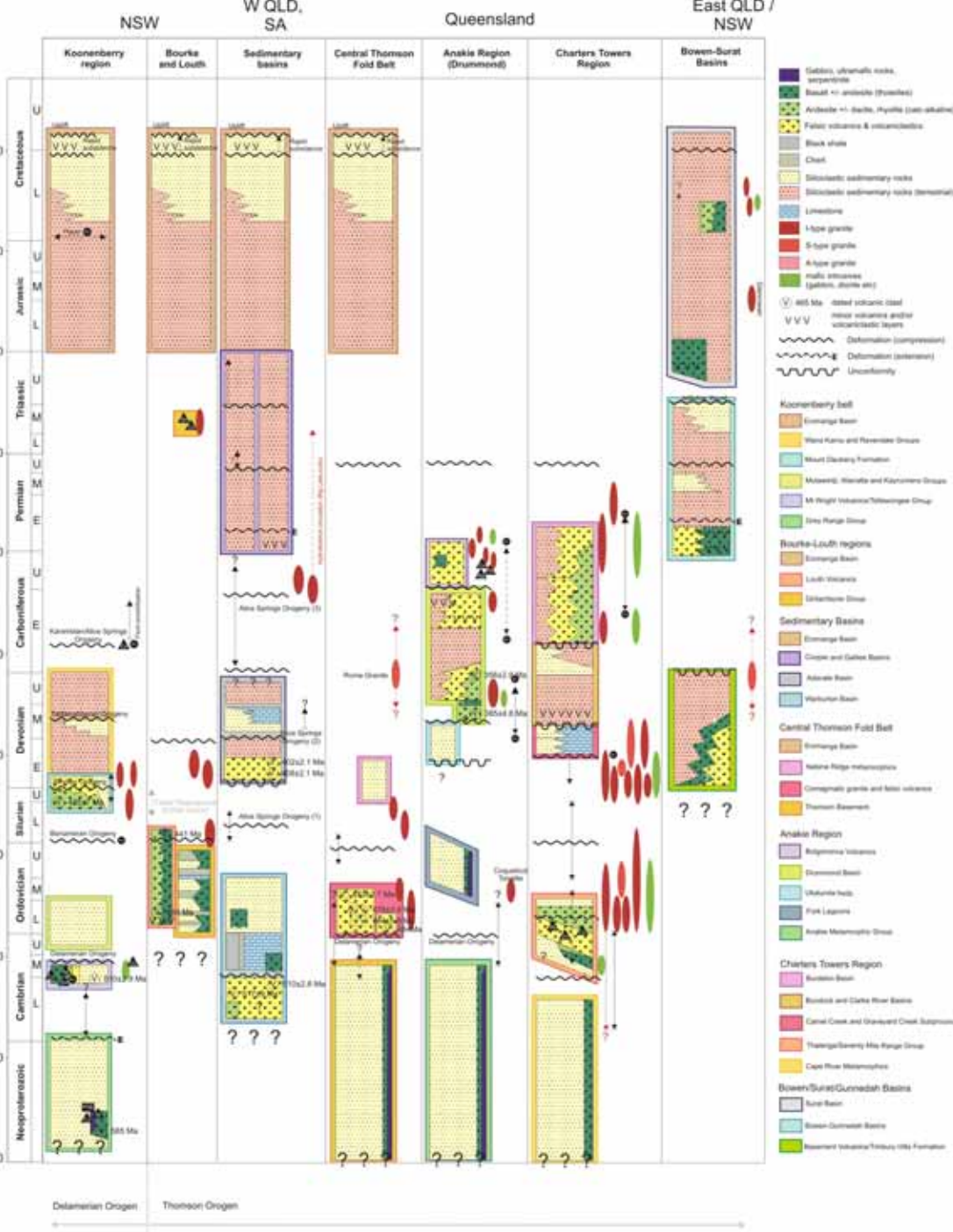
**Second in series synthesising geodynamic evolution of Australia**

[https://www.ga.gov.au/products/servlet/controller?event=GEOCAT\\_DETAILS&catno=68866](https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=68866)

Mines and Wines, September 2010

GEO SCIENCE AUSTRALIA

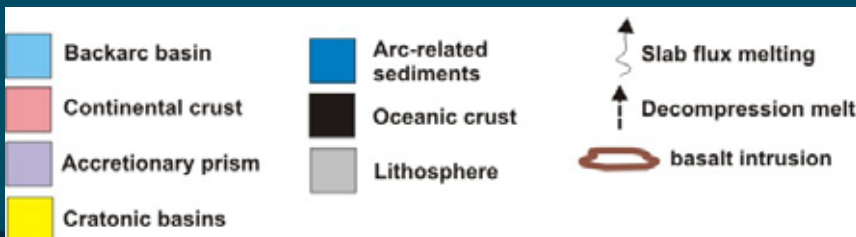
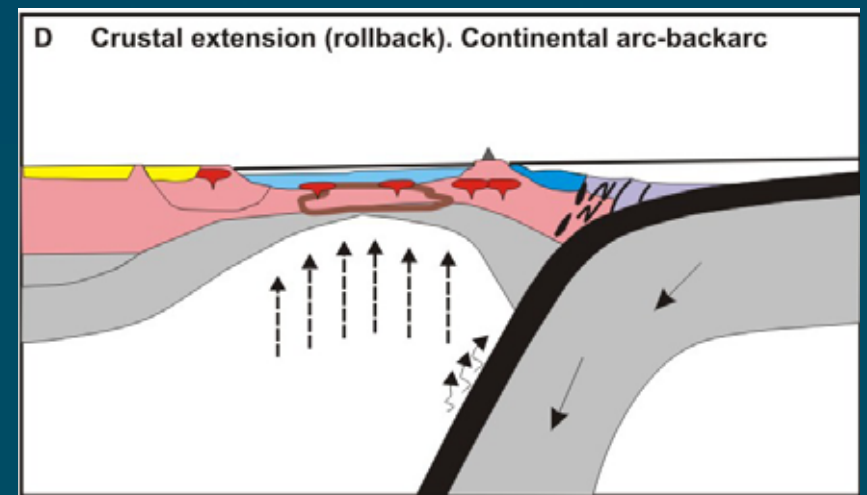
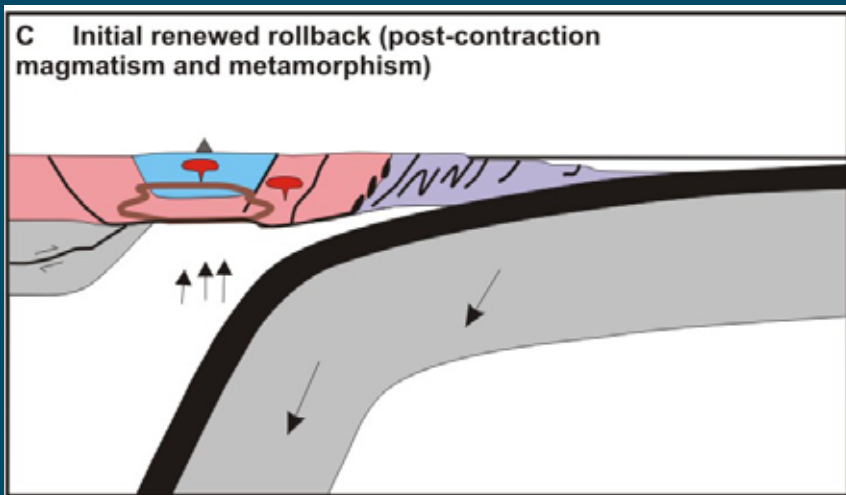
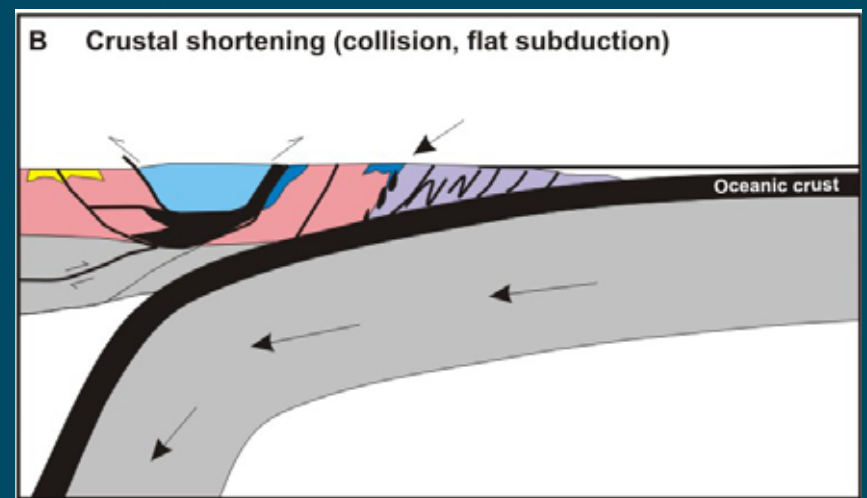
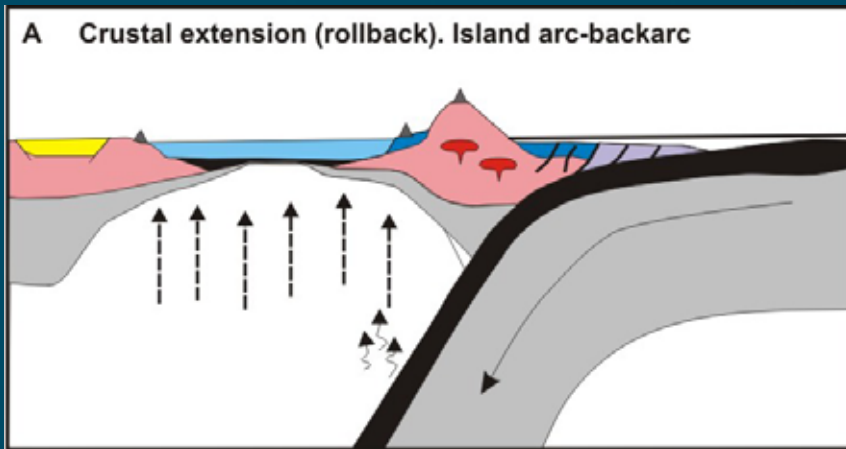




# Geologic synthesis (e.g., Thomson Orogen)

- Summarised geology by region
- Correlated across regions
- Produced time-space diagrams

Then correlated between orogens using cycle framework



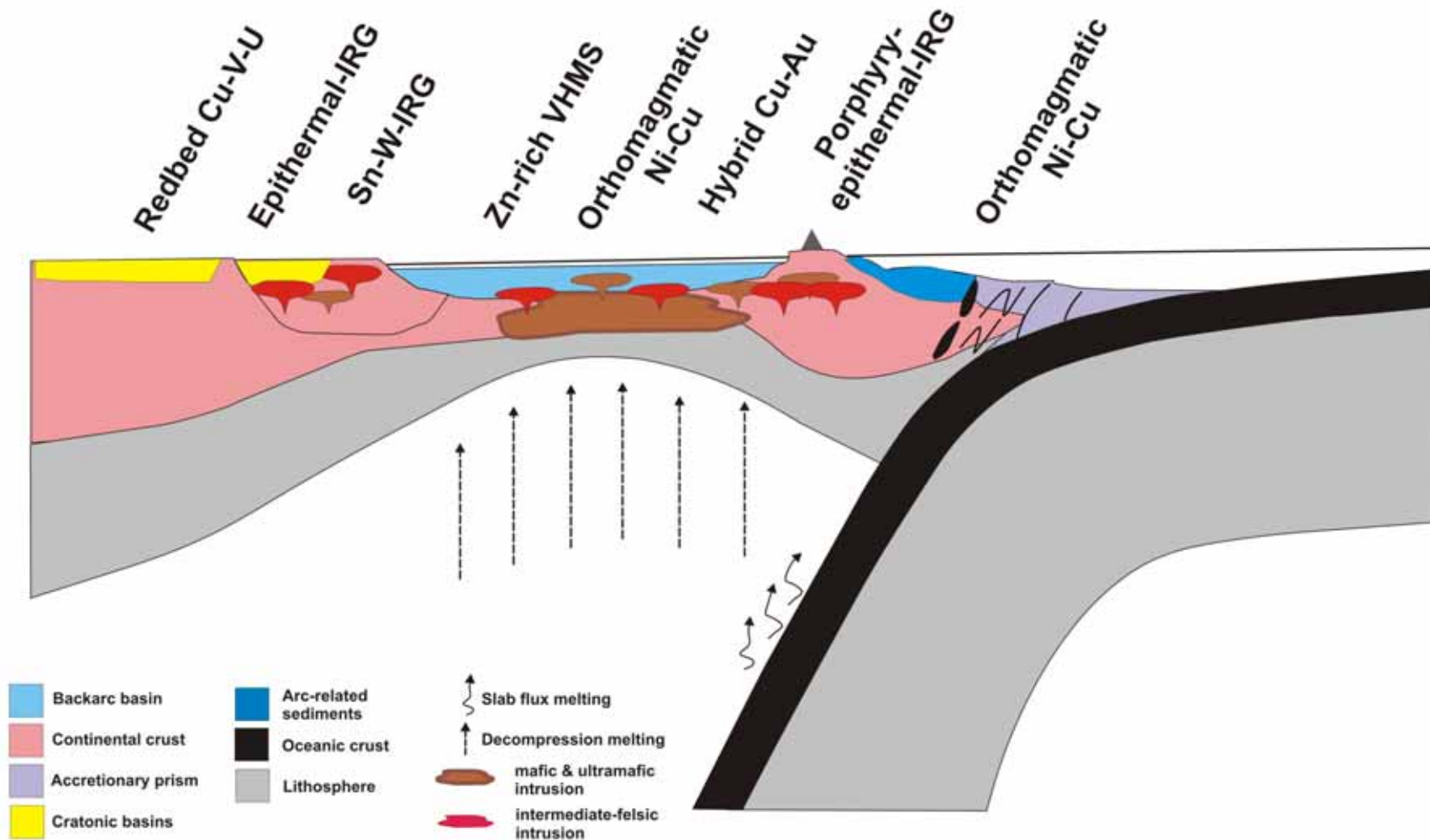
Tectonic synthesis – Cycles  
(e.g., Collins and Richards, 2008)

# Tectonic cycles of the Lachlan Orogen

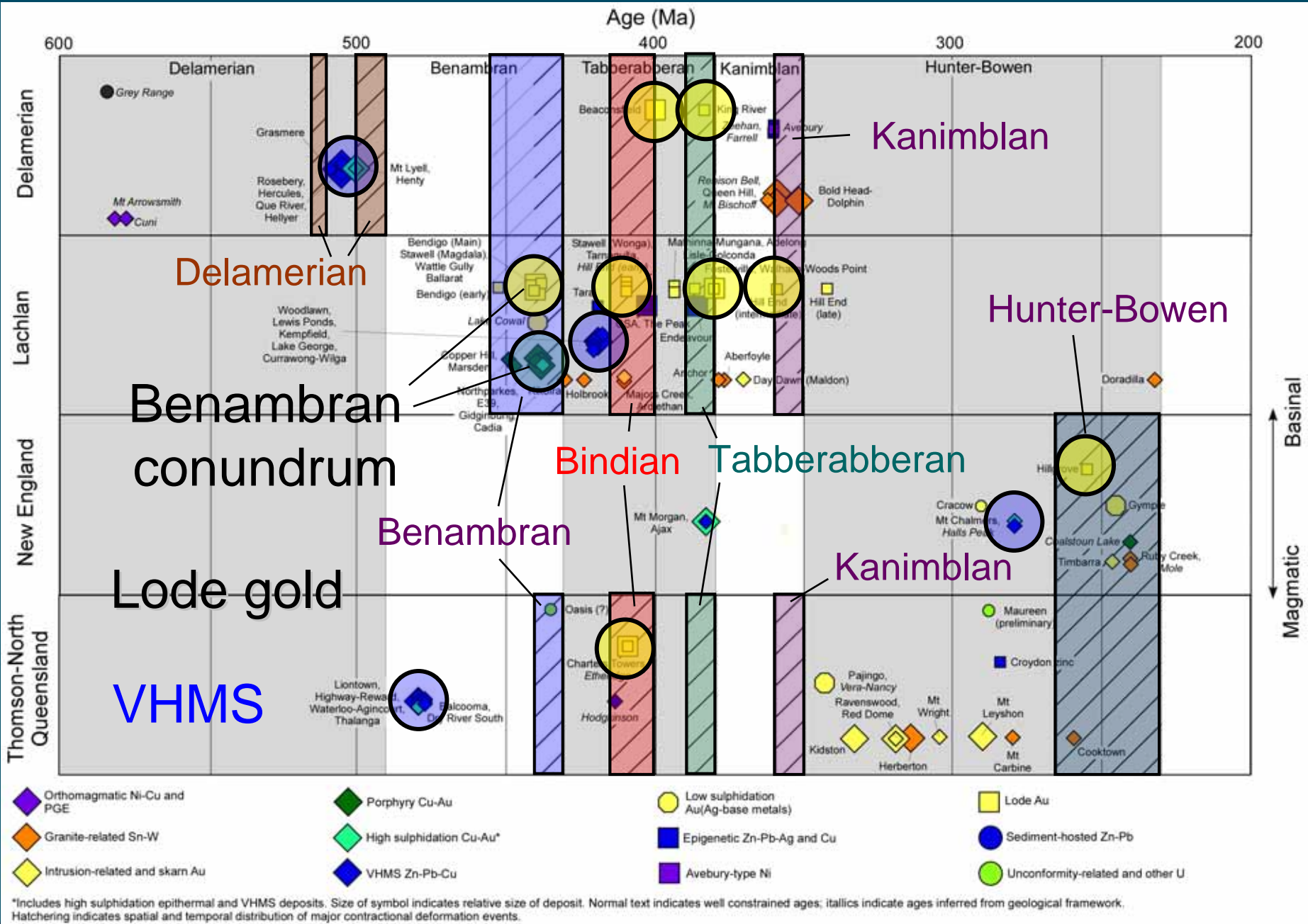
(following Glen, 2005; Gray and Foster, 2004)

Cycle	Age (Ma)
Delamerian	600-490
Benambran	490-430
Tabberabberan (includes Bindian)	430-380
Kanimblan	380-350
Hunter-Bowen	350-230

# Deposit synthesis and mineral potential assessment

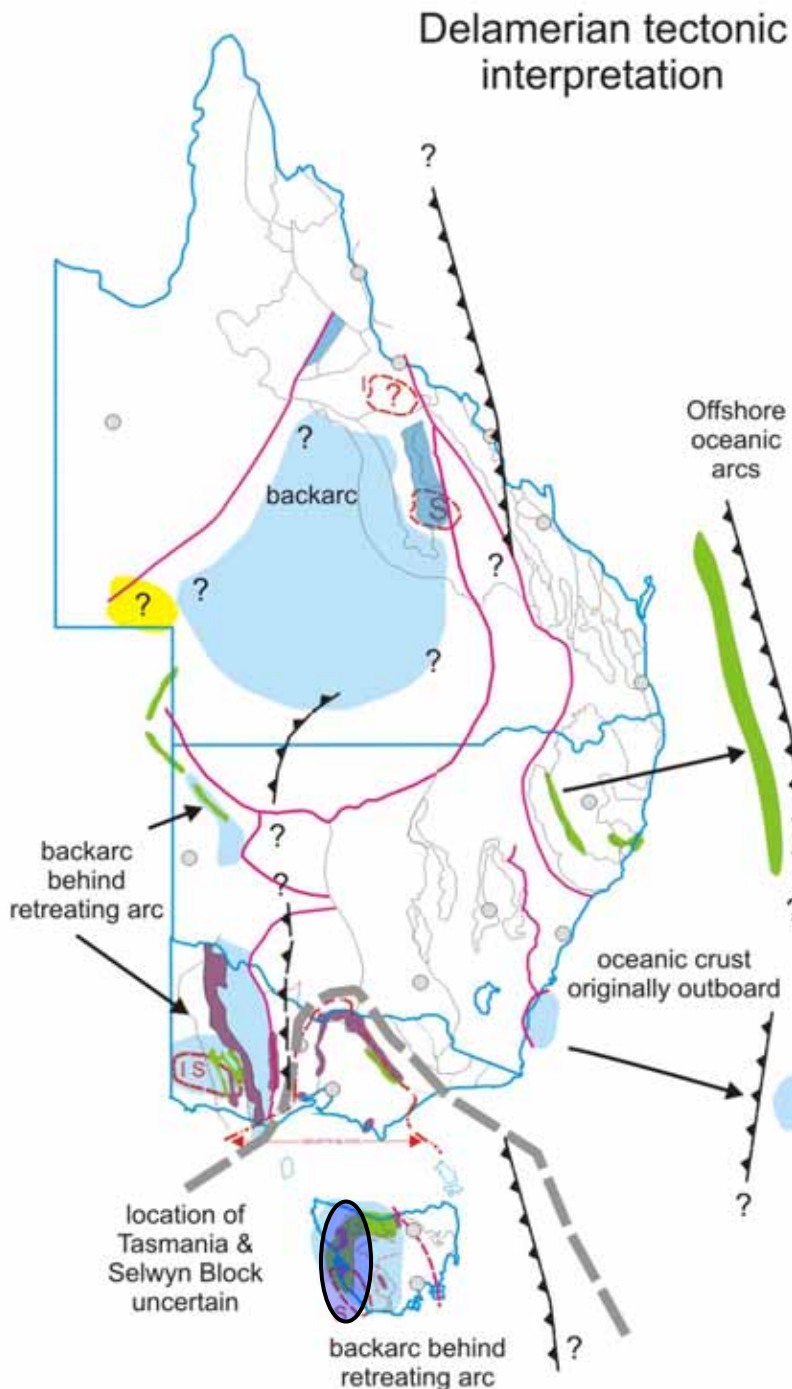


Base after Collins and Richards (2008)



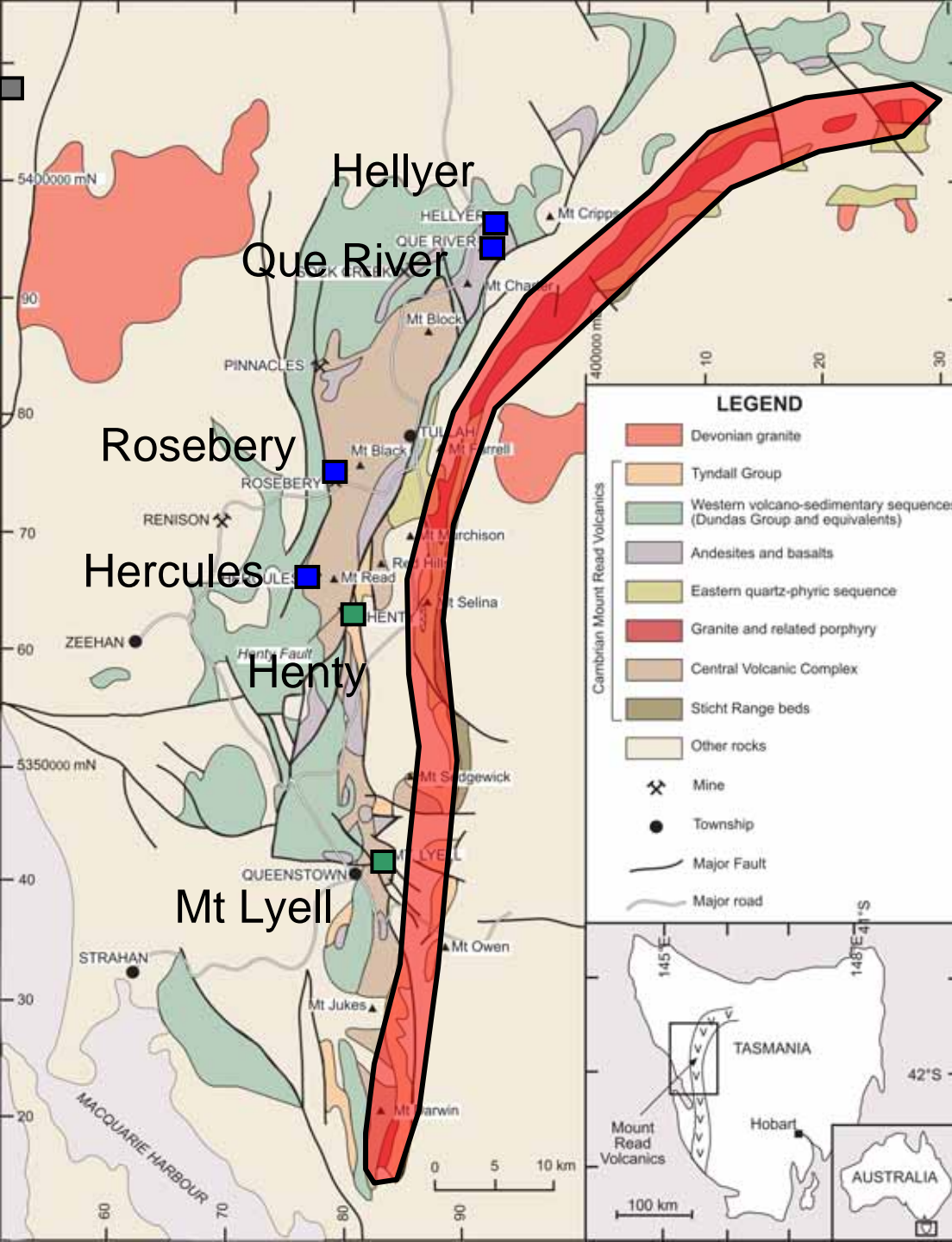


# Delamerian Cycle (>600-490 Ma)



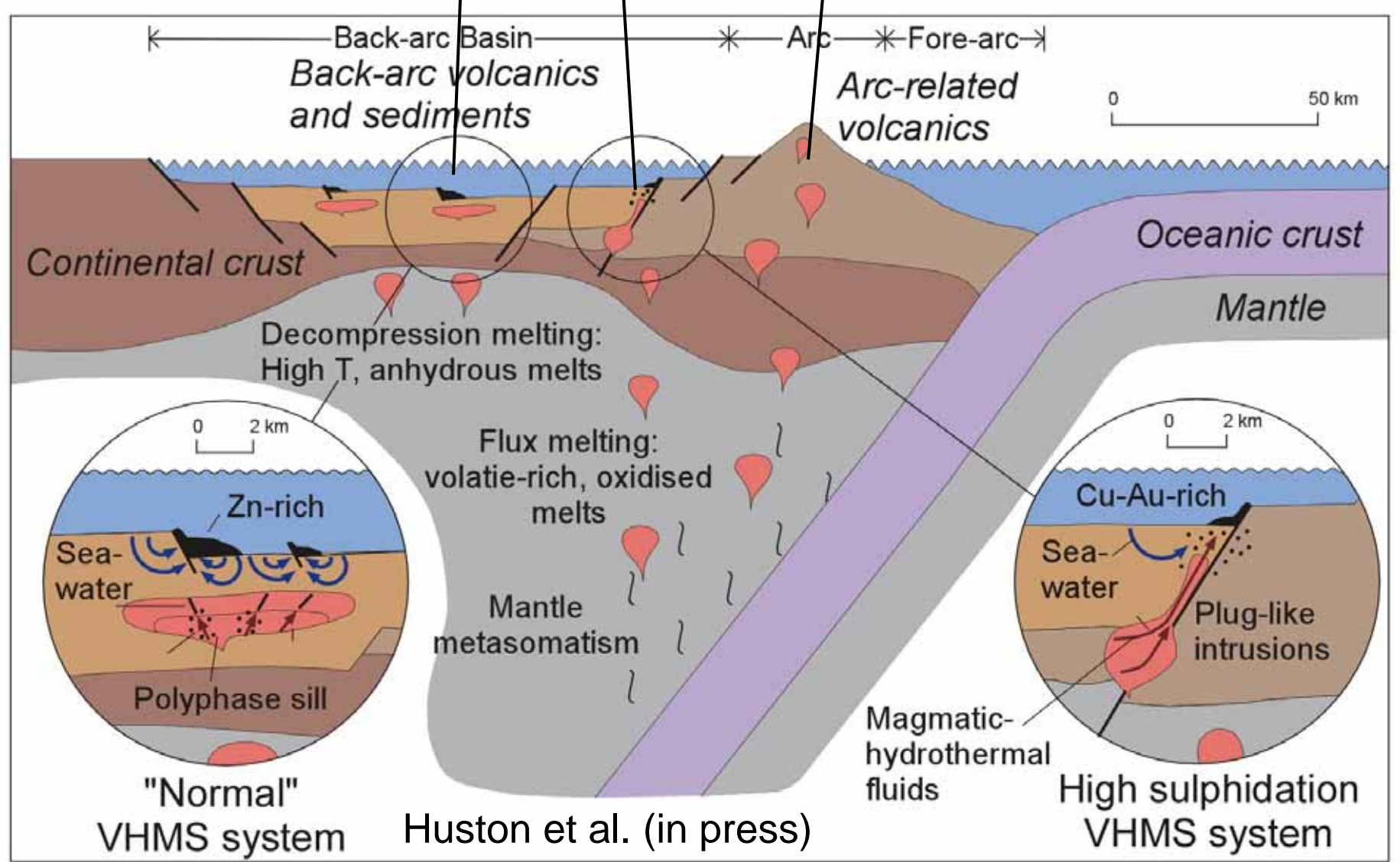
- Developed along margins of Proterozoic Australia
- Extensive felsic and mafic volcanics and associated sediments
- Deep marine turbiditic sediments
- Restricted granites
- Began with Rodinia break-up
- Ended with Delamerian Orogeny (ca. 520-490 Ma)
- Interpreted west-dipping subduction
- Relative position of Tasmania and Selwyn Block uncertain
- VHMS and hybrid Cu-Au deposits in western Tasmania

# Mt Read Volcanics













- Middle Cambrian (~505 Ma) calc-alkaline volcanics
- Coeval granite belt on eastern margin
- Two groups of deposits
  - Hybrid Cu-Au and Au deposits
    - More proximal to granite belt
    - Advanced argillic alteration assemblages
    - Age:  $500.4 \pm 2.3$  Ma (Re-Os)
    - Magmatic-hydrothermal?
  - VHMS Zn-Pb deposits
    - More distal to granite belt
    - Sericite-chlorite assemblages
- Link to Savage River Fe?
  - Some late Cambrian ages (Bottrill and Taheri, 2010)
  - Apatite-magnetite

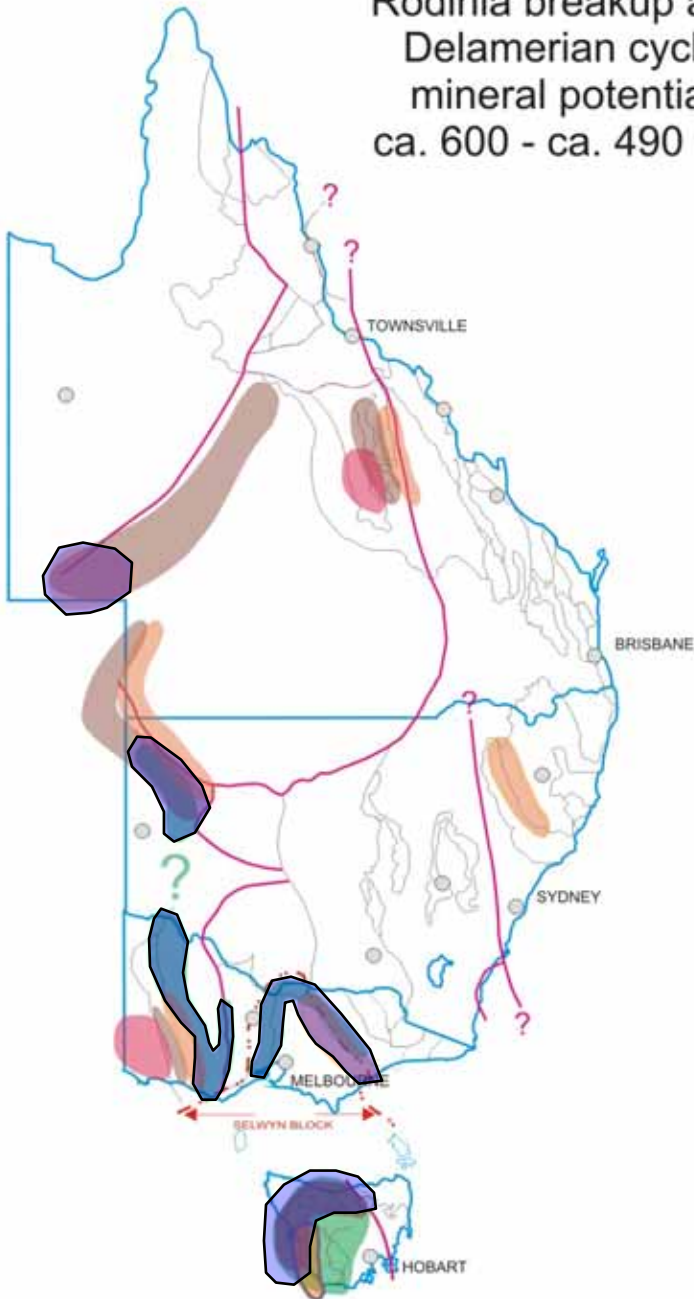
Rosebery Eastern granite belt  
Mt Lyell



Rodinia breakup and  
Delamerian cycle  
mineral potential  
ca. 600 - ca. 490 Ma

LEGEND

-  Hydrothermal Ni
-  Orthomagmatic Ni-Cu-PGEs
-  Mississippi Valley-type Zn-Pb
-  VHMS and sediment-hosted Zn-Pb
-  Sn-W, IRG and porphyry Mo $\pm$ -Cu
-  Porphyry, epithermal, and hybrid Cu-Au
-  Lode Au
-  Structurally controlled Zn-Pb-Ag and Cu-Au
-  City or town
-  Deformation event

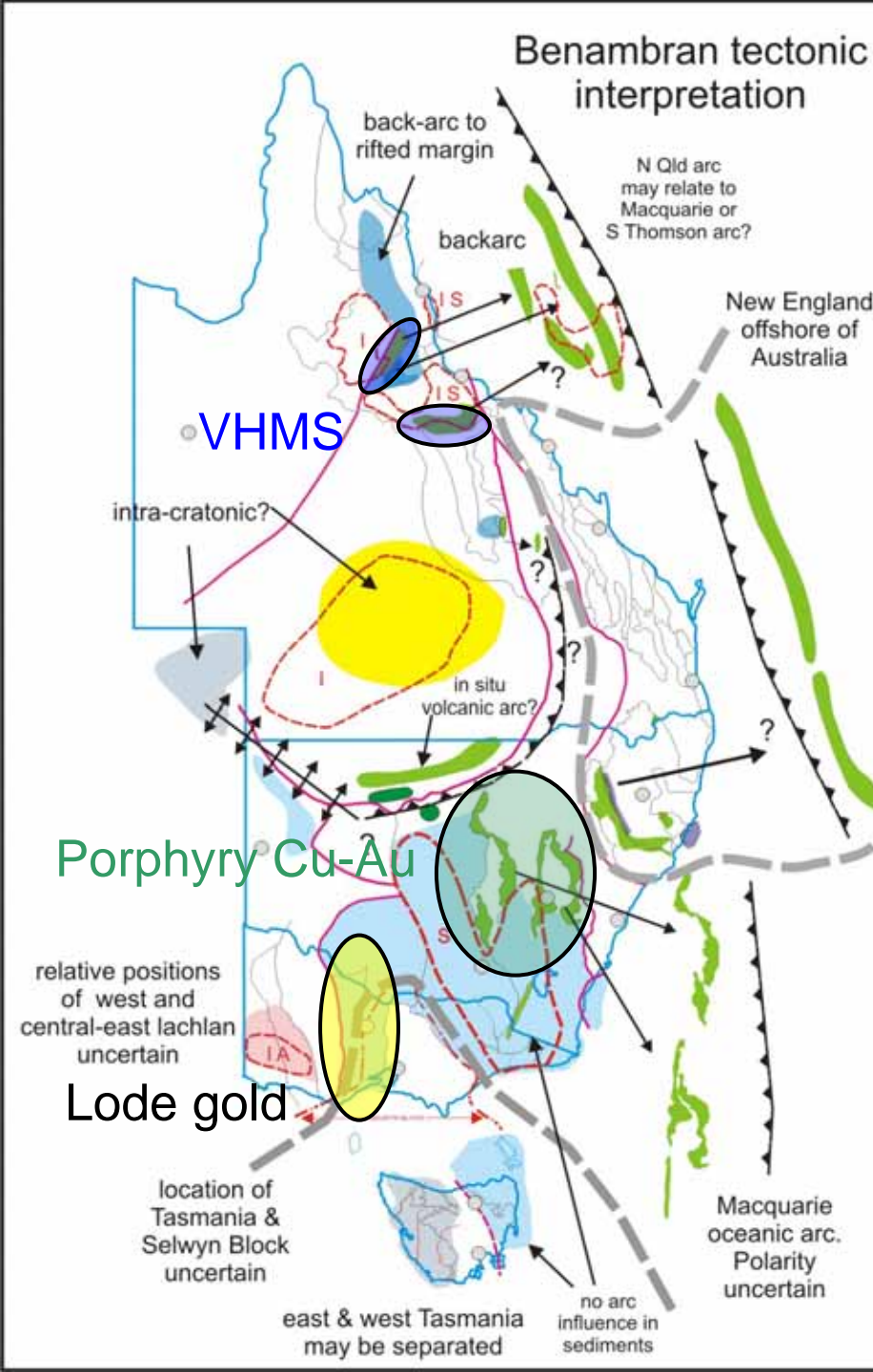


# Delamerian Cycle mineral potential

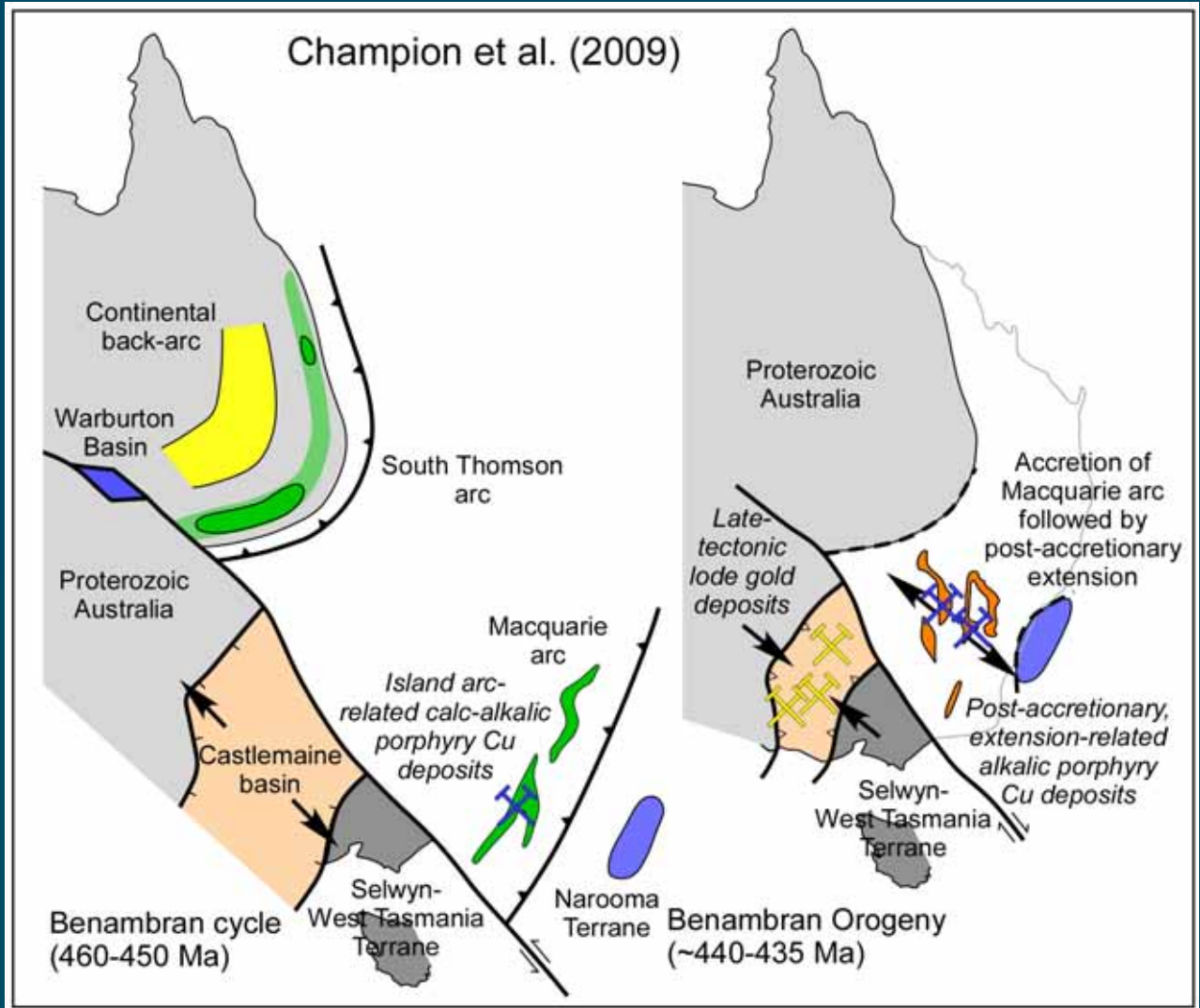
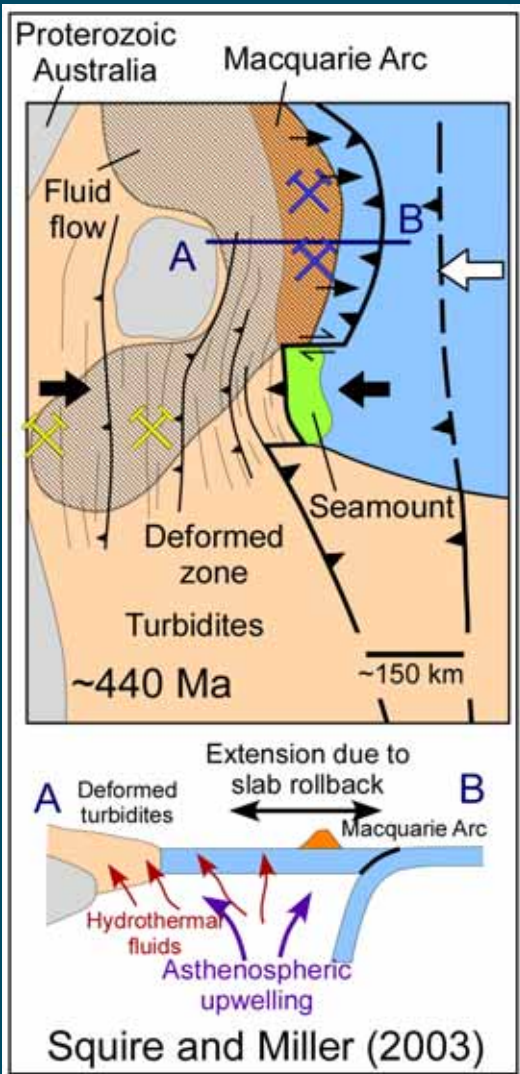
- VHMS/Cu-Au & Ni-Cu-PGE potential extends into central and western Victoria, Koonenberry belt, Warburton Basin
- Is there a relationship to recently discovered VHMS deposits in Mt Riddoch Igneous Complex in Northern Territory?
- What is relationship of Savage River iron to this cycle and Mt Read mineral system?

# Benambran Cycle (490-430 Ma)

- Widespread non-volcanic deep water sediments, and
- Calc-alkaline to shoshonitic magmatic arcs
- Ended with Benambran Orogeny (ca. 450-430 Ma)
- Subduction environment, complex configuration, modified by subsequent tectonism
- Relative position of Tasmania and Selwyn Block uncertain
- VHMS in north Queensland
- Major contemporaneous ore deposition in Victoria (Au) and NSW (Cu-Au)

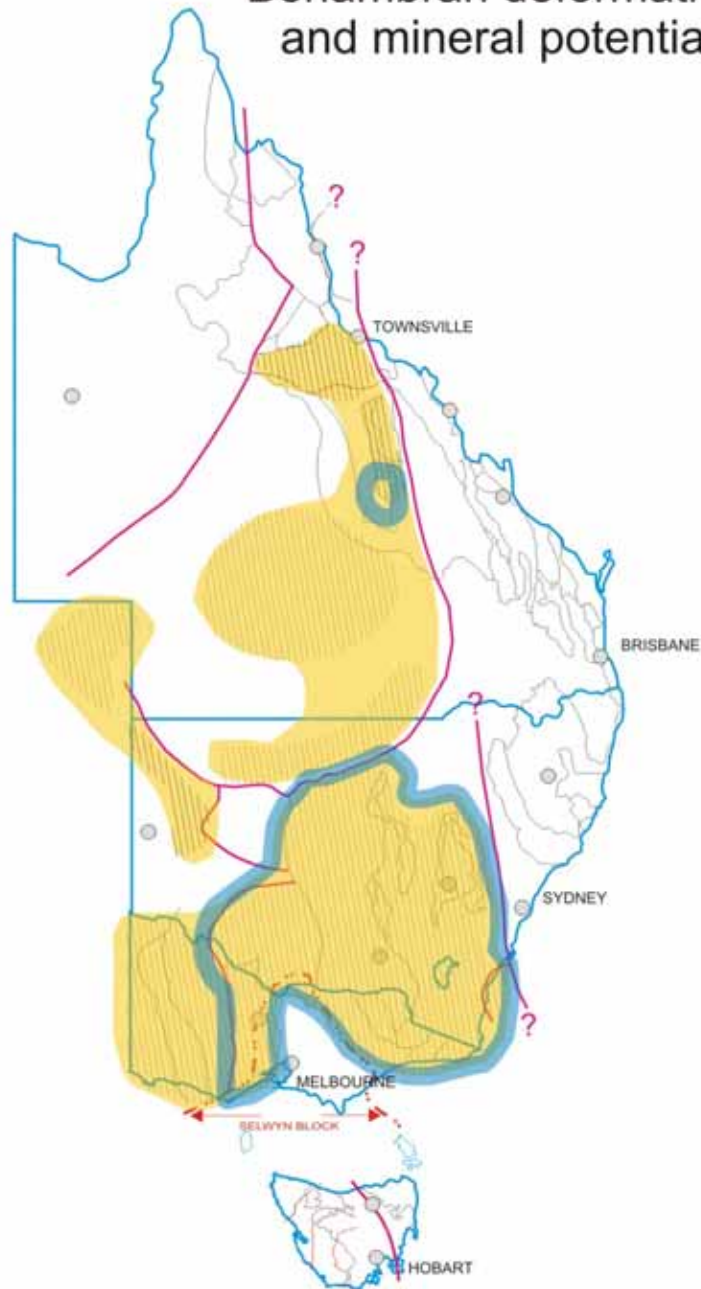


# Juxtaposition of Benambran lode Au and porphyry Cu-Au













Alternatively, Cayley (2010) inferred that the Macquarie Arc was transported southward during the Bindian Orogeny

## Benambran deformation and mineral potential

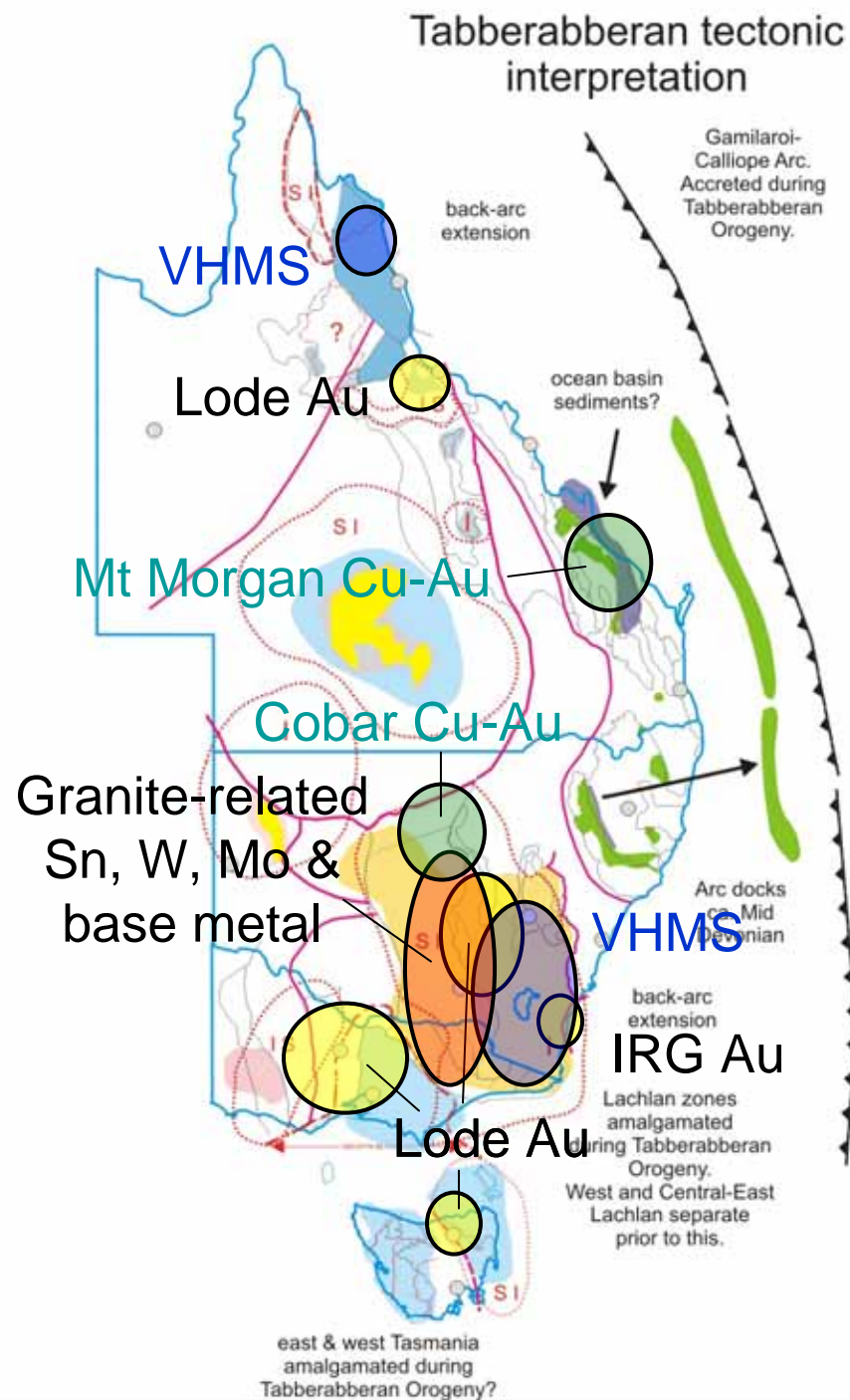


## LEGEND

-  Hydrothermal Ni
-  Orthomagmatic Ni-Cu-PGEs
-  Mississippi Valley-type Zn-Pb
-  VHMS and sediment-hosted Zn-Pb
-  Sn-W, IRG and porphyry Mo+/-Cu
-  Porphyry, epithermal, and hybrid Cu-Au
-  Lode Au
-  Structurally controlled Zn-Pb-Ag and Cu-Au
-  City or town
-  Deformation event

## Benambran Cycle mineral potential

- Interpreted widespread potential for VHMS & Cu-Au/Au early in the cycle
- Lode Au and porphyry Cu-Au late in the cycle
- Ar-Ar data suggests contemporaneous U mineralisation associated with shears in north Queensland



# Tabberabberan Cycle (430-380 Ma)

- Widespread felsic magmatism
- Deep water sedimentation (Selwyn Block-Tasmania, north Queensland) and localised volcanic basins (NSW)
- West dipping subduction formed oceanic? Gamilaroi-Calliope Arc
- Ended with Tabberabberan Orogeny (ca. 390-380 Ma)
- Includes ca. 420-400 Ma Bindian Orogeny
- Final amalgamation of Lachlan
- Early cycle VHMS and granite-related mineralisation
- Bindian lode and intrusion-related gold and Cobar-type copper-gold
- Hybrid copper-gold (Mt Morgan)



# New England Orogen

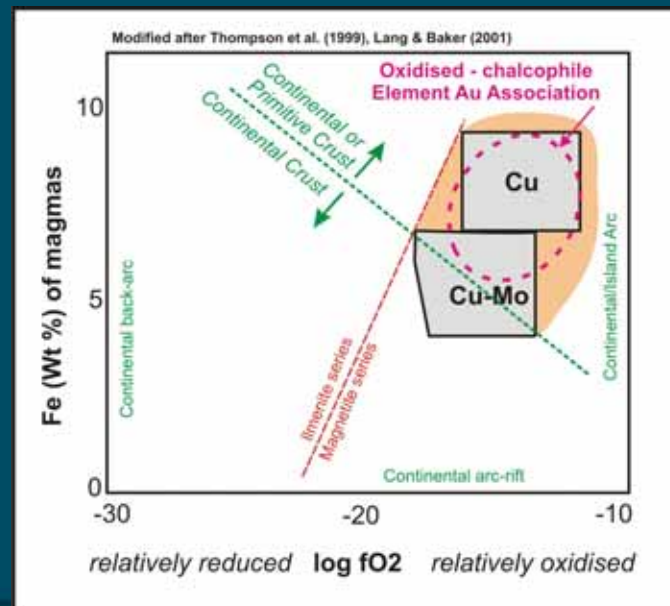
Mt Morgan

Calliope Arc  
(Devonian)

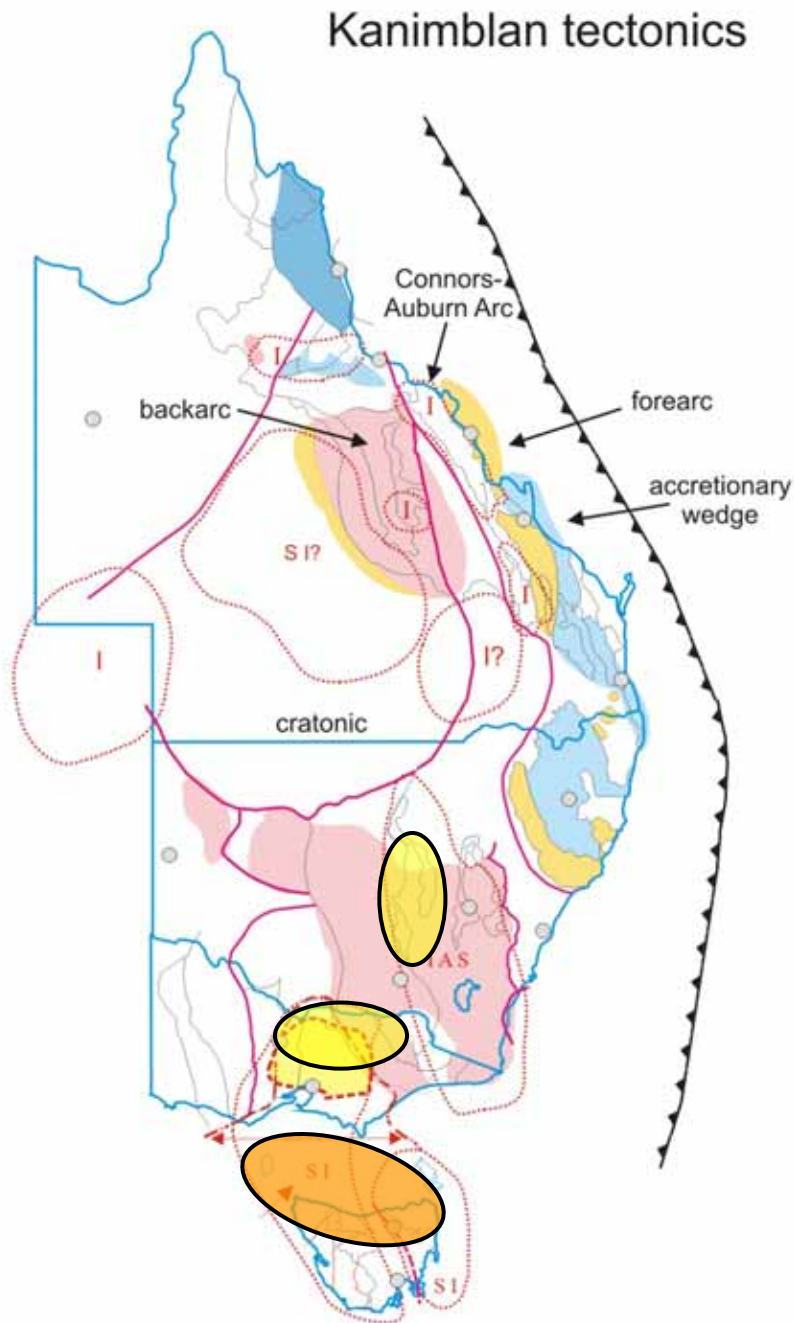
Gamilaroi  
Terrane  
(pre Silurian – Mid  
Devonian)

# Gamilaroi-Calliope Arc

- 425-380 Ma island arc – western margin of New England Orogen
- Extends from northern New South Wales to central Queensland
- Hosts ~380 Ma Mt Morgan Au-Cu
- Potential under cover for Cu-Au, Cu-Mo and Au deposits

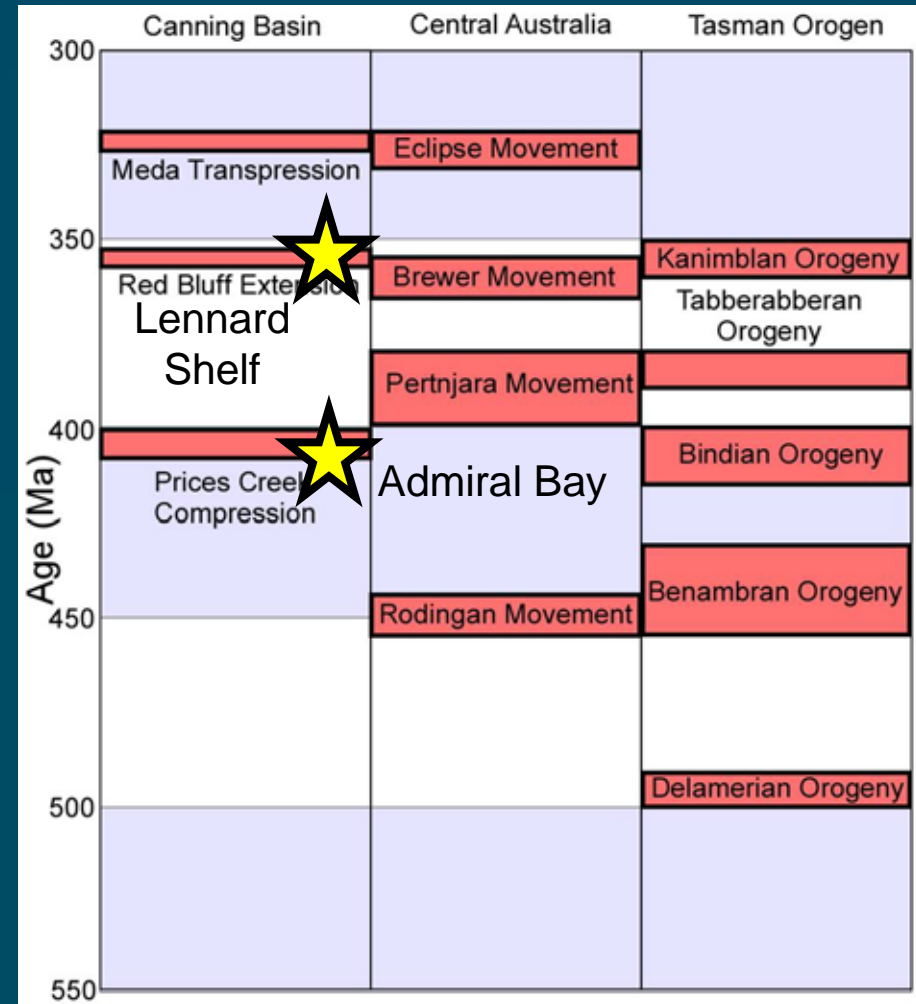
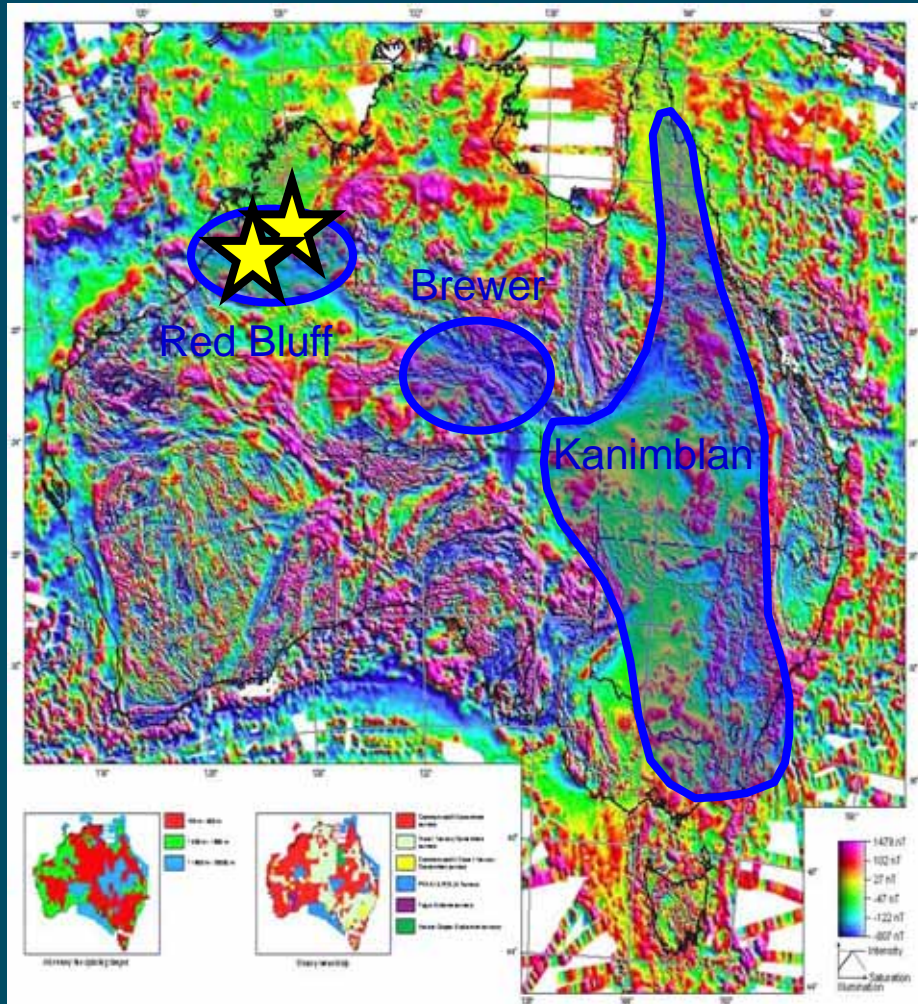


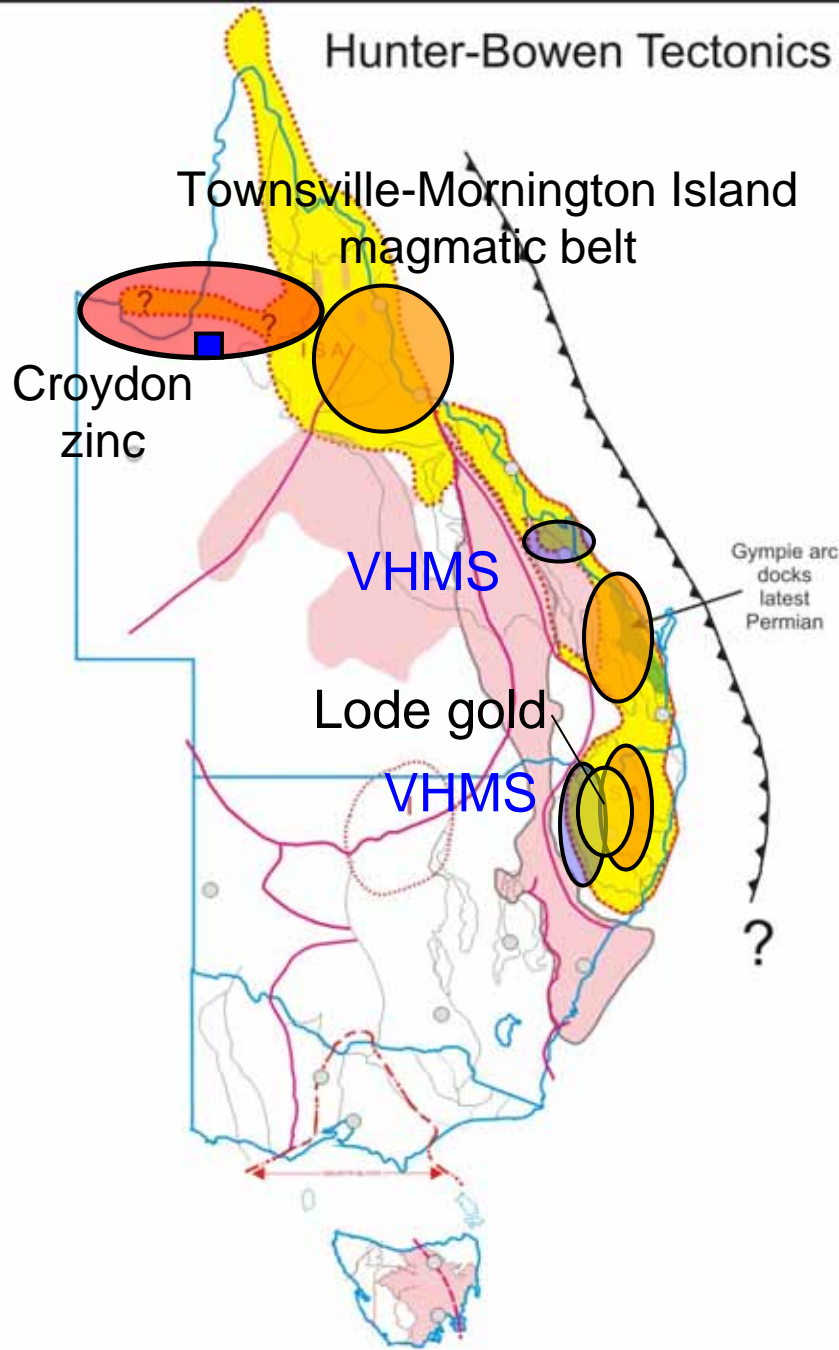
# Kanimblan Cycle (380-350 Ma)



- Widespread felsic magmatism
- Deep water sedimentation (north Queensland, New England Orogen)
- Terrestrial sedimentation elsewhere
- Andean-style continental arc, New England orogen
- Widespread intracratonic extension, rifting & basin formation, back-arc and inboard of arc
- Ended with Kanimblan Orogeny (ca. 350 Ma)
- Granite-related Sn-W in Tasmania
- Lode gold, Victorian Goldfields and Hill End Trough

# Kanimblan Cycle – links to intracontinental deformation and mineralisation?



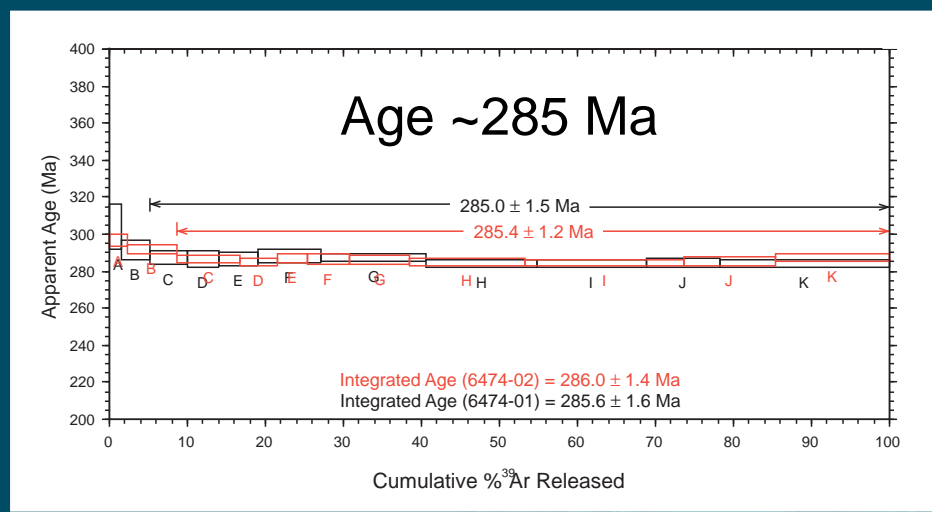
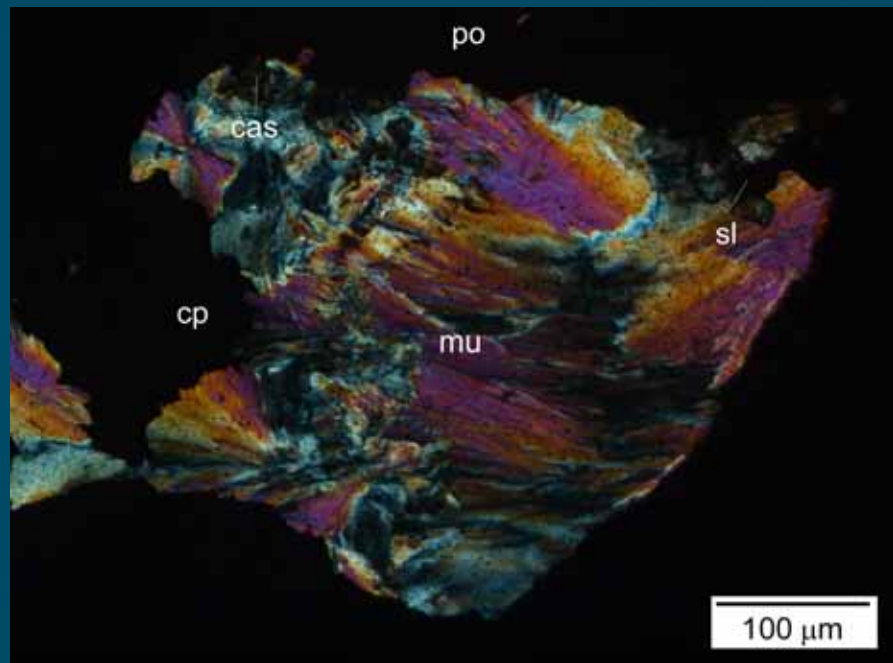
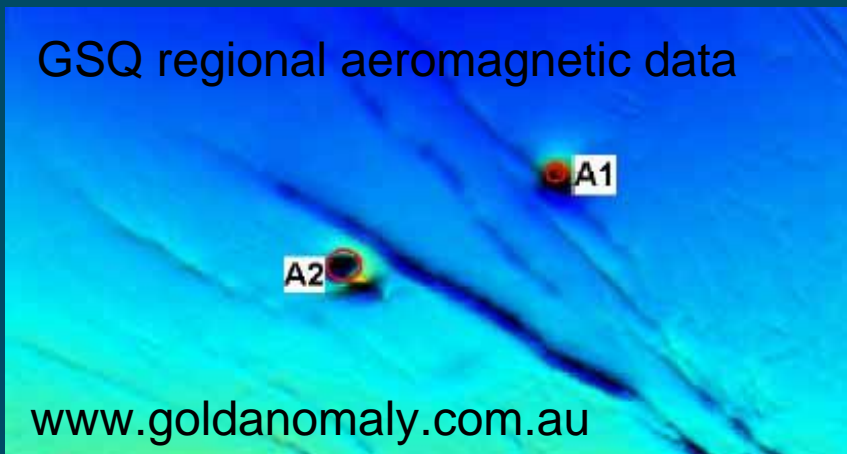


# Hunter-Bowen Cycle (350-230 Ma)

- Terrestrial to marine sediments
- Widespread Kennedy Province magmatism
- Andean-style continental arc, New England orogen
- Sydney-Gunnedah-Bowen system - backarc
- Ended with Hunter-Bowen Orogeny (ca. 265-230 Ma)
- Extensive Sn-W, IRG, porphyry Cu-Mo-Au, epithermal Au associated with Kennedy magmatism
- Lode gold, VHMS

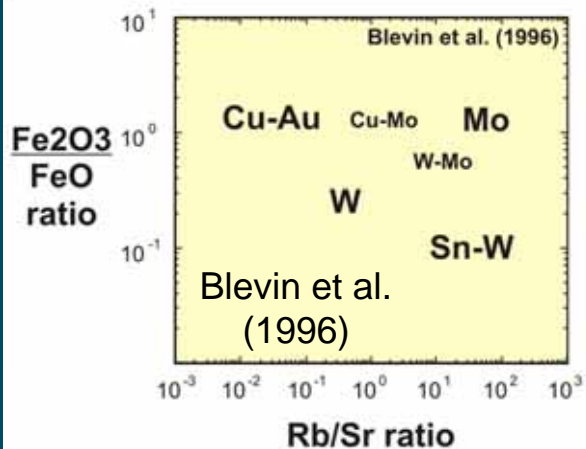
# New results – Croydon zinc-copper-tin

GSQ regional aeromagnetic data

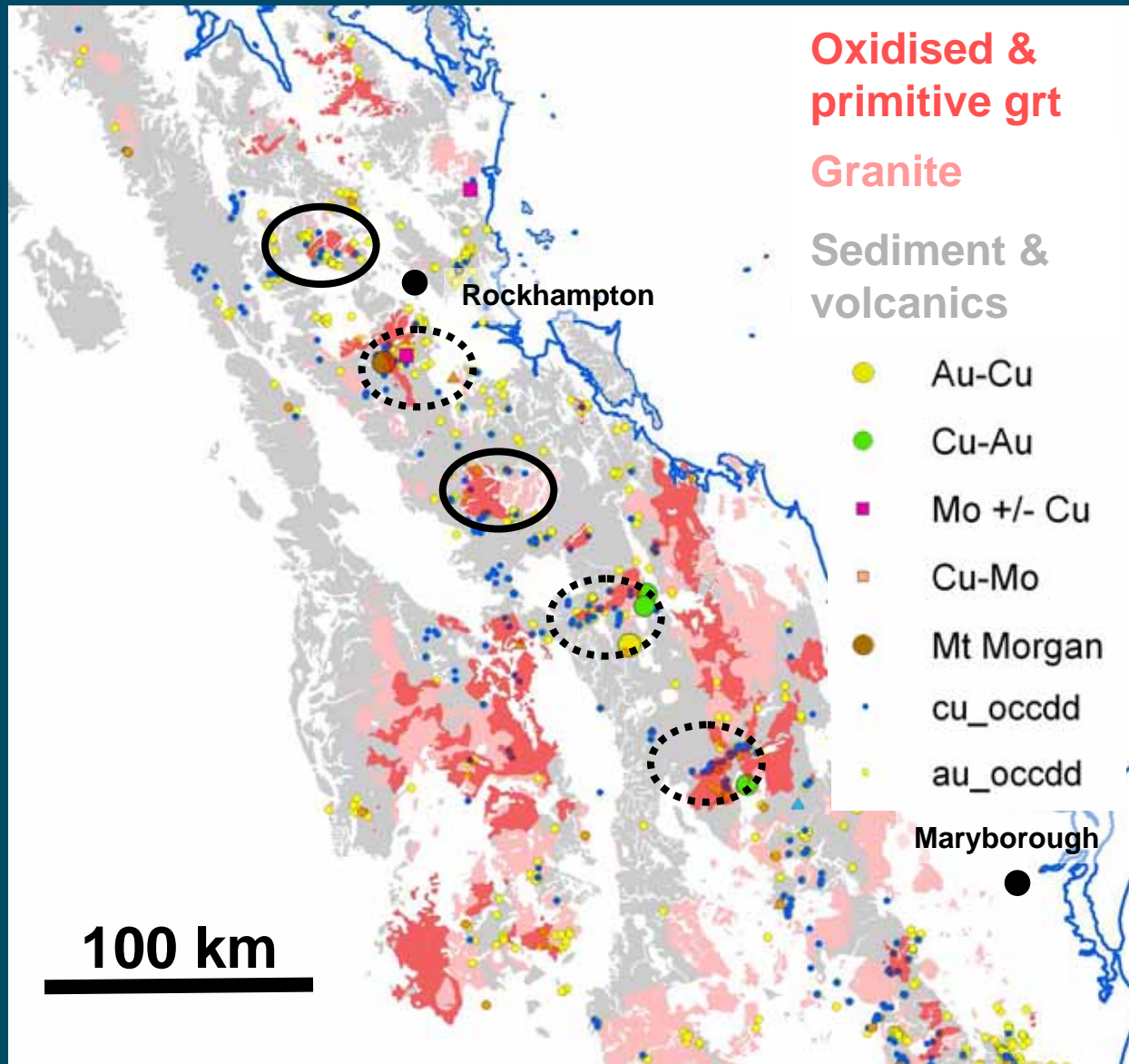
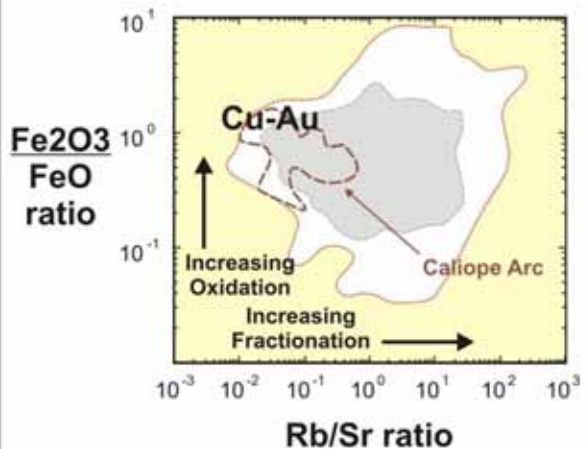


# Kennedy Province – New England Orogen

## Igneous Metallogeneses



## Igneous Metallogeneses



# Conclusions

- Mineralisation is linked to tectonic cycles that developed episodically during the evolution of the Tasman Orogen
- The style of mineralisation is related to both spatial and temporal location within each cycle
- Because of this cyclicity, there have been repeated mineralising events of different types (e.g., VHMS, lode gold)
- These relationships can be used to predict locations and periods of mineralisation
- The evolution of the Tasman Orogen may have had significant repercussion in board – both in terms of orogenesis and mineralisation