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Geological Survey of New South Wales 

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new south wales

In The Beginning: Initiation Of Subduction And Arc Volcanism In The Tasmanides

Robert Musgrave

John Greenfield, Phil Gilmore & Stephen Dick

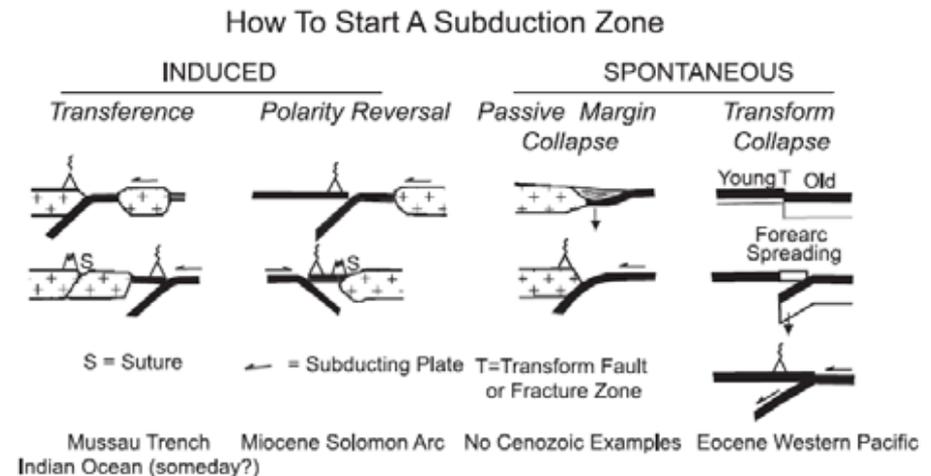
Geological Survey of NSW



Mines & Wines 2010, Mudgee

Initiating subduction

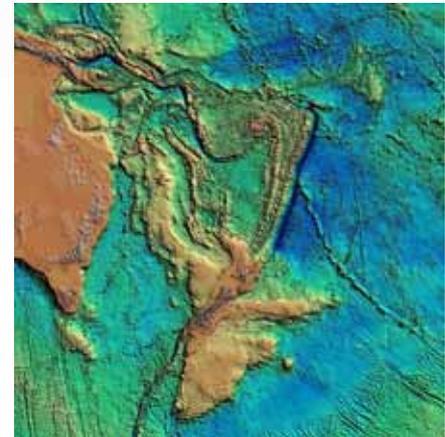
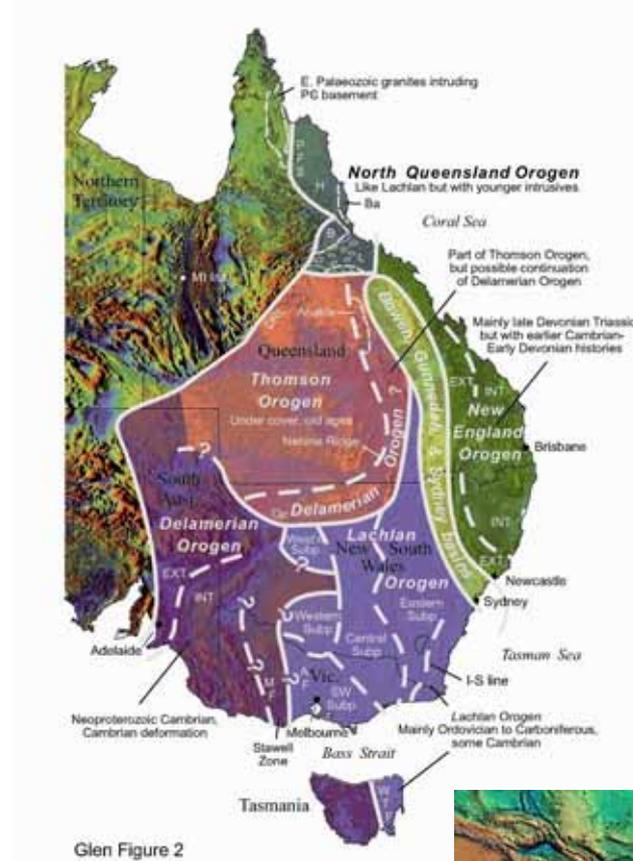
- Just how do new subduction systems start?
 - Review paper by Robert Stern, 2004
- Easy method is “induced nucleation of subduction zones” (INSZ)
 - Simply transferred convergence
 - Should be evidence of prior compressive tectonics
- “Spontaneous nucleation...” (SNSZ)
 - No pre-existing convergence
 - May reflect contrasting buoyancy across oceanic transform
 - Izu-Bonin-Marianas (IBM) example
 - Or maybe passive margin collapse?
 - But no clear example known
 - Must have happened at least once!



Stern, R., 2004, Subduction initiation: spontaneous and induced, *EPSL* **226**, 275-292

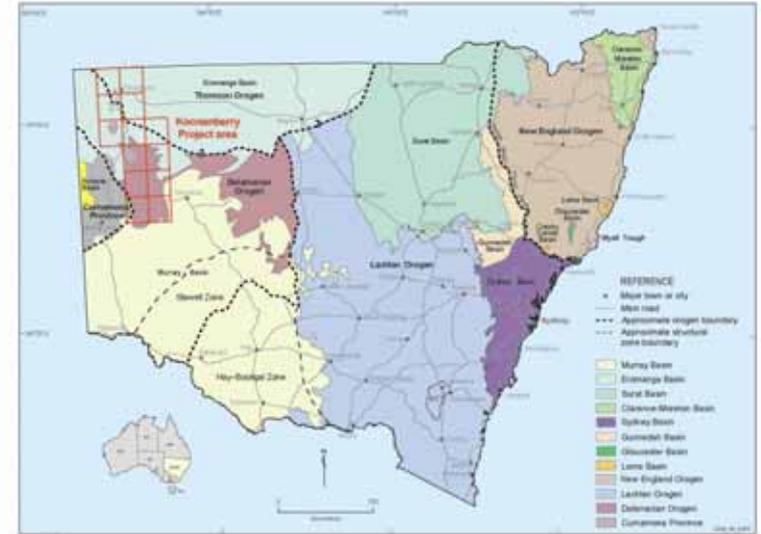
Initiating subduction in the Tasmanides

- Paleozoic Tasmanides built out from Gondwana margin.
 - Similar to modern SW Pacific.
- Problem: How did subduction start on the Neoproterozoic passive margin of Gondwana in south-eastern Australia?
- Tasmania and Victoria have Delamerian (Cambrian) boninites and ophiolites
 - IBM-style subduction-zone initiation along oceanic transform?
- But what about NSW?

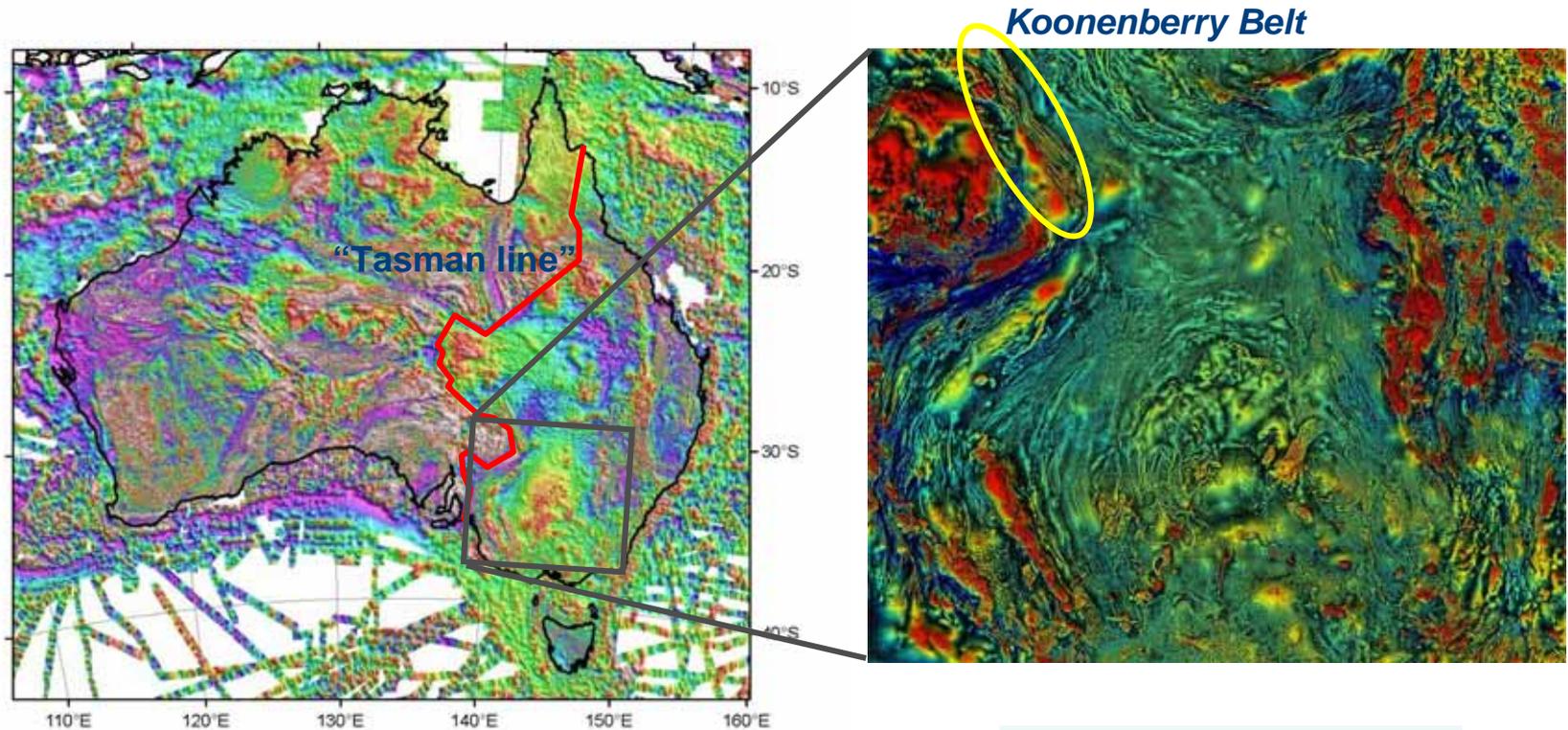


Koonenberry mapping project

- 2010 release
 - Explanatory Notes
 - 12 × 100K geological sheets
 - 4 × 25K special geologic sheets
- Outstanding result
 - A Cambrian arc/back-arc complex, complete with fore-arc, built on a late Neoproterozoic volcanic passive rifted margin.
 - Beginning of subduction in NSW



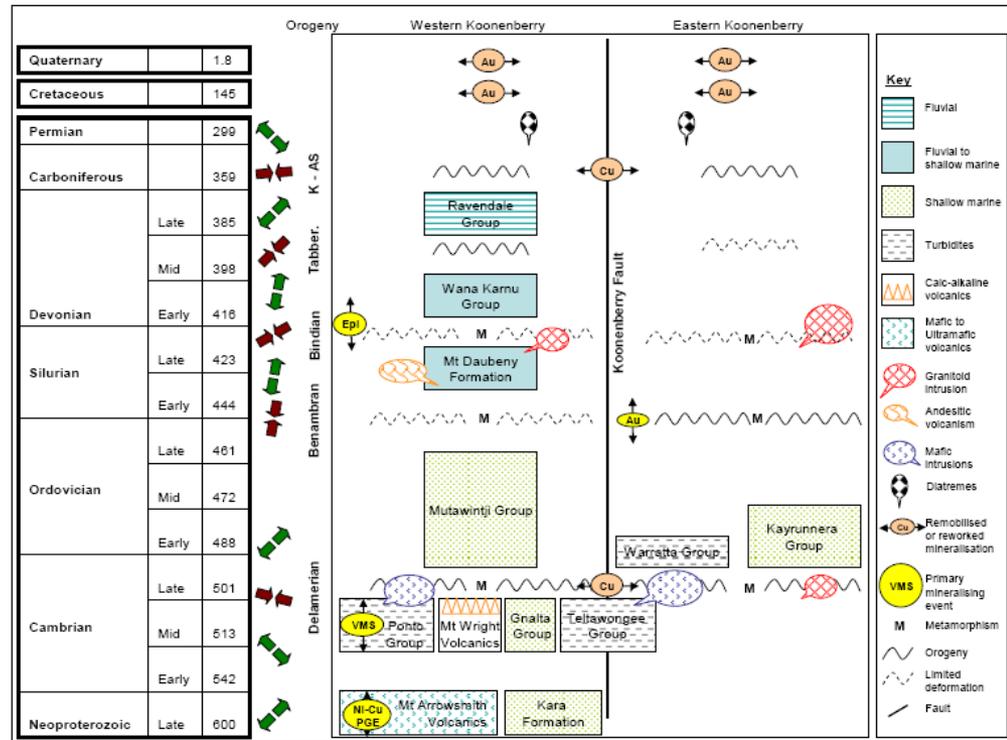
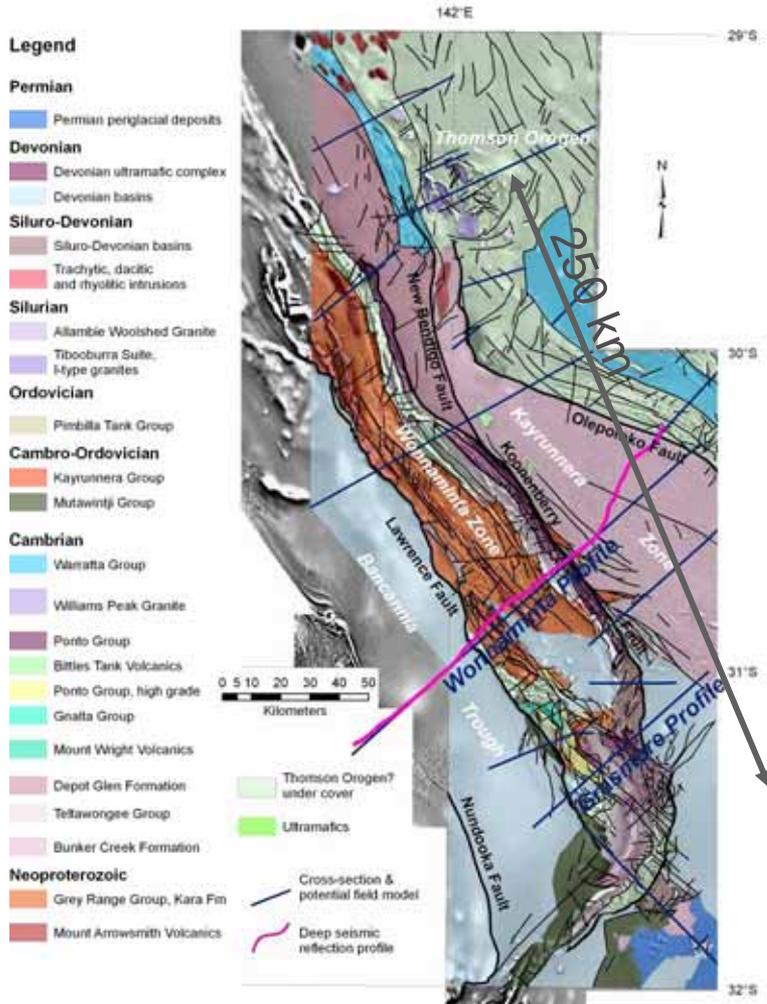
The Koonenberry Belt



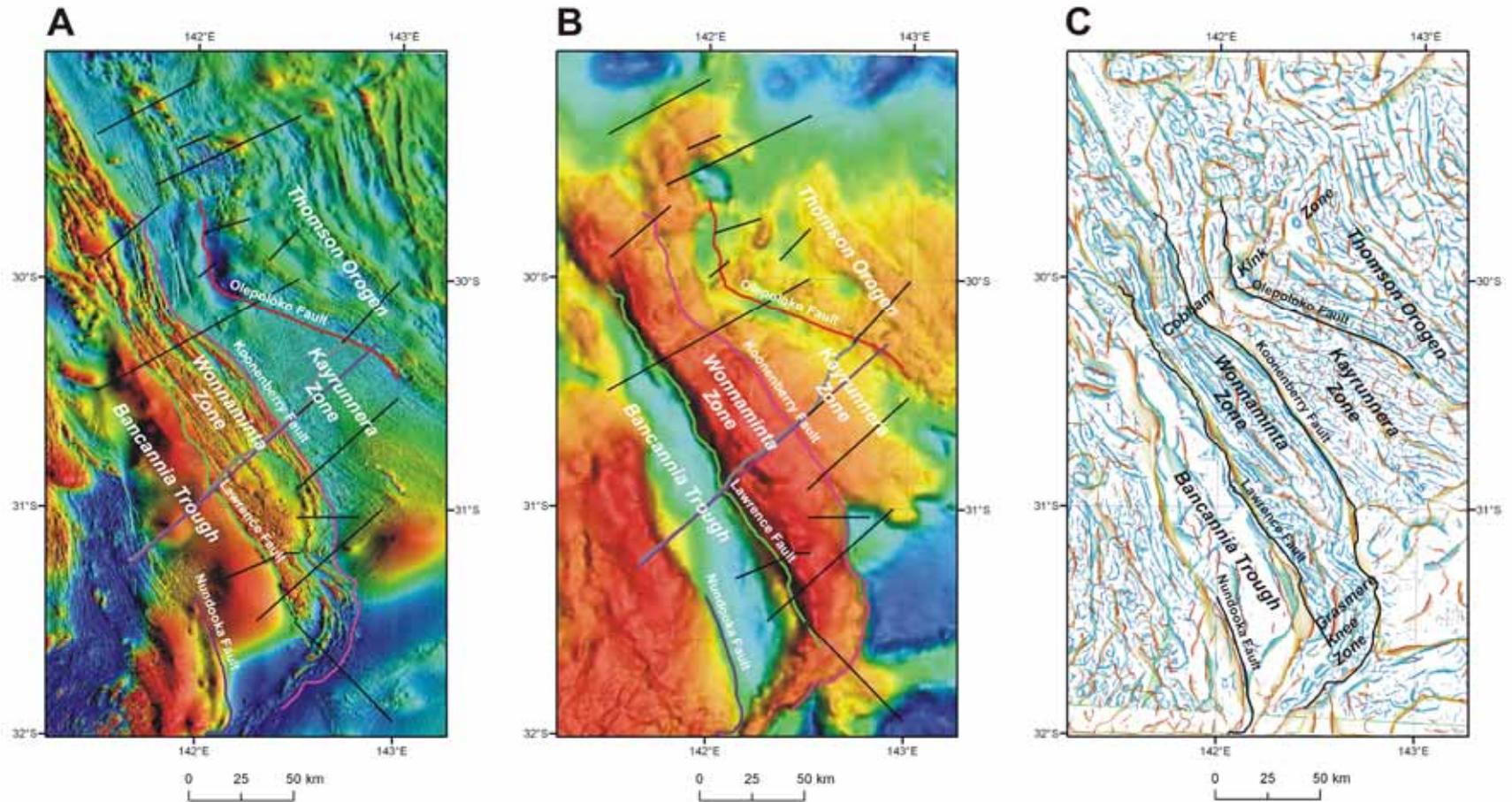
TMI
Geoscience Australia

Tilt-filter on TMI
Geological Survey of NSW

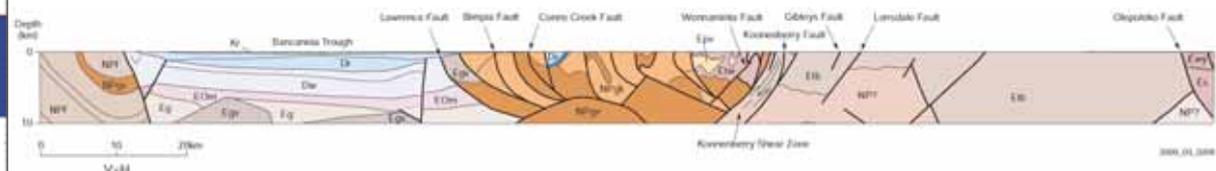
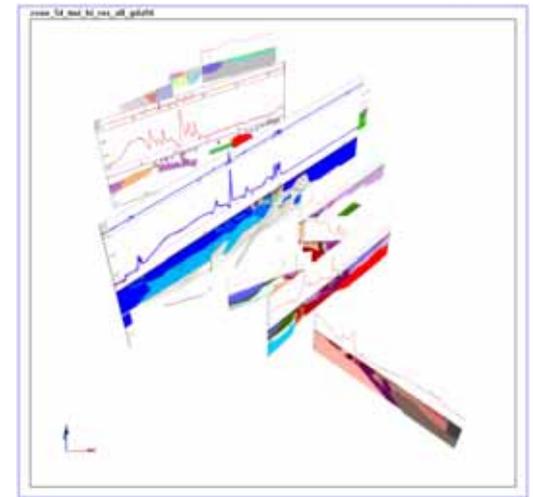
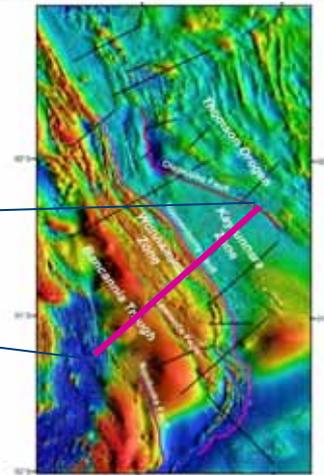
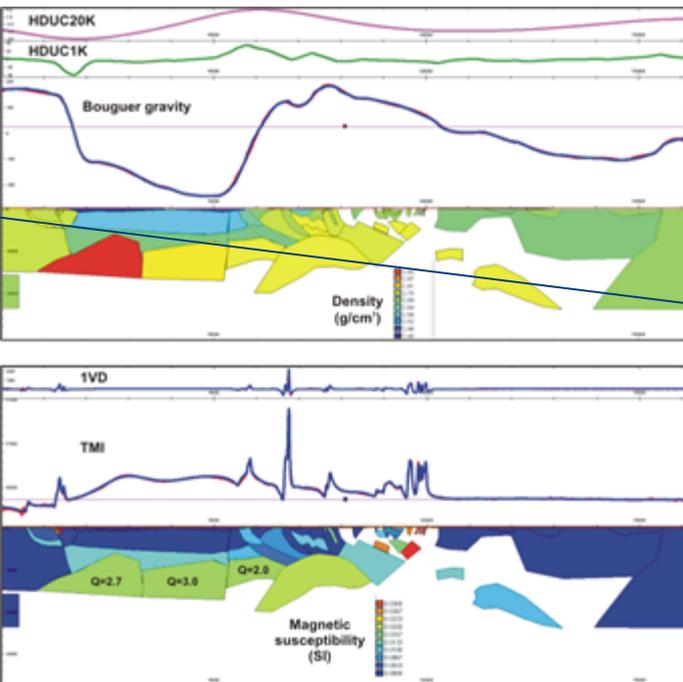
Koonenberry Belt: Geological outline



Koonenberry Belt: Geophysical structure

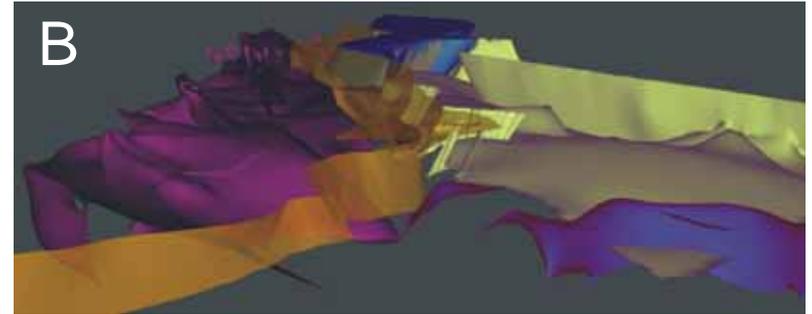
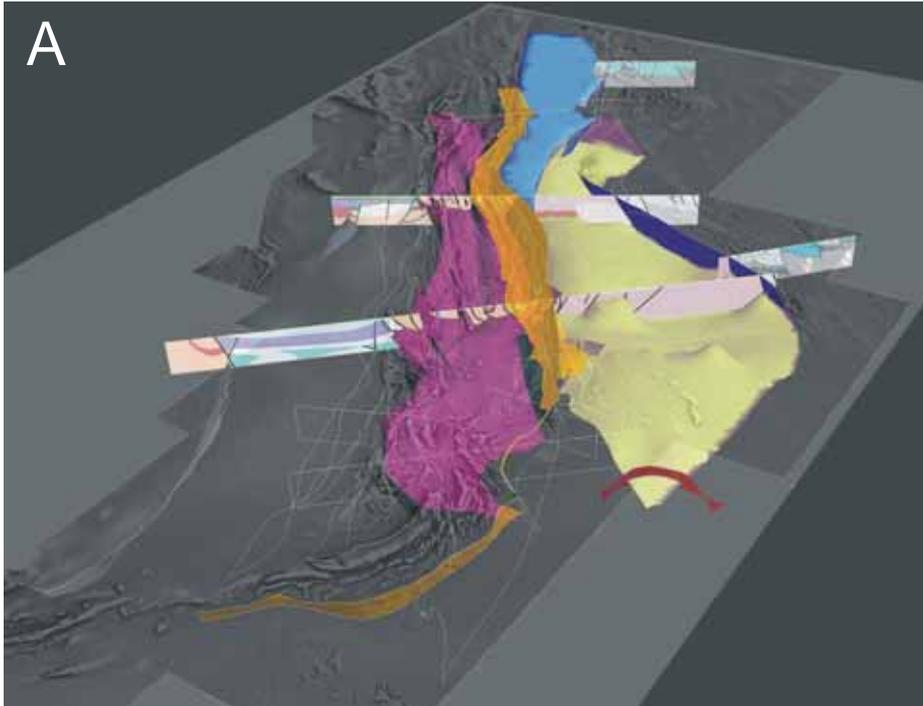


Koonenberry Belt: Geophysics and 2D models

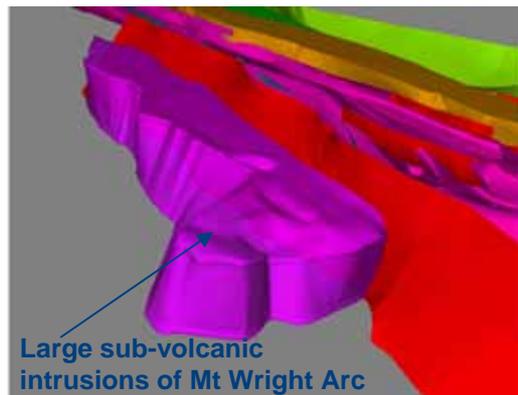


2009_01_2004

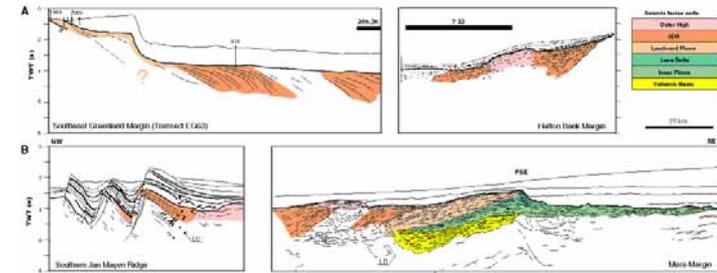
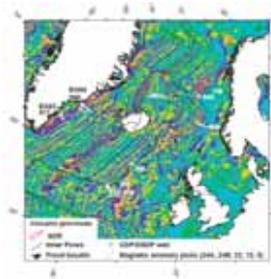
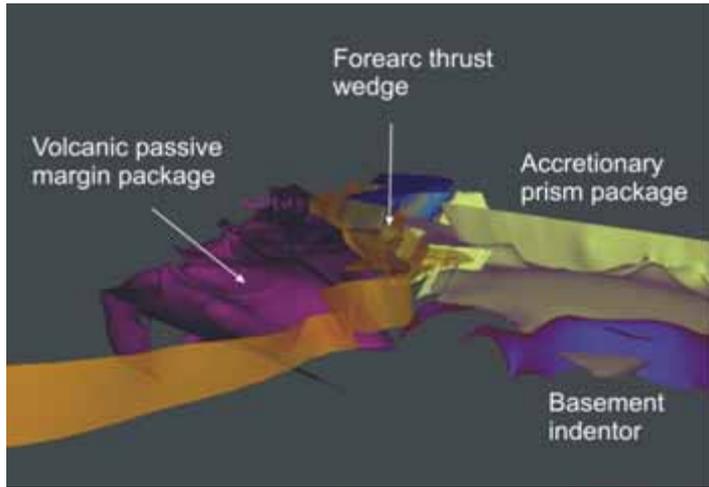
Koonenberry Belt: 3D model



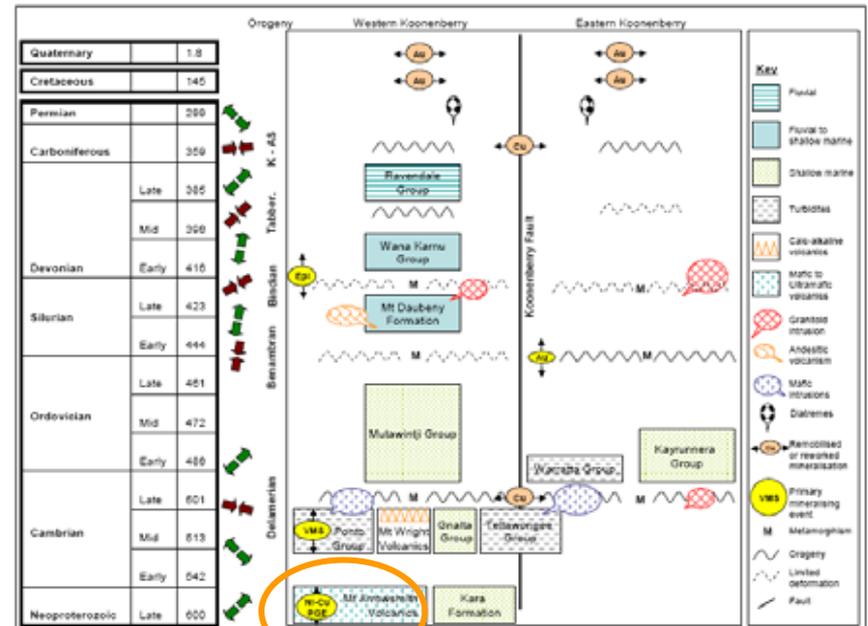
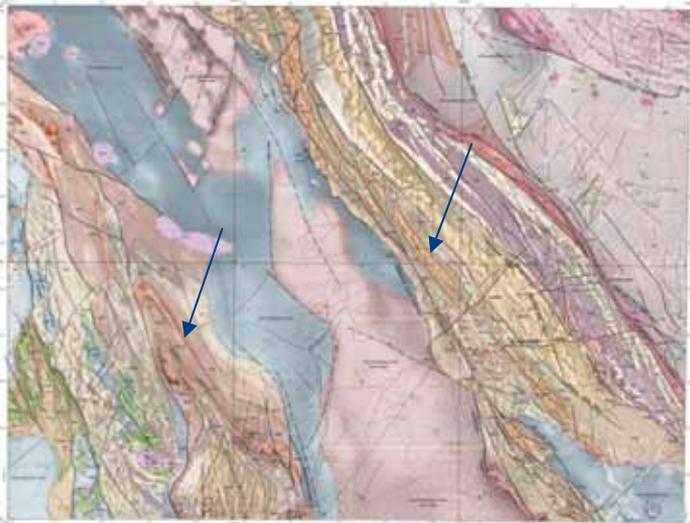
- Wonnaminta Zone - Mt Arrowsmith Volcanics
- Wonnaminta Zone - thrust wedge
- Kayrunnera Zone - base of Bunker Creek Fm
- Kayrunnera Zone - Depot Glen Fm
- Indentor - seamount?



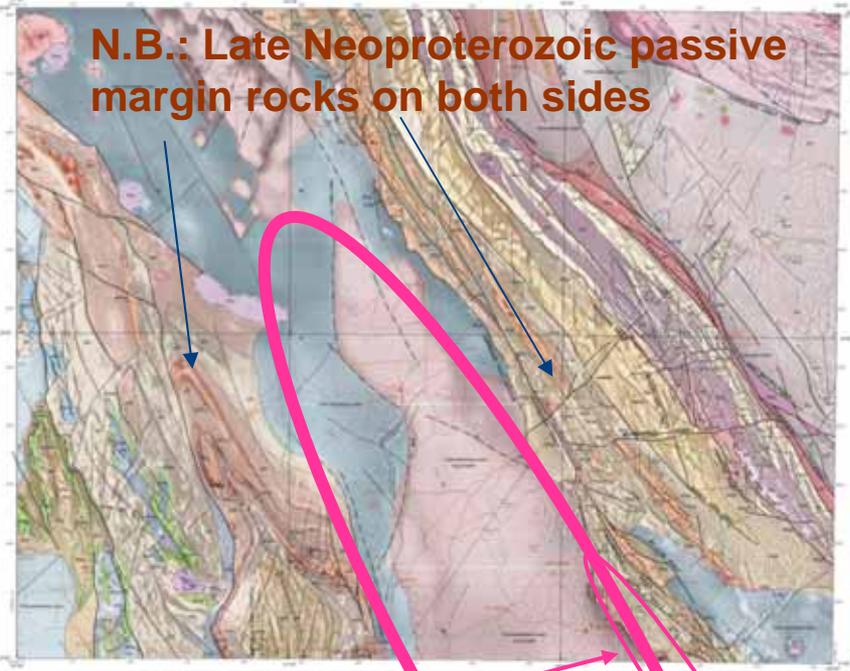
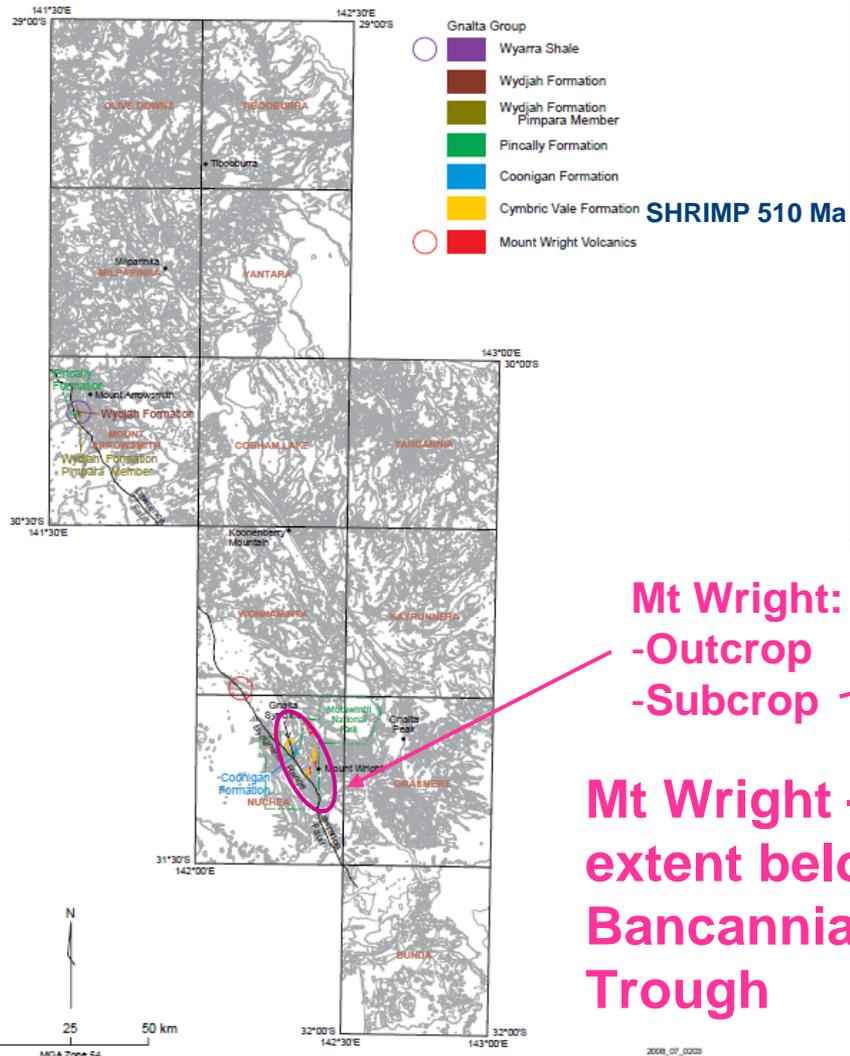
Neoproterozoic volcanic passive margin



Seaward-dipping reflectors, North Atlantic

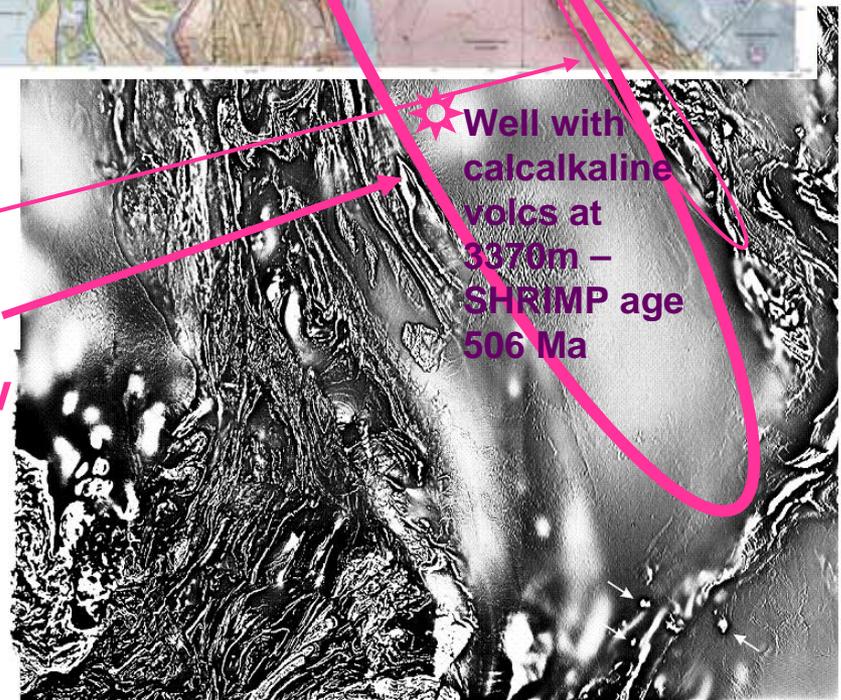


The Mount Wright Arc



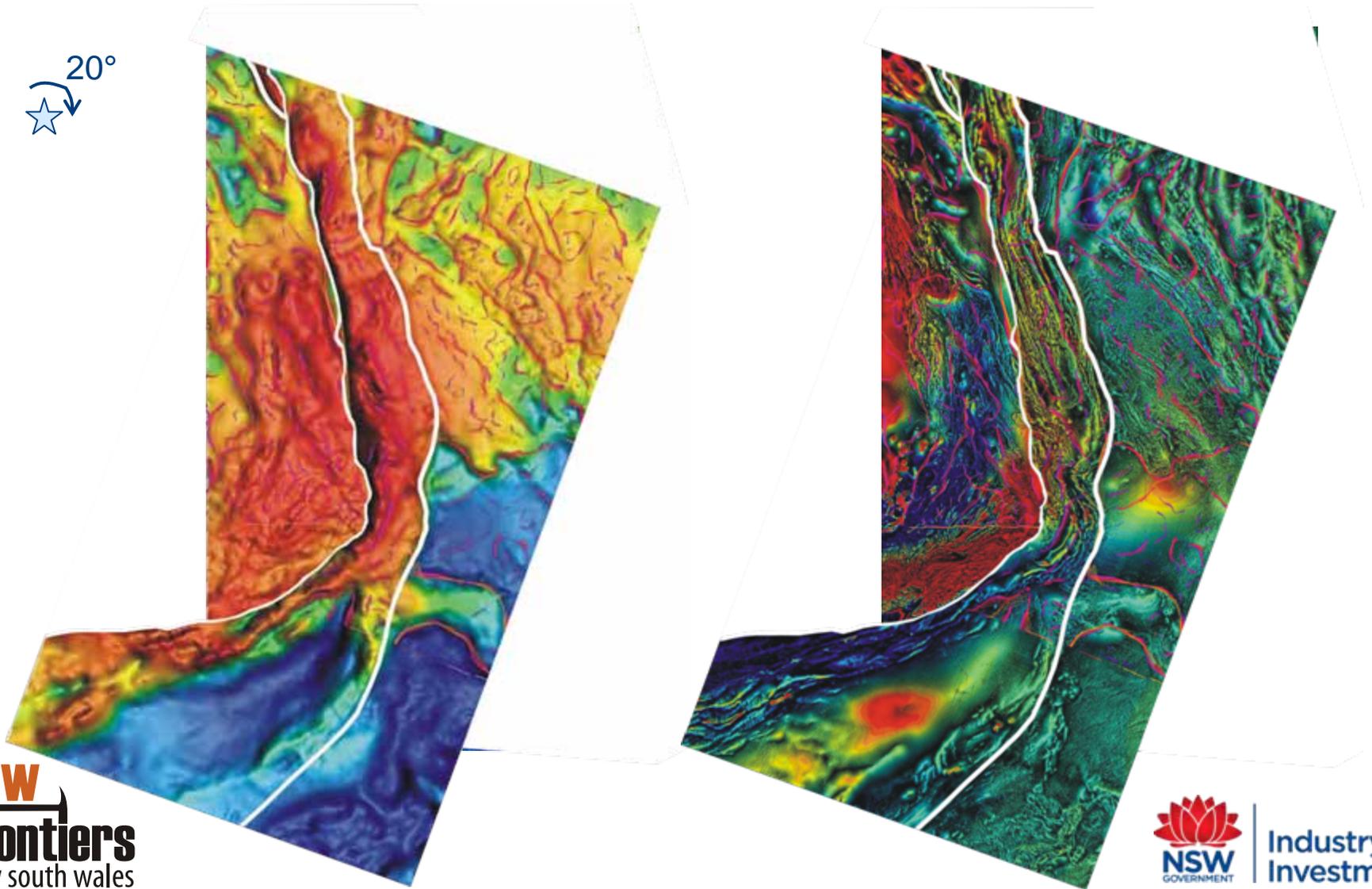
Mt Wright:
-Outcrop
-Subcrop

Mt Wright –
extent below
Bancannia
Trough

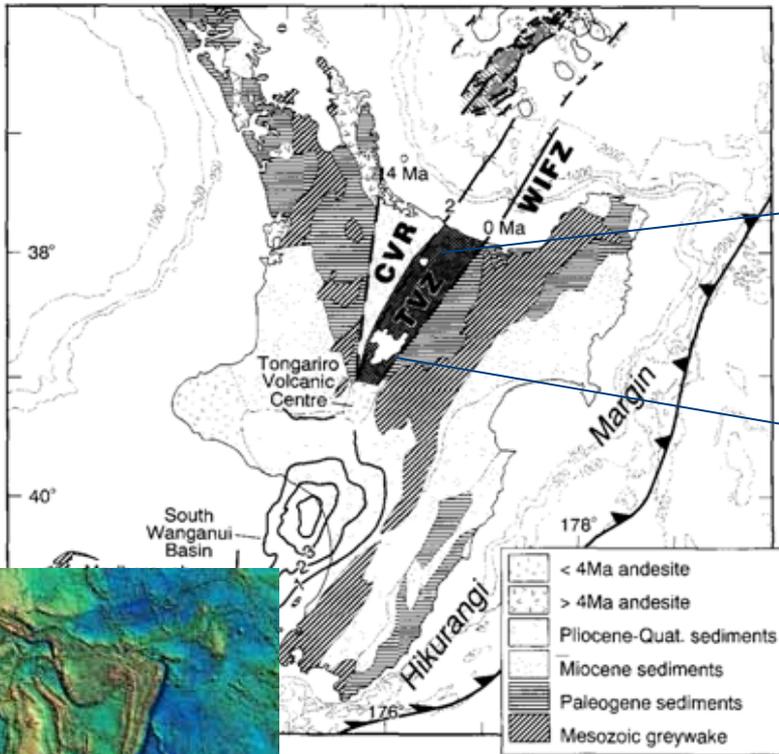


Restoring the Bancannia rift

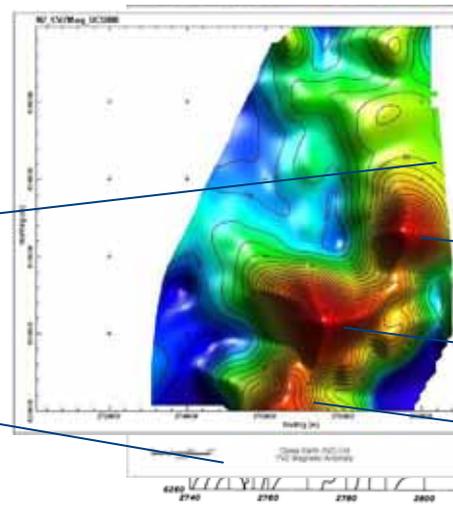
20°
☆



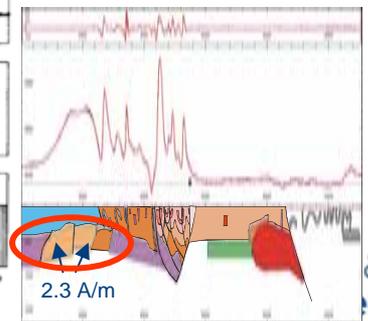
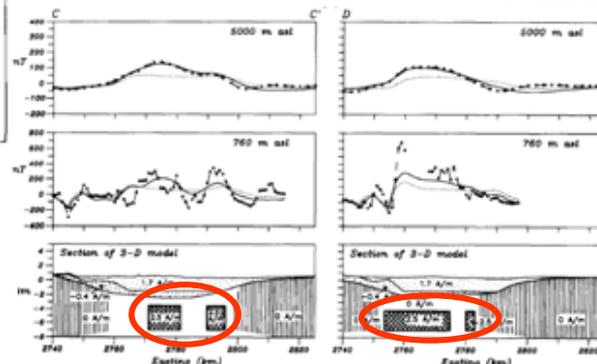
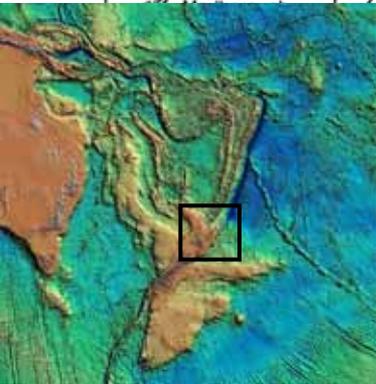
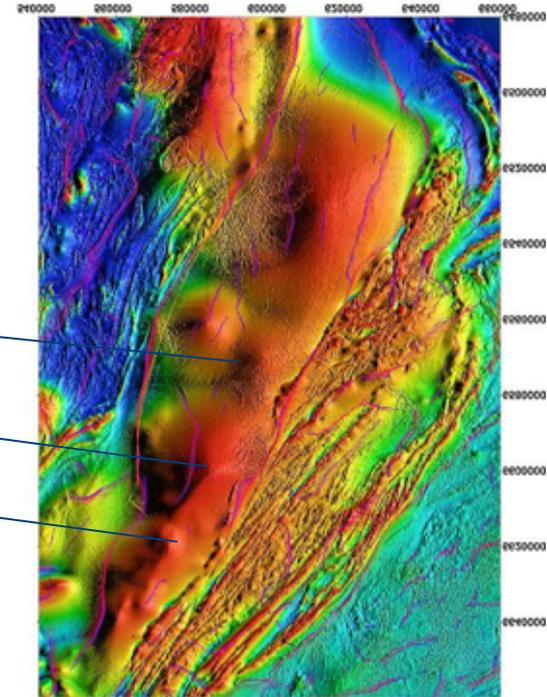
Arc/back-arc – Taupo analogue



Parson & Wright, 1996

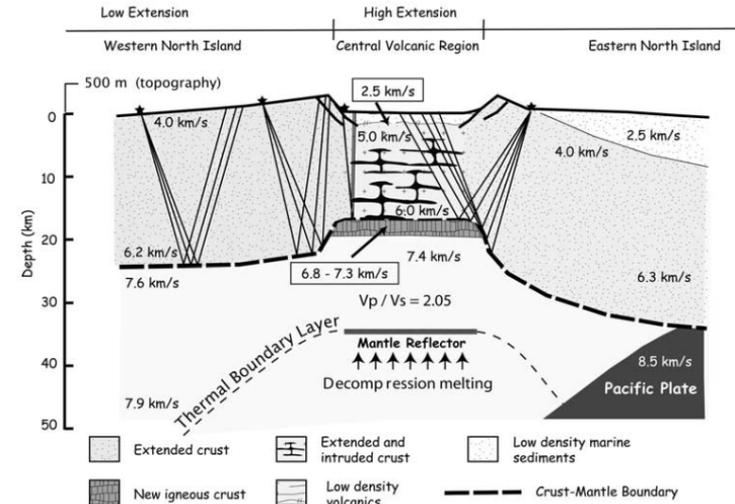
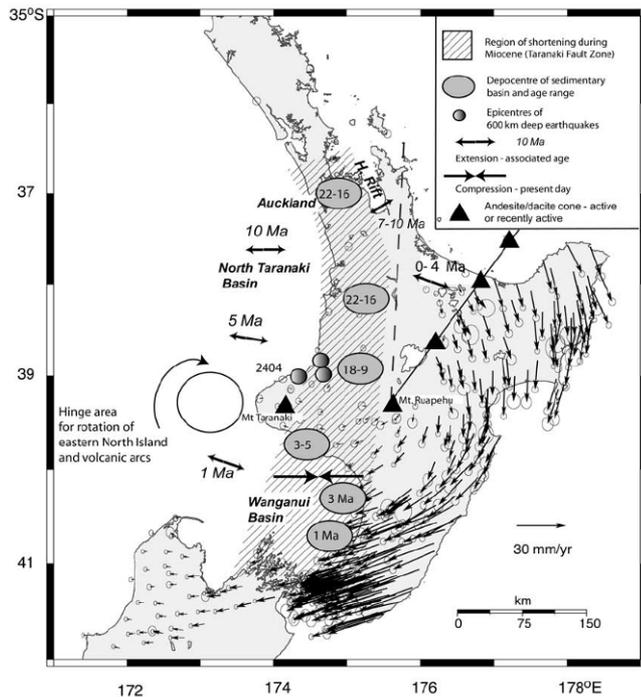
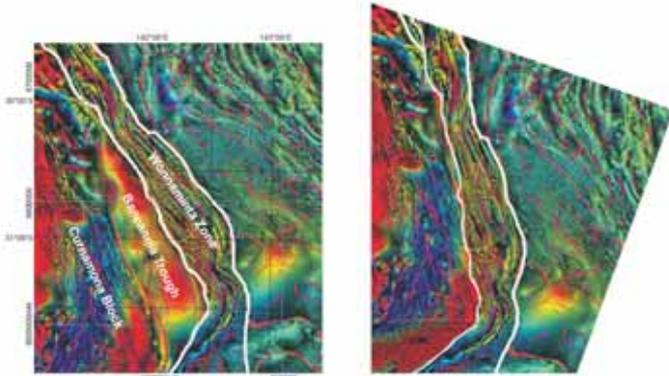


Thanks to Supri Soengkono and Glass Earth (NZ) Inc

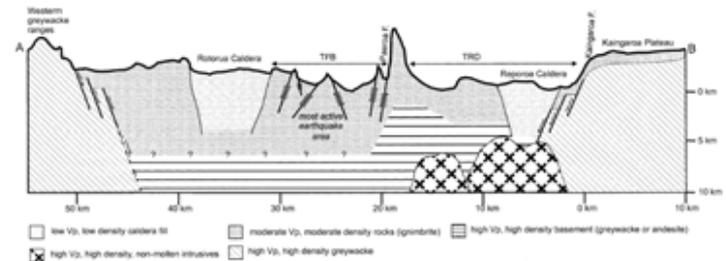


S. Soengkono, *Journal of Volcanology and Geothermal Research* 68 (1995) 193-207

Arc/back-arc – Taupo analogue

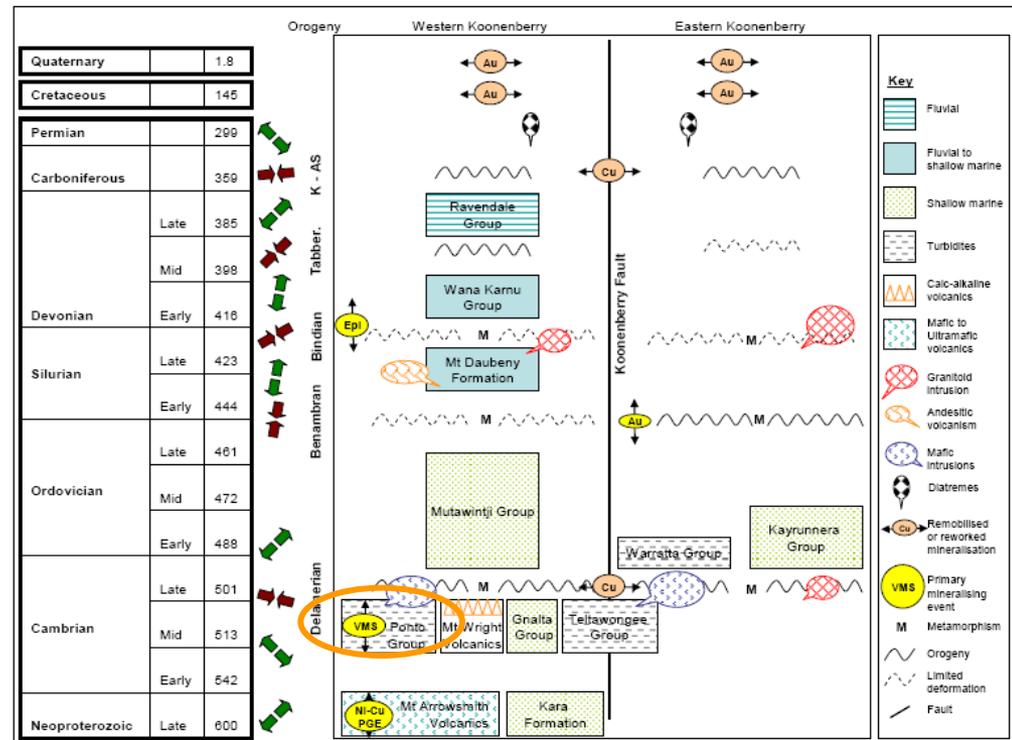
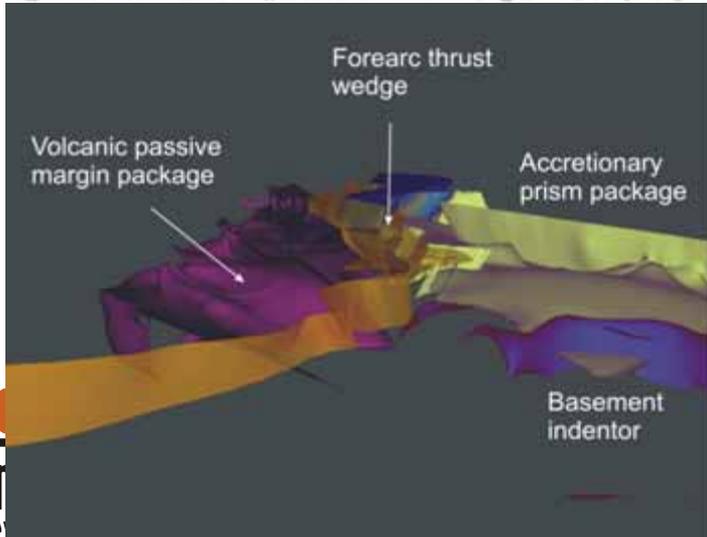


Stern, T., et al., 2006, *Rev. Geophys* 44, 1-36

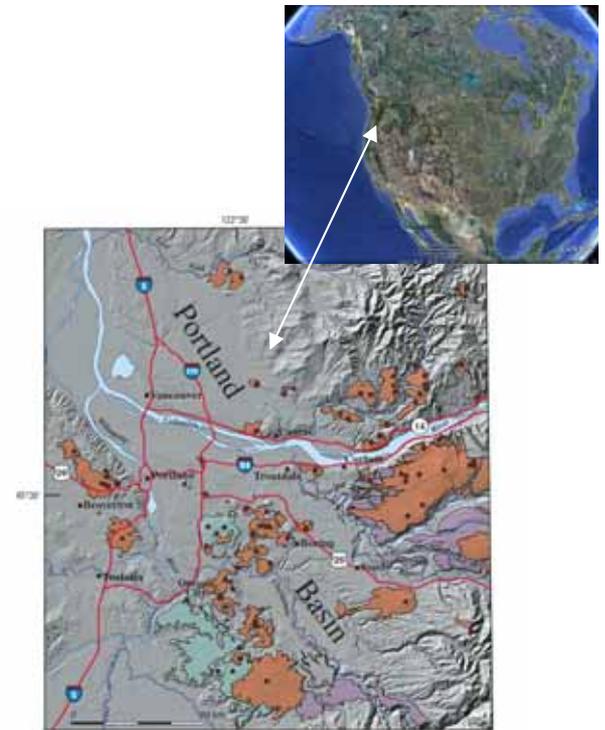
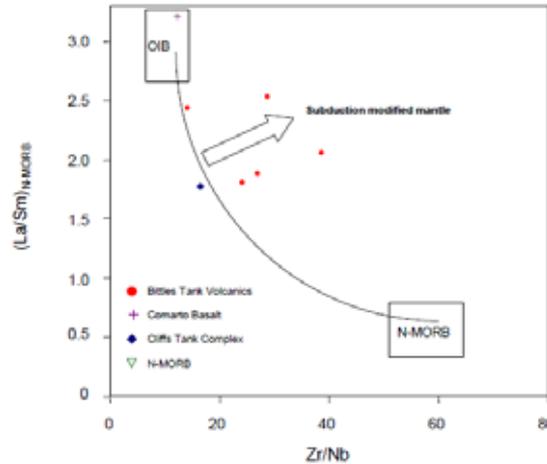
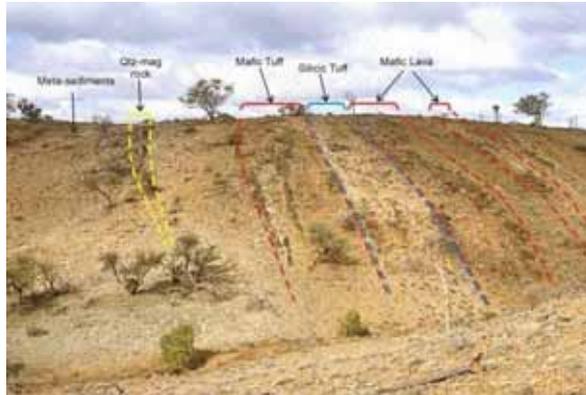
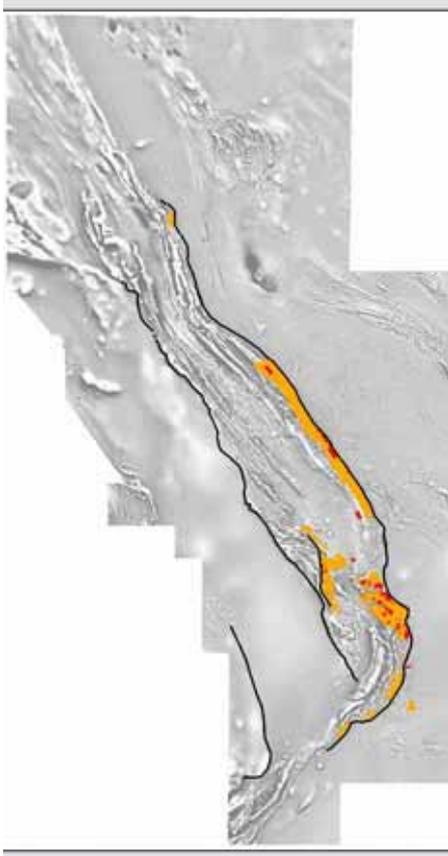


Sherburn et al., 2003, *J. Volc. Geotherm. Res.*, 122, 69-88

A volcanic fore-arc: Ponto Group & Bittles Tank Volcanics



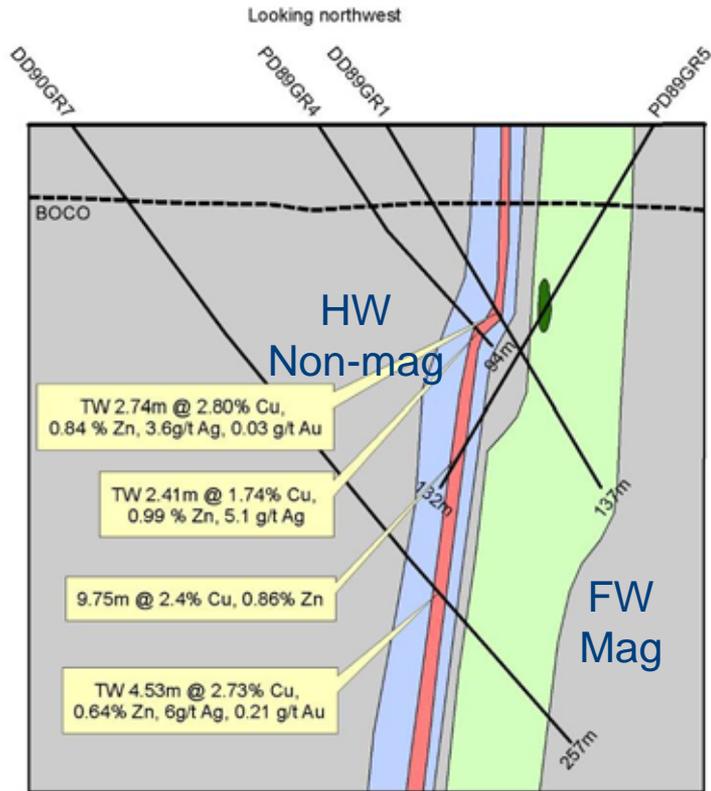
Bittles Tank Volcanics - anomalous fore-arc



Boring Volcanics, Cascadia Arc
– modern analogue in fore-arc
of rifted arc with similar OIB-
MORB anomalous chemistry.

Evarts et al., 2009, Geol. Soc. Am.
Field Guide 15.

Grasmere (Ponto Group) – Besshi-style VMS



Legend

- Surface
- Drill hole trace
- - - Base Of Complete Oxidation
- Hangingwall meta-sediments

- Mylonite zone
- Massive sulphide ore zone
- Footwall calc-silicate schist
- Massive basalt
- Meta-sediments

Massive sulphide ore



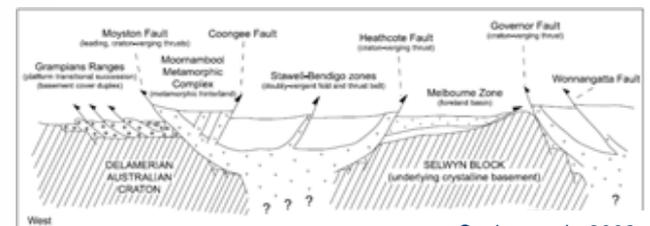
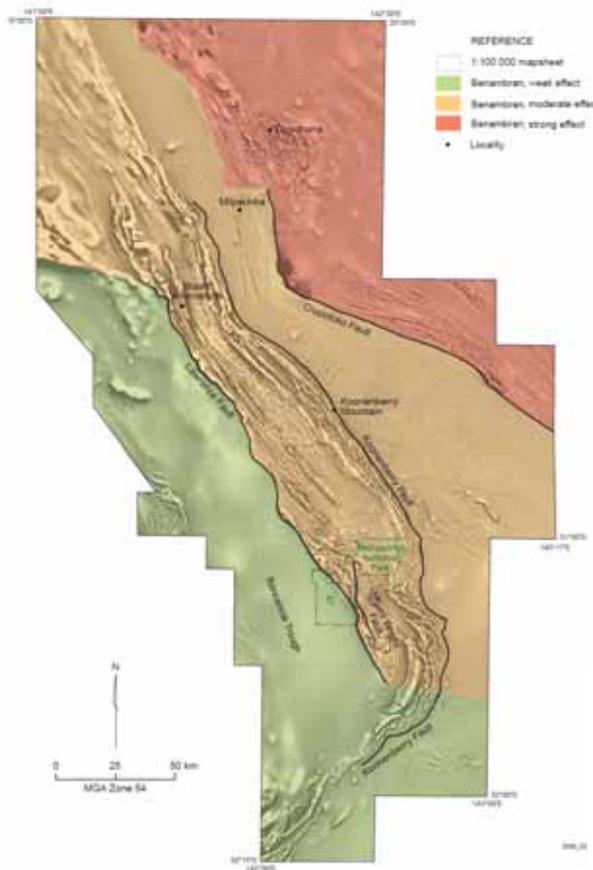
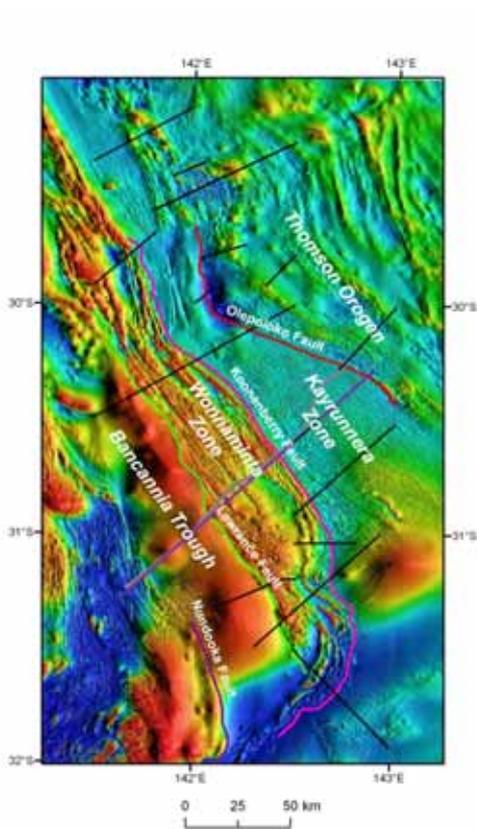
Brecciated & MS ore



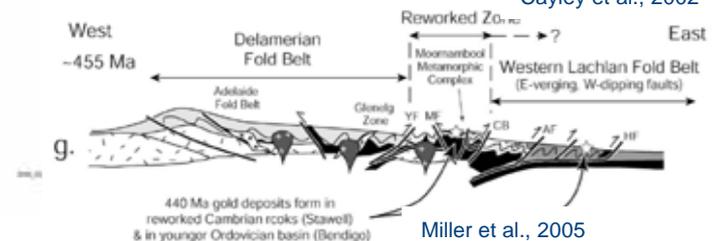
Late
qtz-carb-chal
veins in FW



The Kayrunnera Zone: Delamerian fore-arc, Benambran reworking

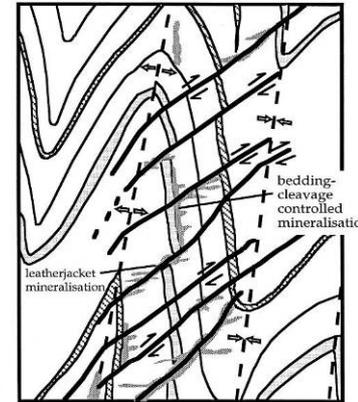
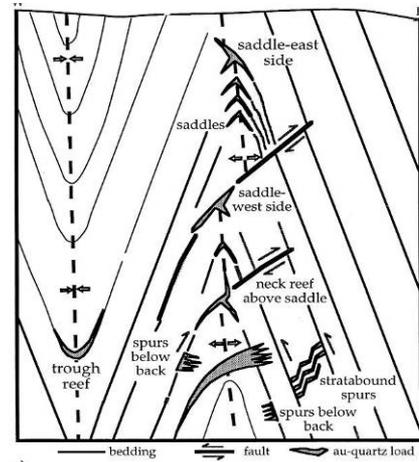
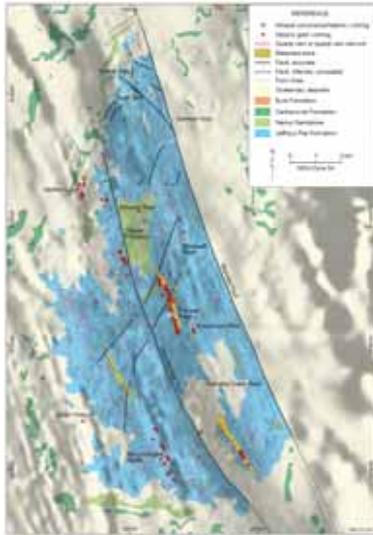
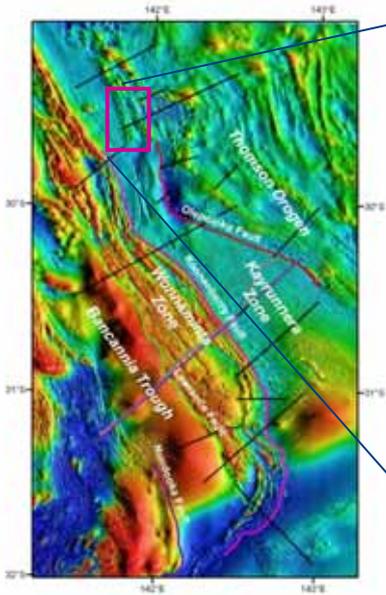


Cayley et al., 2002

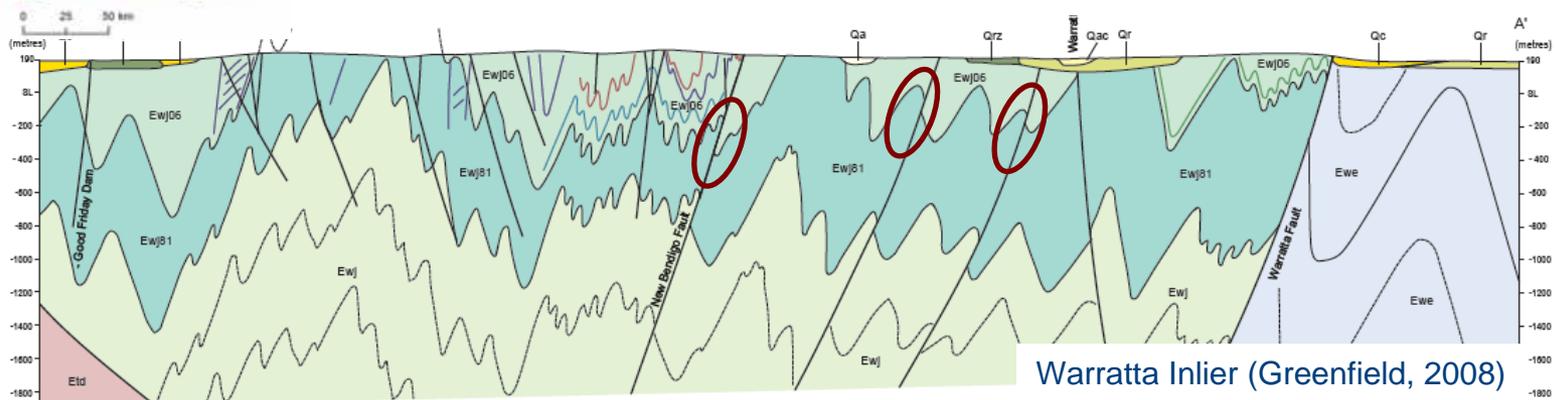


Miller et al., 2005

Kayrunnera Zone, Warratta Inlier - orogenic Au



Victorian Goldfields (Ramsay, 1998)



Warratta Inlier (Greenfield, 2008)

Mt Wright – Menindee – Dimboola Arc?

Mt Wright (Koonenberry) Arc:

Cambrian calc-alk volcs in rifted arc setting on continental margin.

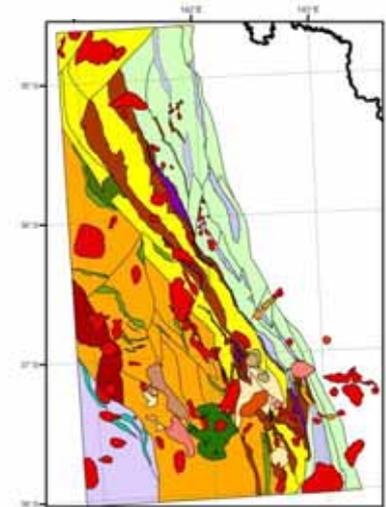
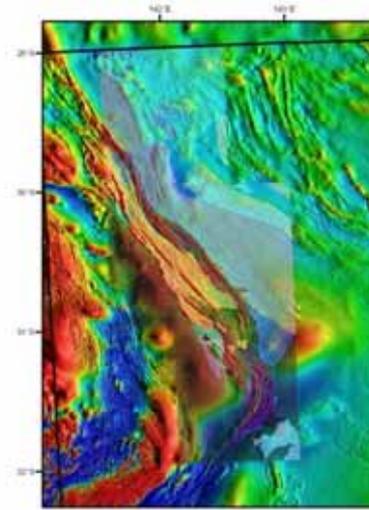
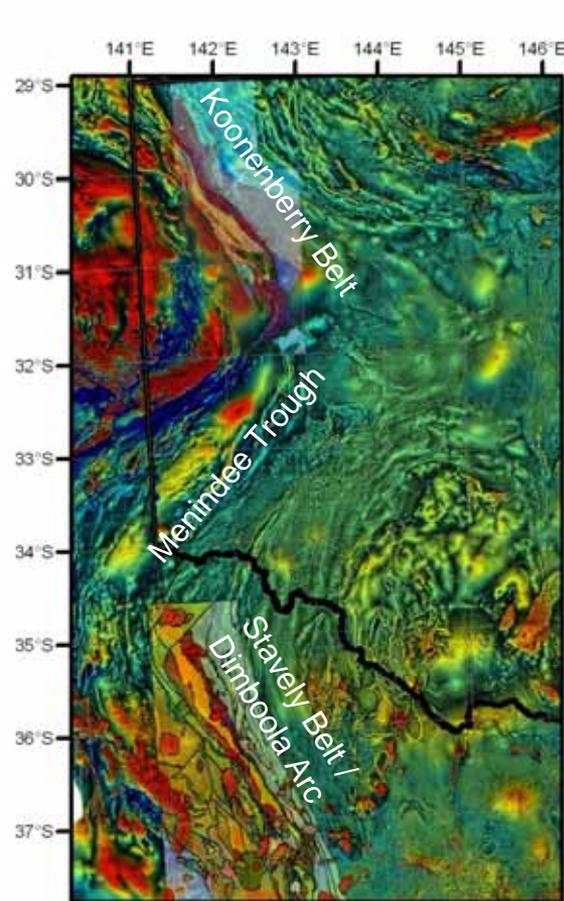
Ponto Group: Cambrian tholeiites, Besshi-style VMS

Kayrunnera Zone - Warrata inlier: Benambran orogenic gold

Dimboola Arc:

Cambrian calc-alkaline volcs, supra-subduction zone ophiolite (oceanic arc)

Volcanic basement of Stawell Zone: Cambrian tholeiites (Magdala Volcanics), Besshi-style VMS, + Benambran gold



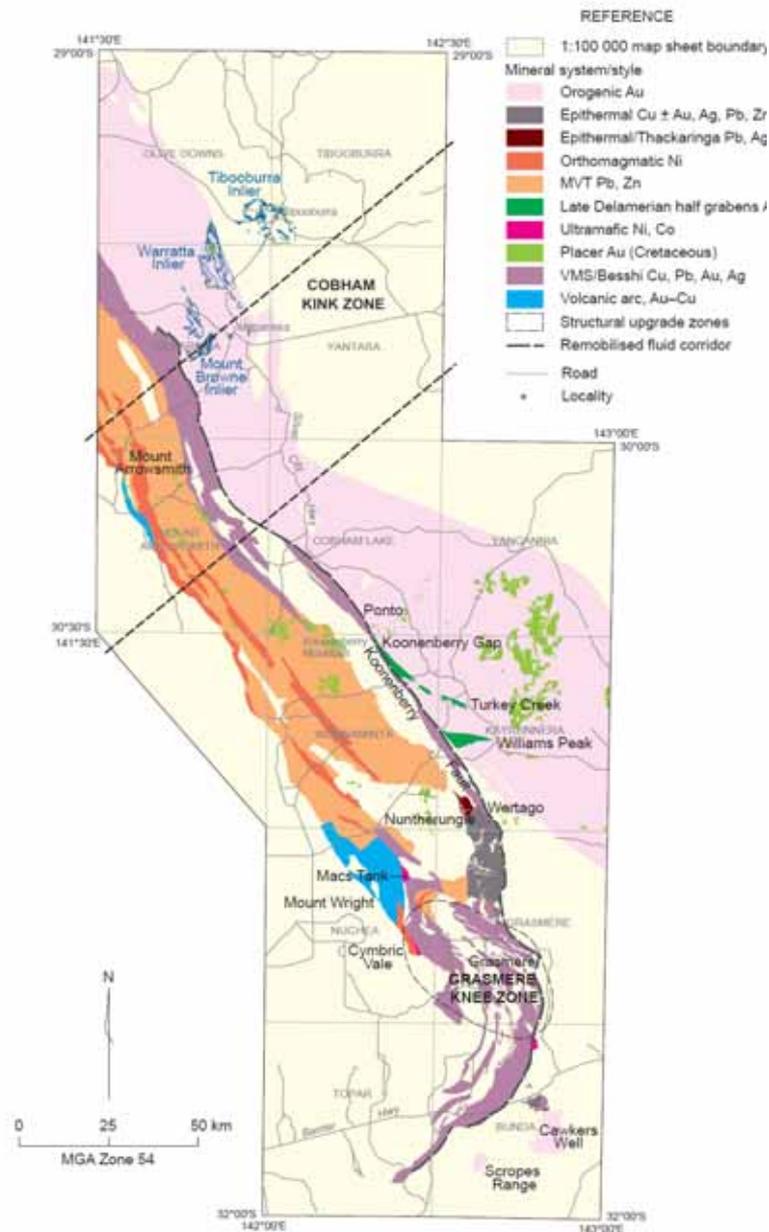
Wrap-up

- So we have a Cambrian arc system
 - Oceanic in Victoria
 - Suprasubduction zone ophiolites, extensive boninitic volcanism
 - Spontaneous subduction zone nucleation by transform collapse?
 - IBM type?
 - Or Induced nucleation by transfer of convergence from pre-existing subduction system (“Mussau trench” type)?
 - Note 580-600 Ma ?magmatic zircon ages from Warraweena Volcanics, southeast Thomson Orogen
 - Developed on passive continental margin in NSW
 - Volcanic calc-alkaline arc sits within passive margin sequence
 - Definitely not an accreted system
 - Was subduction transferred by propagation of trench from Victoria?
 - “early Delamerian” deformation preceded main volcanic phase.
 - Or is this spontaneous nucleation by passive margin collapse?
 - Note voluminous arc products under Bancannia Trough, and extensive and anomalous fore-arc volcanism
 - What is relationship with earlier (~540 Ma) Ross Orogeny in Antarctica?

Koonenberry Belt – mineral systems

Courtesy Phil Gilmore

And of course, there's also the Thomson Orogen...



Brought to you by...

- **Data Release – Southeast Lachlan airborne geophysical survey**
- 107 000 line km, 24 000 km²
- 60 m agl, 250 m line spacing (500 m in ACT)
 - Silurian volcanics and sed. rocks (base metals, *a la* Woodlawn and Captains Flat)
 - Siluro-Dev. intrusives (Au, Mo, Cu)
 - Southern Eden-Comeray-Yalwal rift zone (epithermal Au-Ag)
- Released today, at the lunch break!
- Available at the GSNSW booth. **Preliminary** aeromagnetic and radiometric data as grids and georectified images
 - DVD, \$110
- **Final, fully processed** data, including located data (ASCII, GDF2 format) available later in 2010
 - Free to purchasers of the preliminary data!
- Low resolution jpegs can also be downloaded from www.dpi.nsw.gov.au/minerals

