Geological framework of the Albany–Fraser Orogen

Archean granite in the Biranup Zone

Catherine Spaggiari, Chris Kirkland, Hugh Smithies, Sandi Occhipinti and Mike Wingate

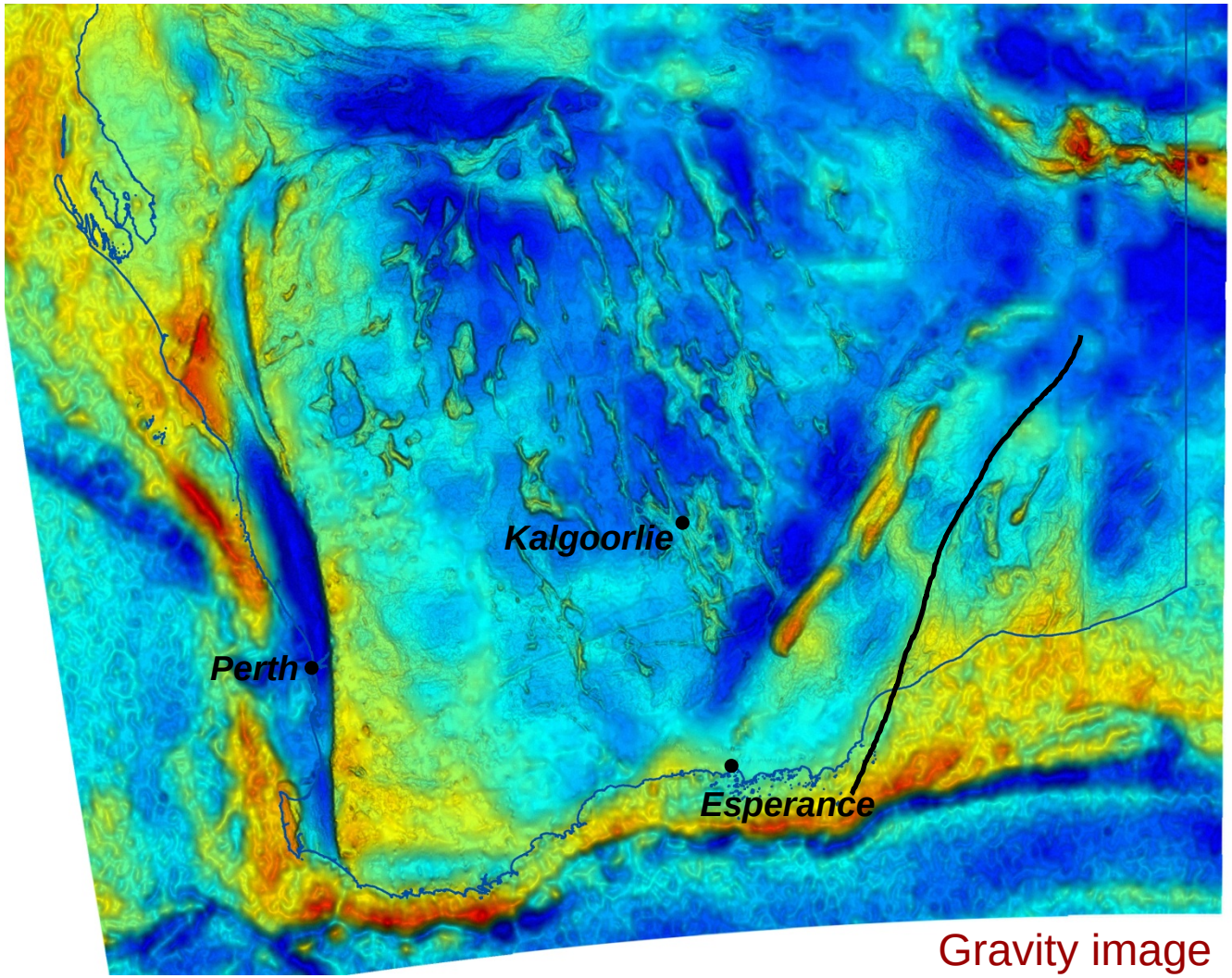
Introduction

- Fundamental role of the Archean Yilgarn Craton in the evolution of Albany–Fraser Orogen
- Yilgarn Craton with a ‘make-over’
- The Albany–Fraser Orogen is not simply a Mesoproterozoic collision zone – no internal suture
- Records a long history of extensional tectonics (basins, magmatism) as well as thrust tectonics (long-lived structures)

Paleoproterozoic granite gneiss in the Biranup Zone

AFO is part of the West Australian Craton (WAC)

Albany–Fraser Orogen (AFO)

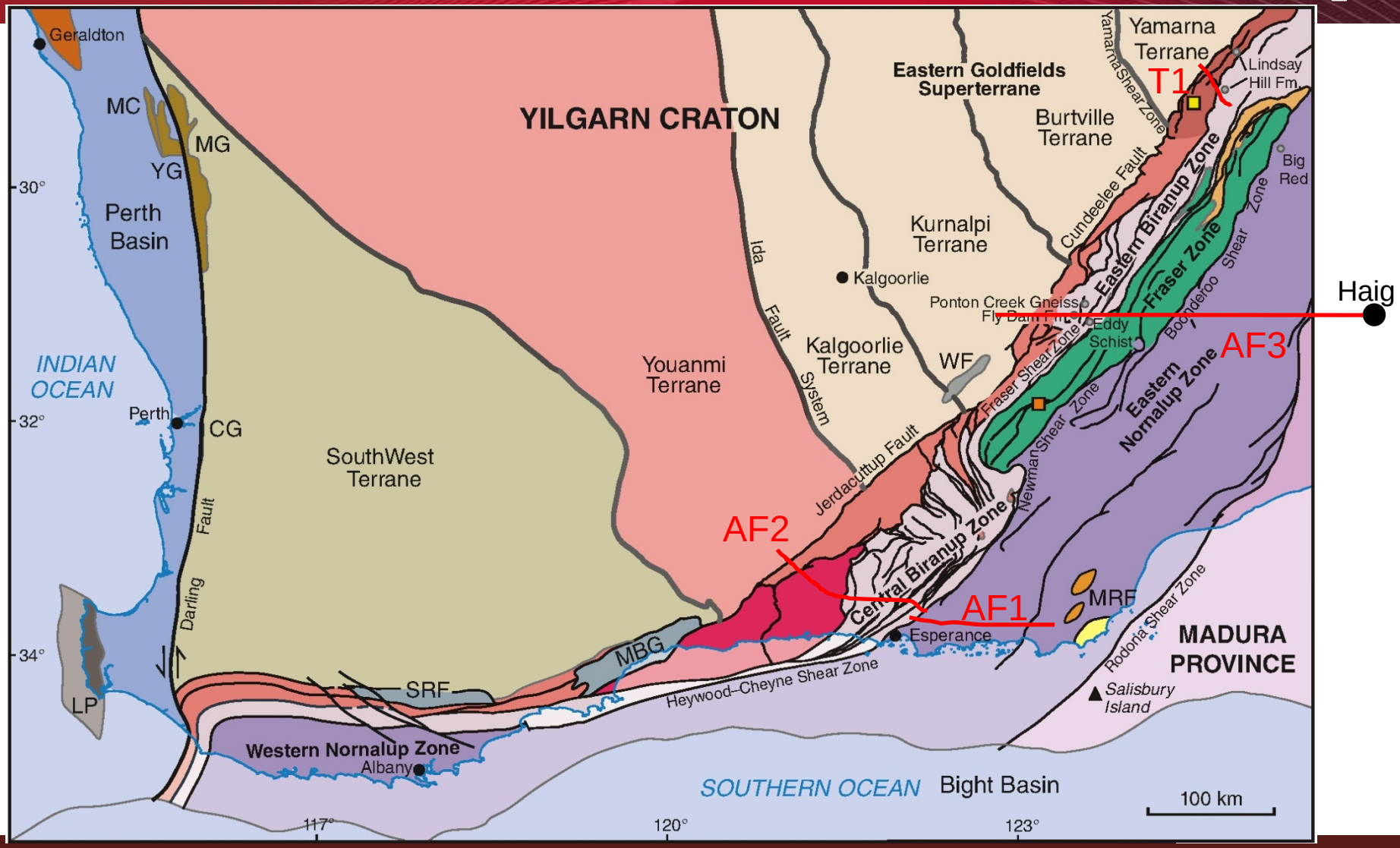


Gravity image

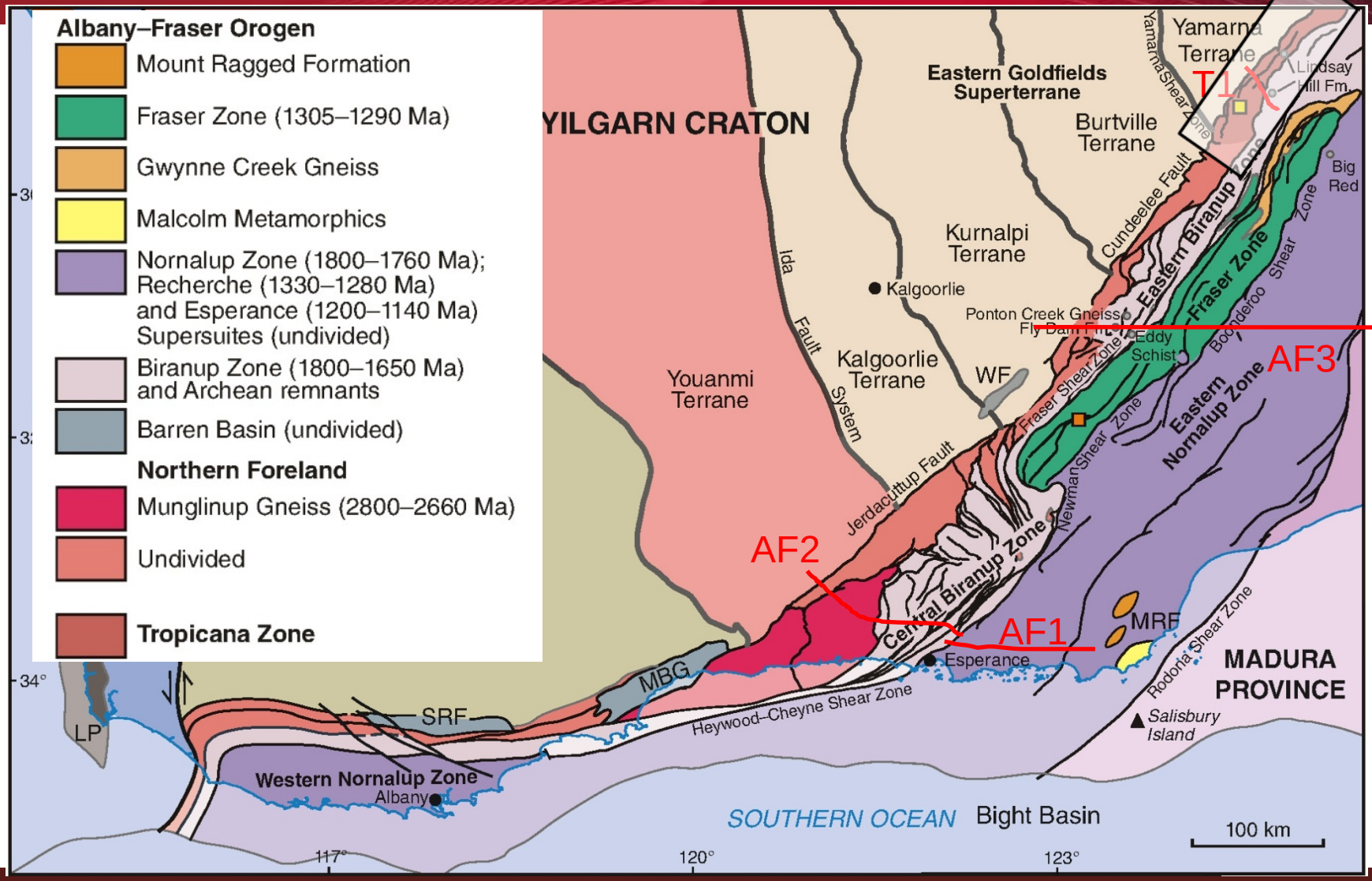
AFO is part of the West Australian Craton (WAC)

AFO tells the story of modification of the southern and southeastern Yilgarn Craton margin

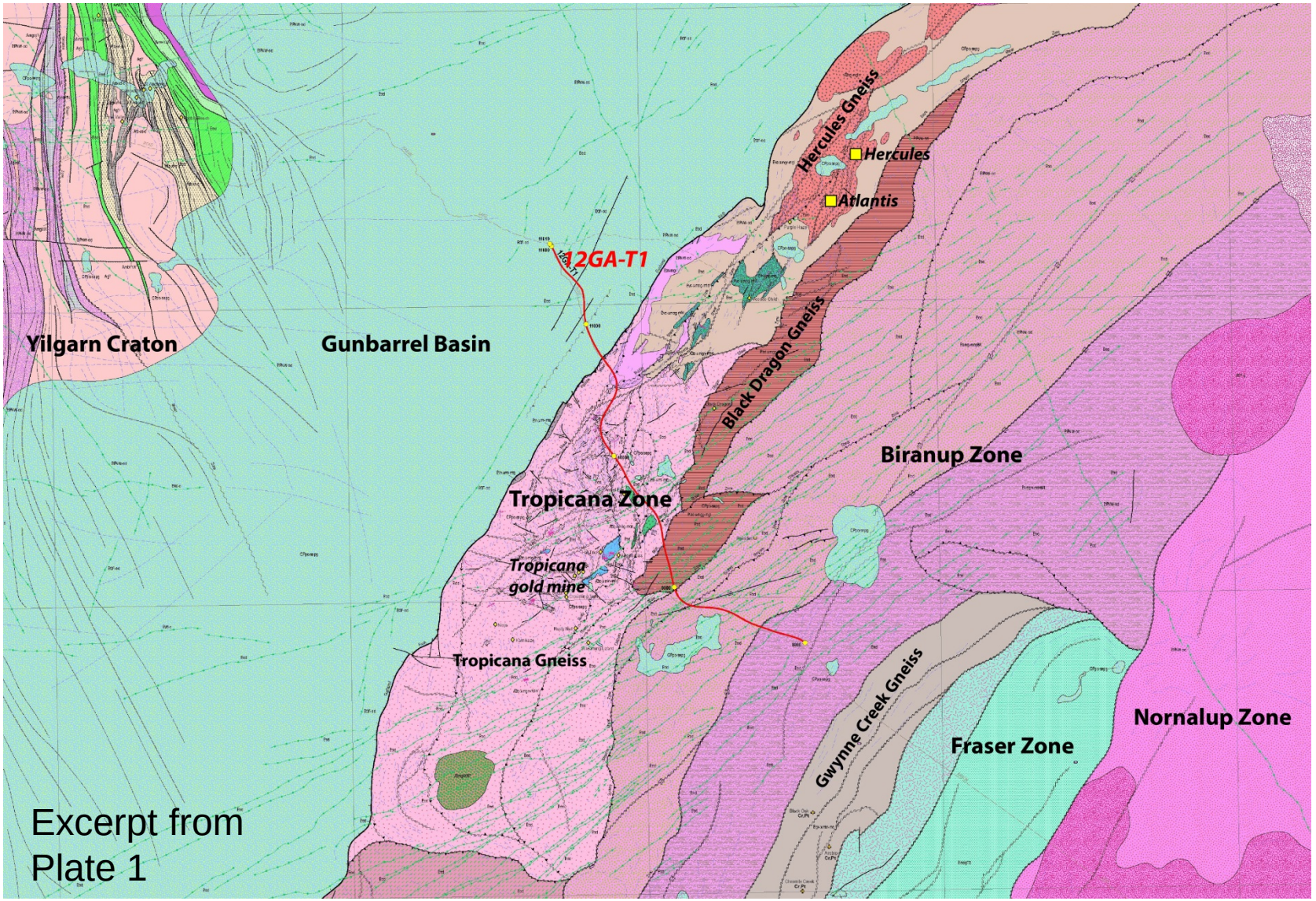
Albany–Fraser Orogen



Albany–Fraser Orogen

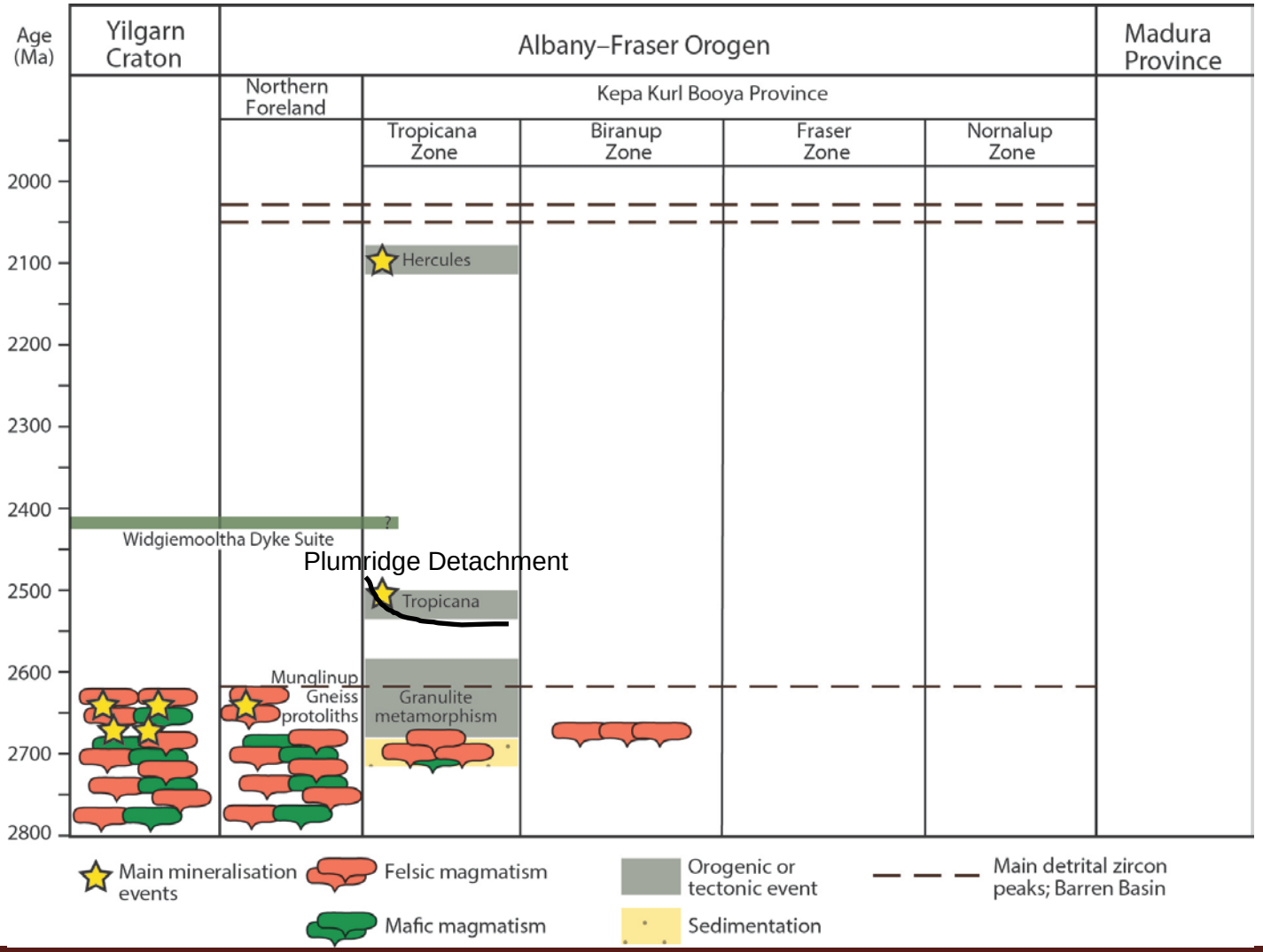


New unit: Tropicana Zone – part of the Kepa Kurl Booya Province

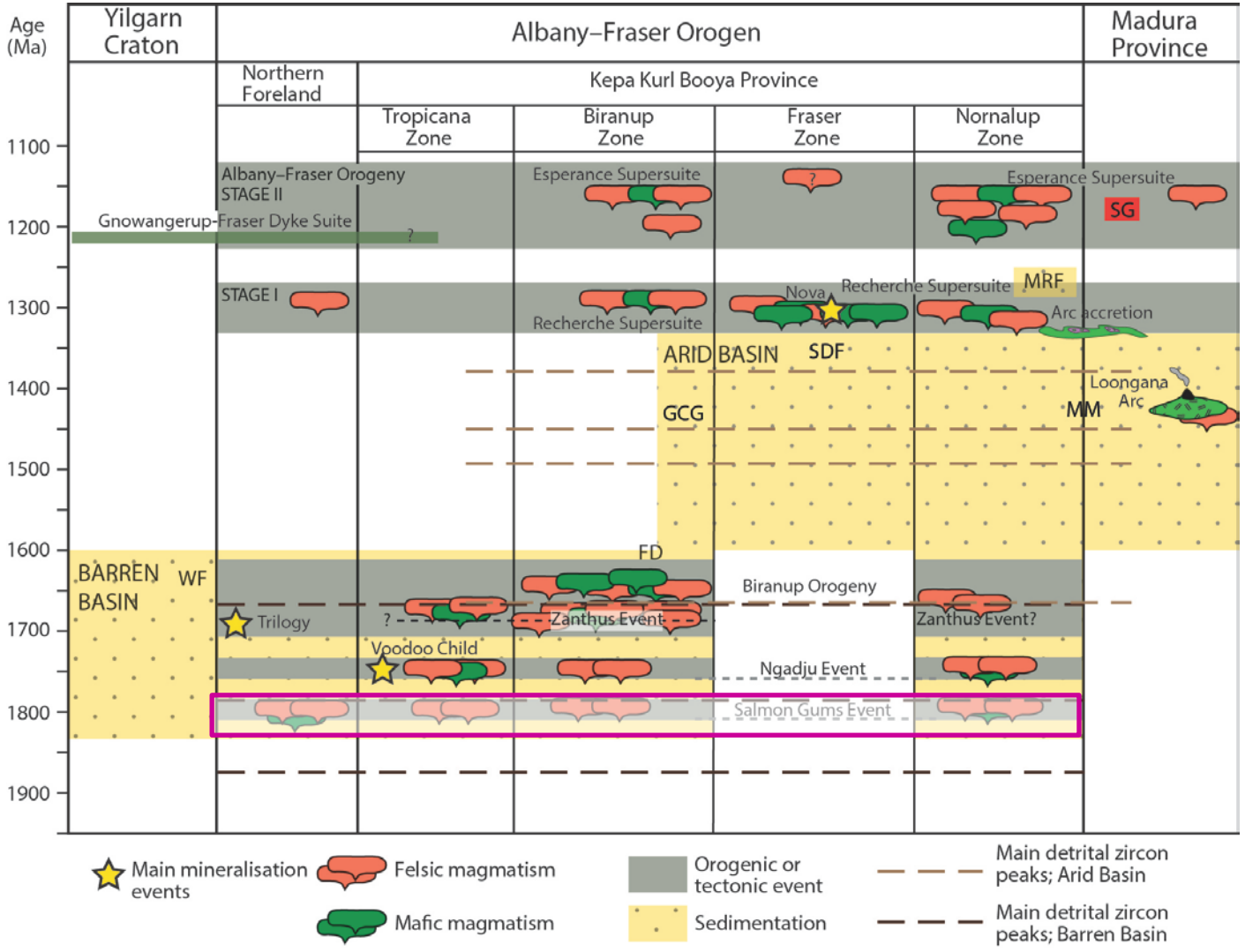


Excerpt from Plate 1

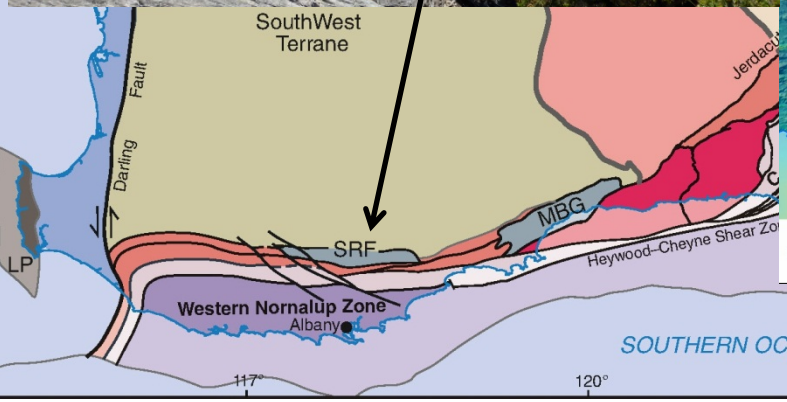
Tectonic events older than 2000 Ma

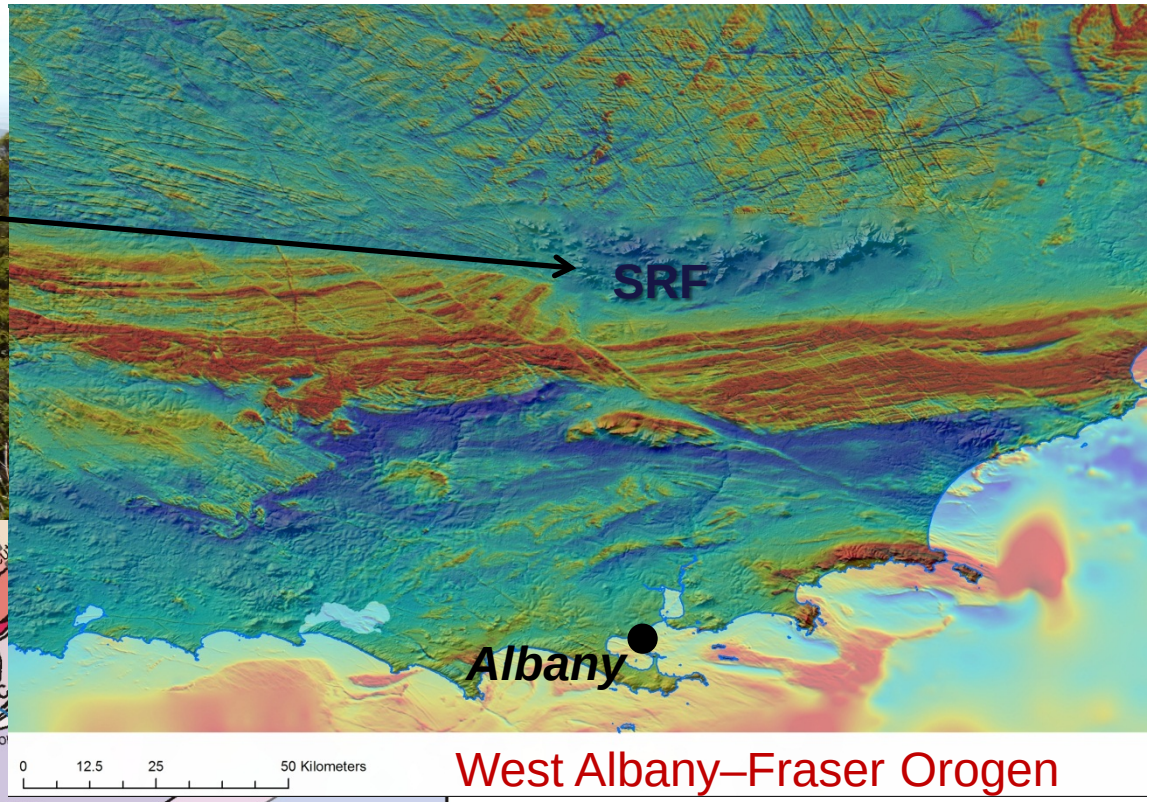


Tectonic events younger than 2000 Ma



c. 1800 Ma Stirling Range Formation – initiation of the Barren Basin





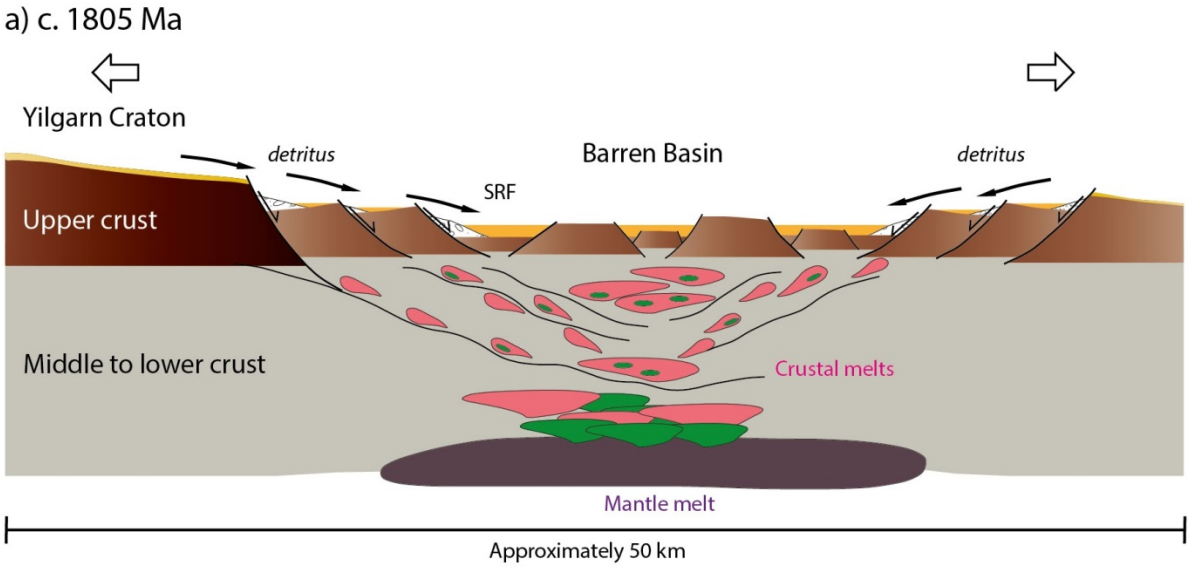
West Albany–Fraser Orogen

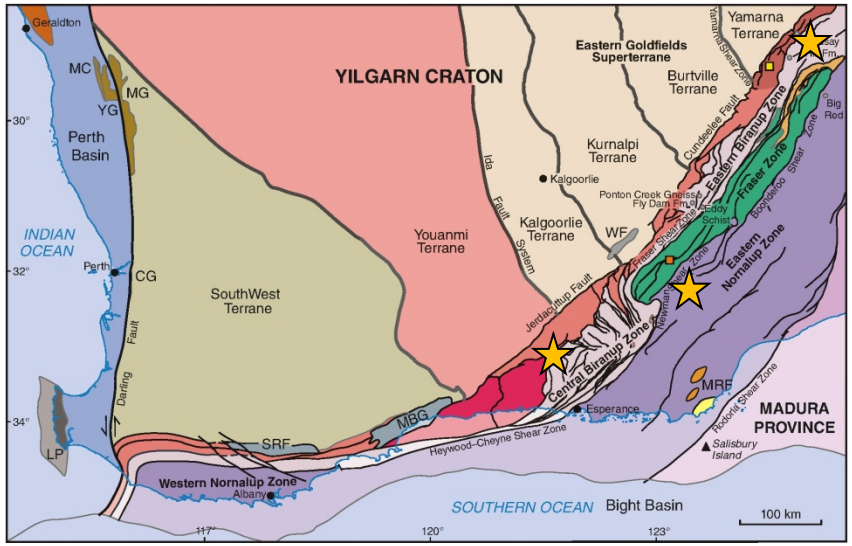
Drape image of SRTM (topography) over magnetics

Salmon Gums Event: 1815 to 1800 Ma

Extension of the southern and southeastern Yilgarn Craton formed a horst and graben architecture exposing basement highs.

Mantle melting produced lower crustal melts and granitic intrusions along middle crustal shear zones (see GSWA Report 133 for details).

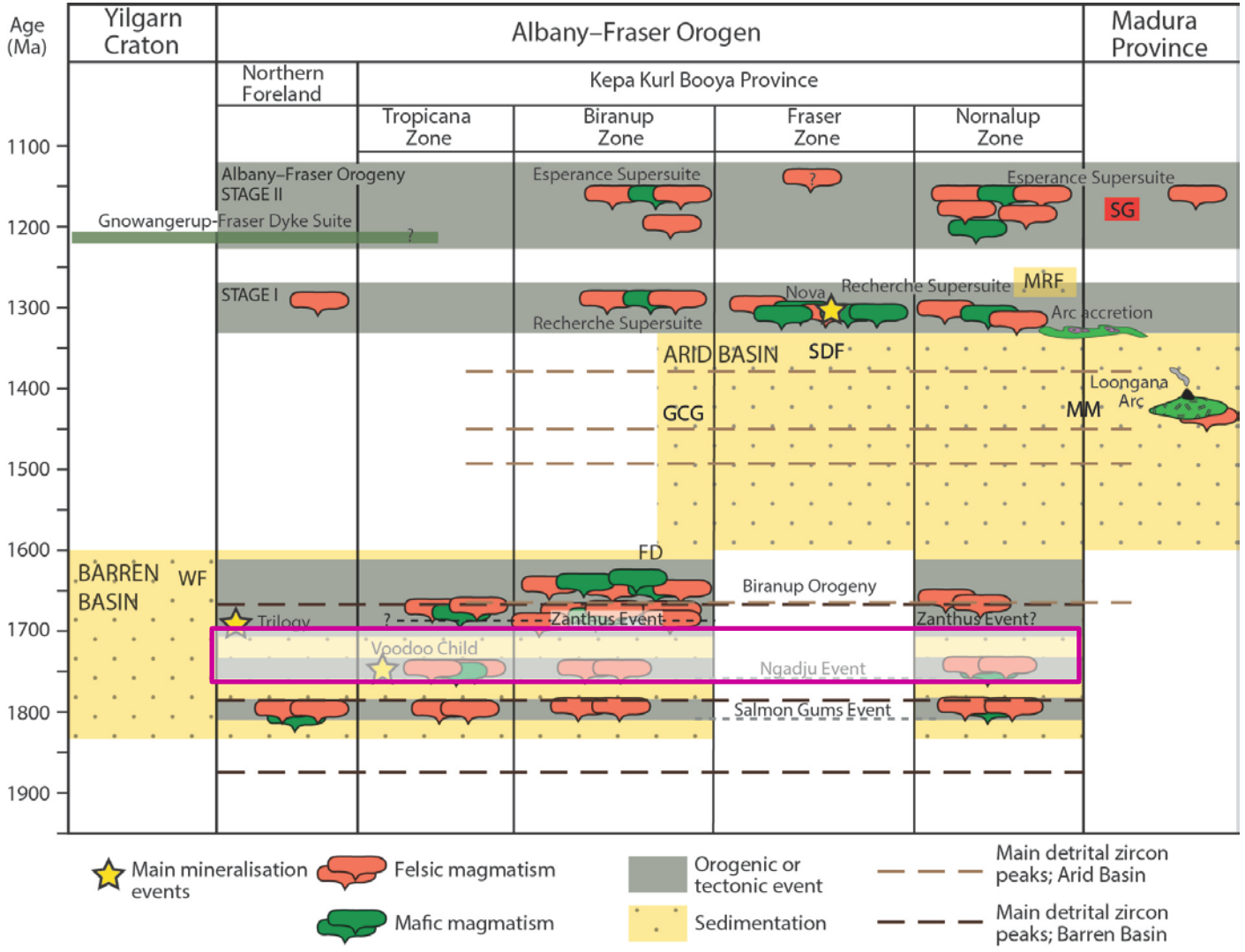




★ Locations of 1815 to 1800 Ma granites

Salmon Gums co-funded EIS drill core

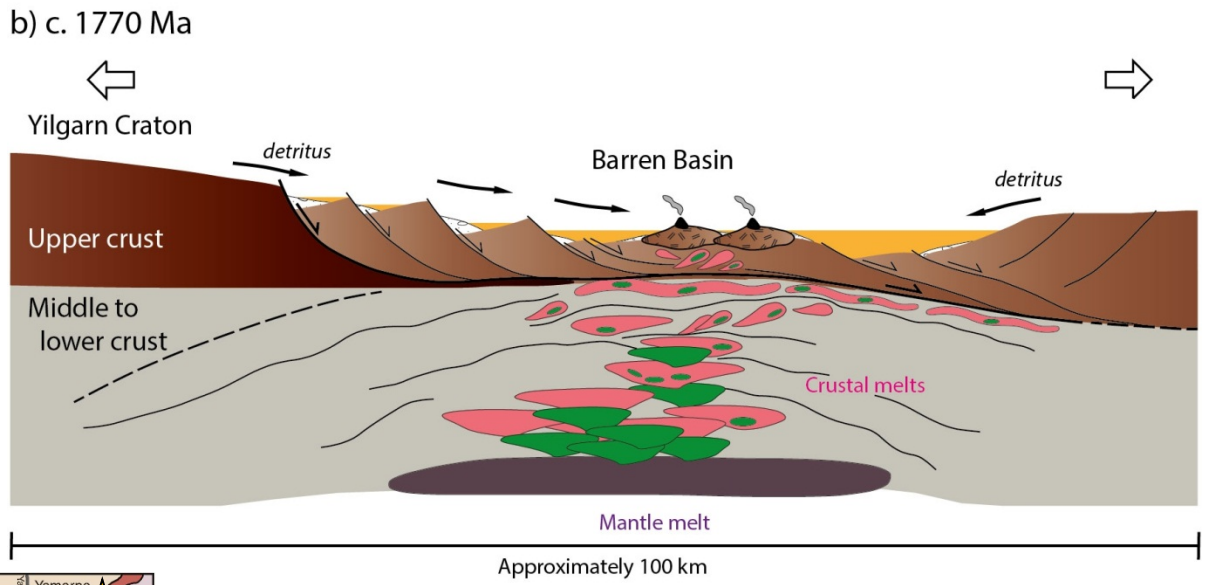
Tectonic events younger than 2000 Ma

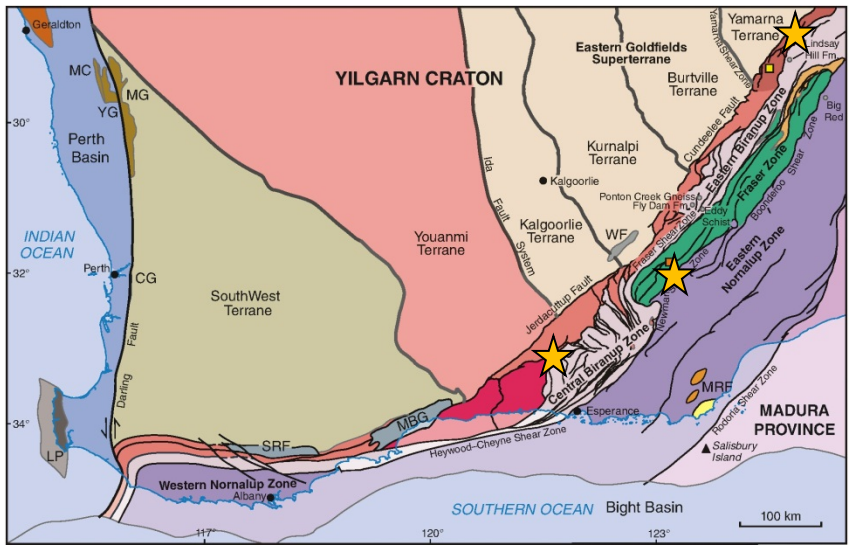


Ngadju Event: 1780 to 1760 Ma

Zircon detritus of this age is orogen-wide.

Extension and magmatism produced an asymmetric, melt lubricated detachment leading to doming and a core-complex mode of extension, and basin widening. (see GSWA Report 133 for details).

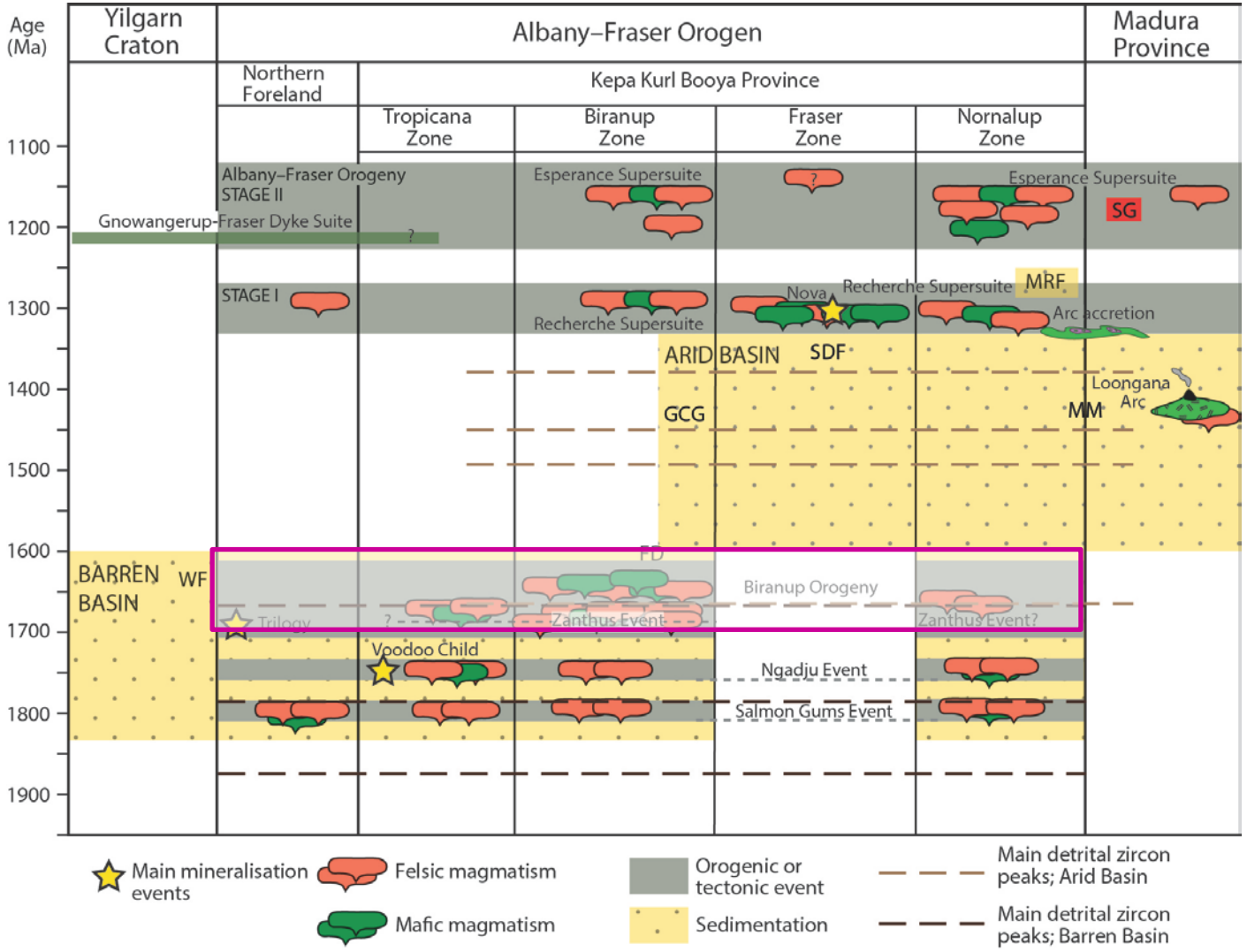




c. 1763 Ma granitic gneiss; Newman Shear Zone

★ Locations of 1780 to 1760 Ma granites

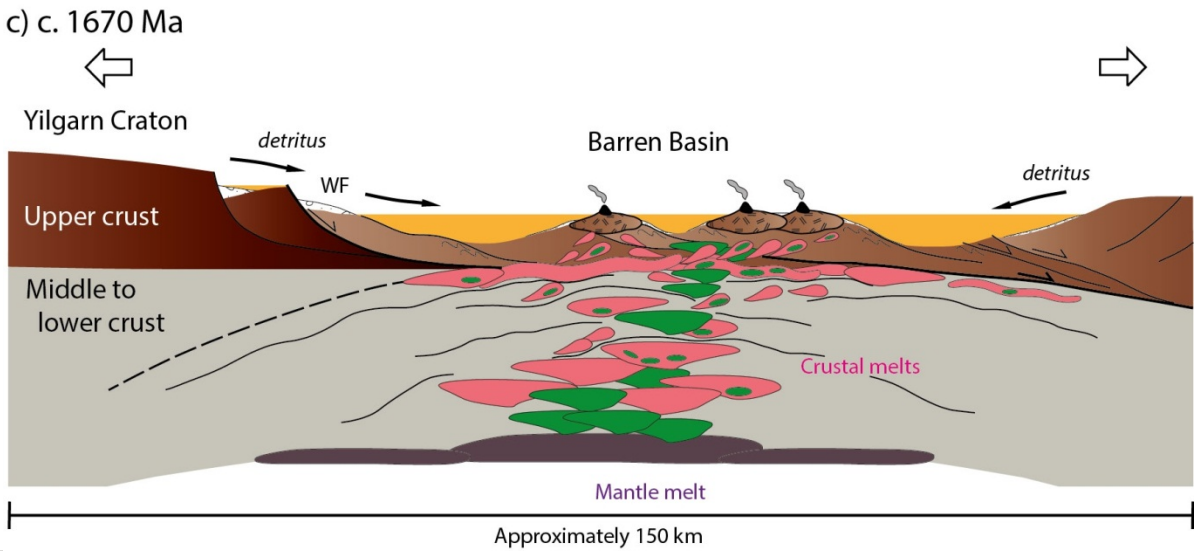
Tectonic events younger than 2000 Ma

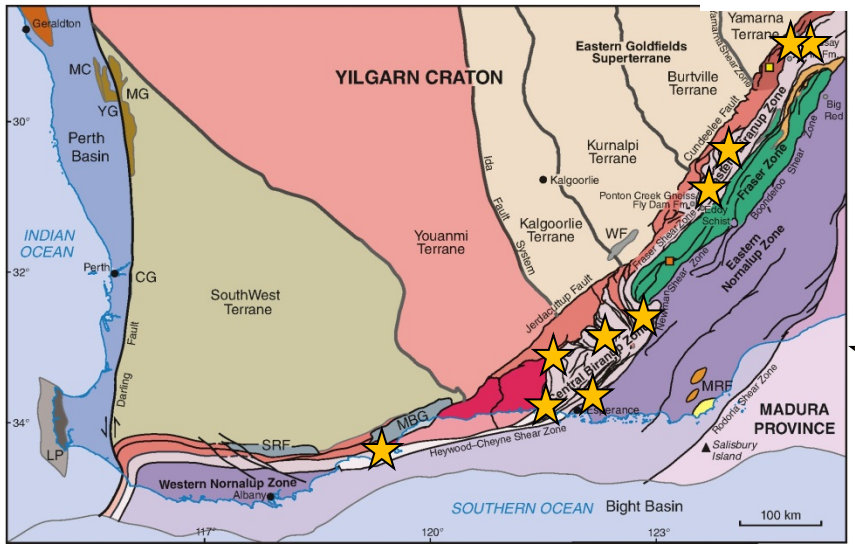


Biranup Orogeny: 1710 to 1650 Ma

Deposition of Mount Barren Group, Woodline Formation (WF), etc.

Increased magmatism and mantle component, thermal subsidence, and deepening of the basin. (see GSWA Report 133 for details).

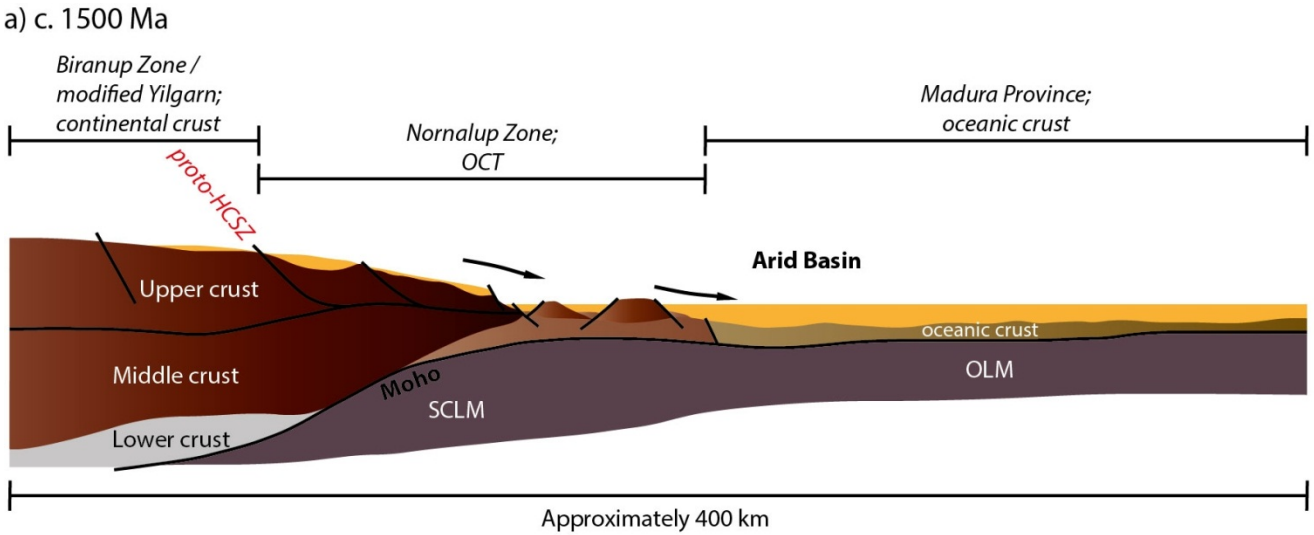




★ Locations of 1710 to 1650 Ma granites (simplified)

Folding during the c. 1680 Ma Zanthus Event

1600 to 1500 Ma: Tectonic quiescence



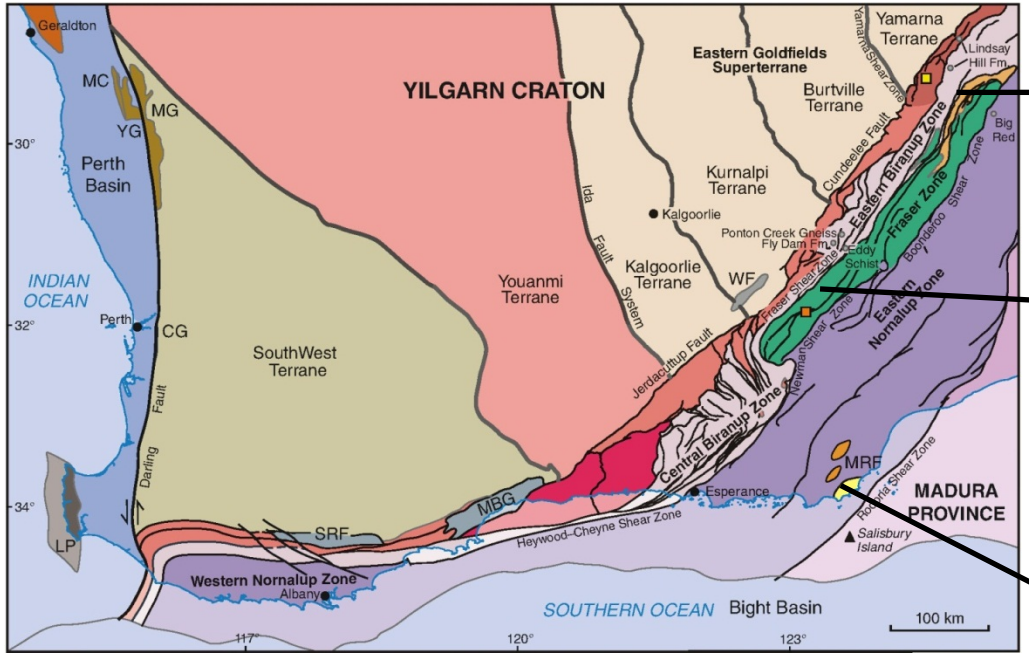
Initiation of the Arid Basin as a marginal basin:

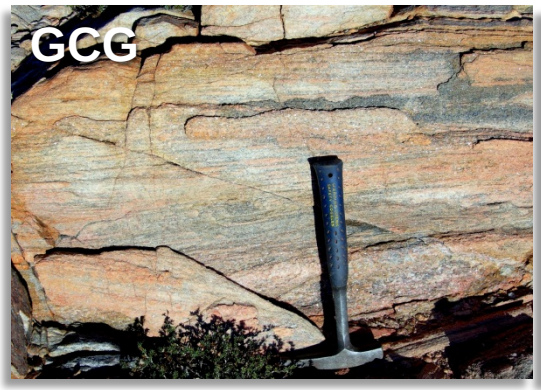
- The Arid Basin lay outboard of the Yilgarn Craton and Biranup Zone, with the Nornalup Zone as an ocean–continent transition (OCT).

- These zones define a passive margin that provided the bulk of the detritus to the basin at that time (phase 1 of the Arid Basin).

(see GSWA Report 133 for details).

Arid Basin (pre-Stage I of the Albany–Fraser Orogeny)





Gwynne Creek Gneiss; dominantly psammitic to semi-pelitic gneiss

- Maximum depositional age of c. 1483 Ma

Snowys Dam Formation (Fraser Zone) amphibolite to granulite facies pelitic, semipelitic to calcic, and locally iron-rich metasedimentary rocks

- Maximum depositional age of c. 1330 Ma

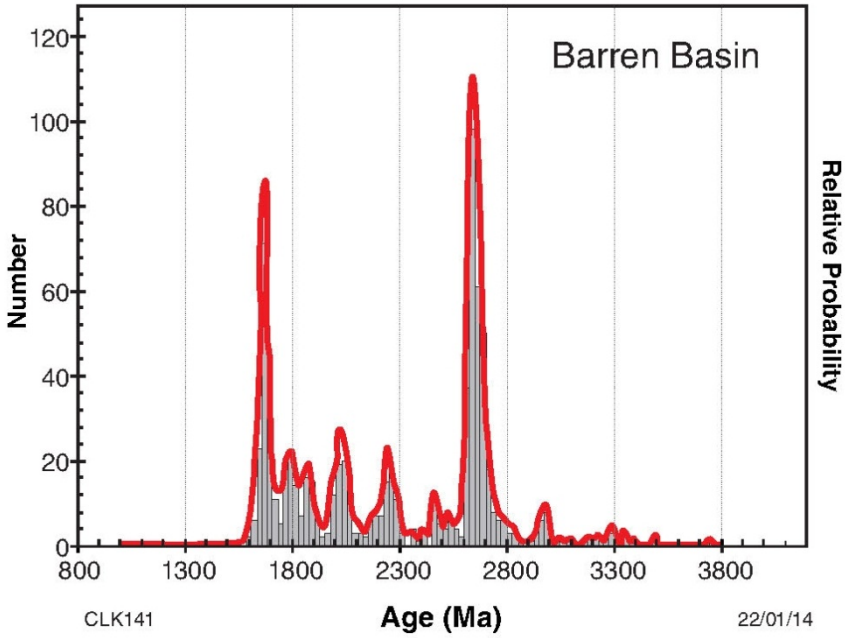
Malcolm Metamorphics; variable lithologies

- Maximum depositional age of c. 1455 Ma; possibly syn-volcanic (Adams, 2012)

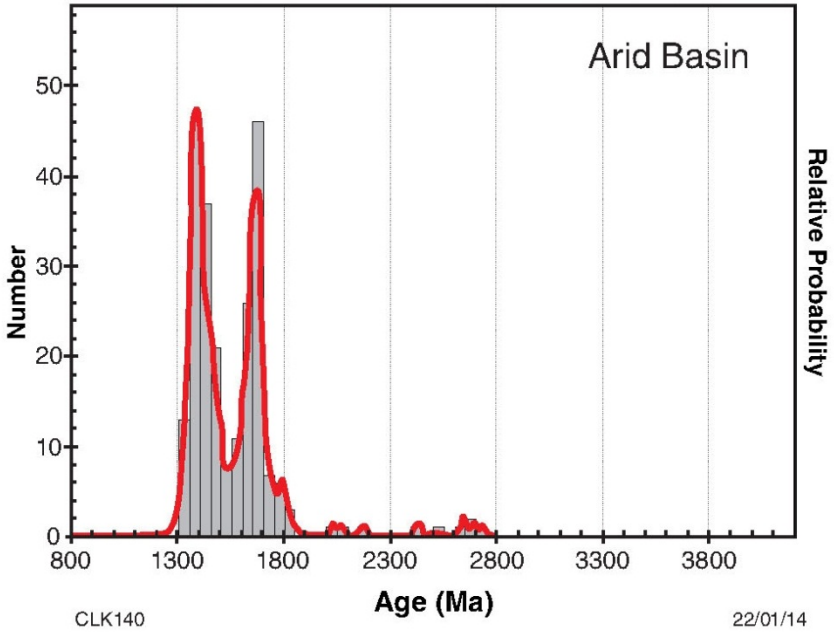
Whalehead Rock, western Nornalup Zone

- Maximum depositional age of c. 1360 Ma (Love, 1999)

Barren Basin versus Arid Basin zircon detritus – change in tectonic setting

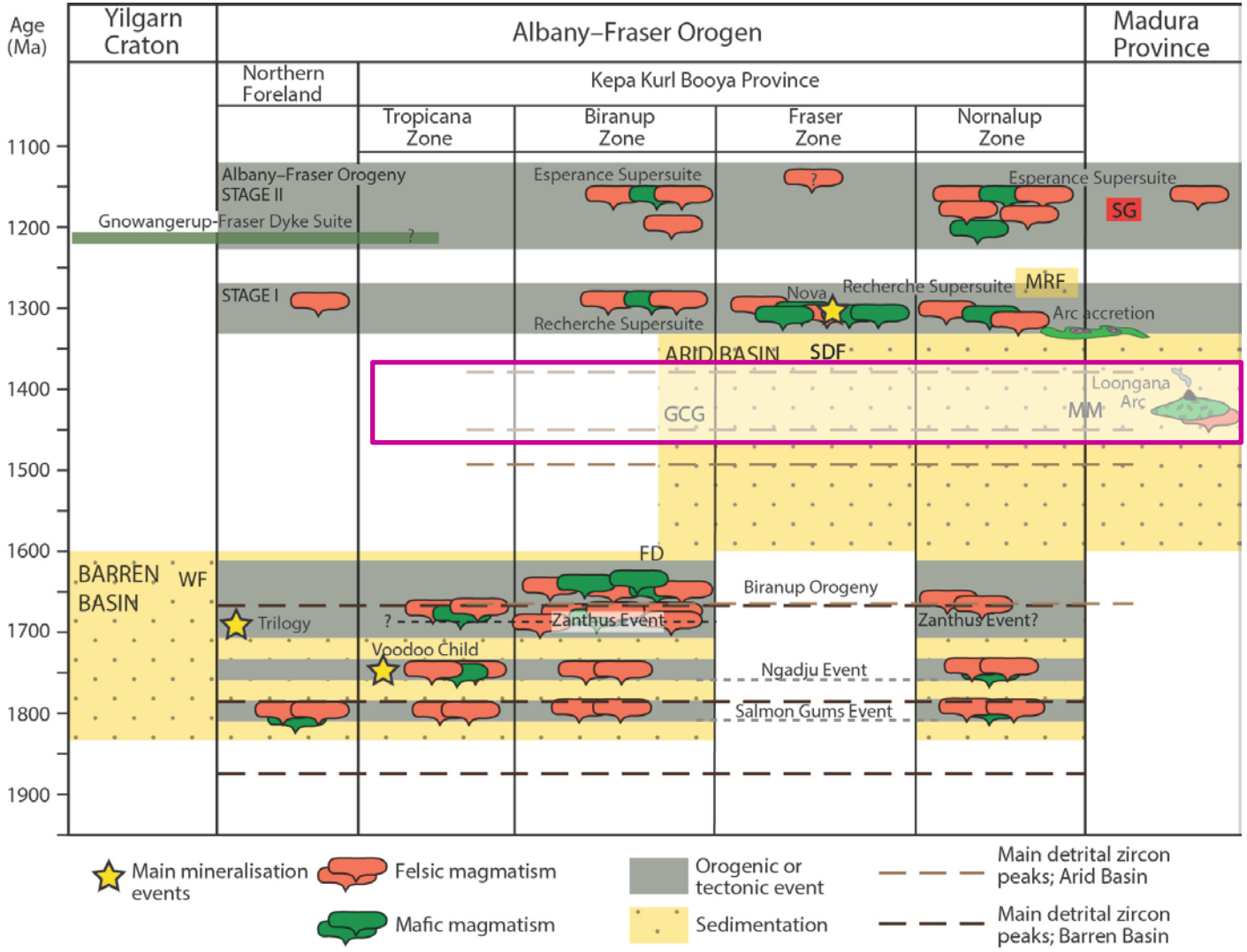


- Most dominant age component is Neoarchean / Yilgarn-derived (2750–2600 Ma)
- Second-most dominant component is locally-derived Paleoproterozoic (1700–1600 Ma)



- Most dominant age component is Mesoproterozoic / exotic (1450 to 1350 Ma)
- Second-most dominant component is locally-derived Paleoproterozoic (1700 to 1650 Ma)

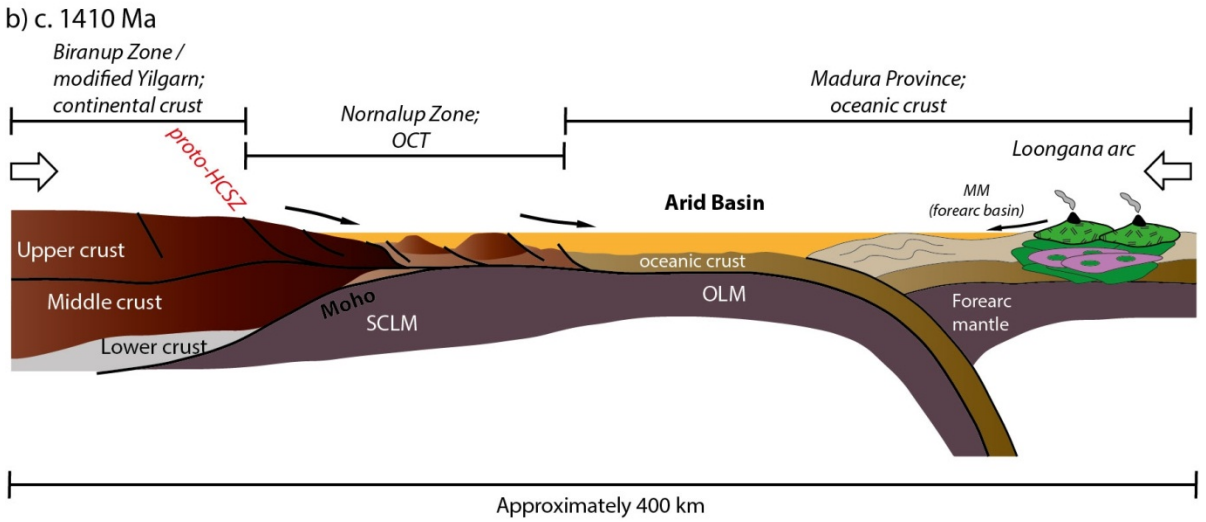
Tectonic events younger than 2000 Ma



Madura Province:
c. 1410 Ma Loongana oceanic-arc

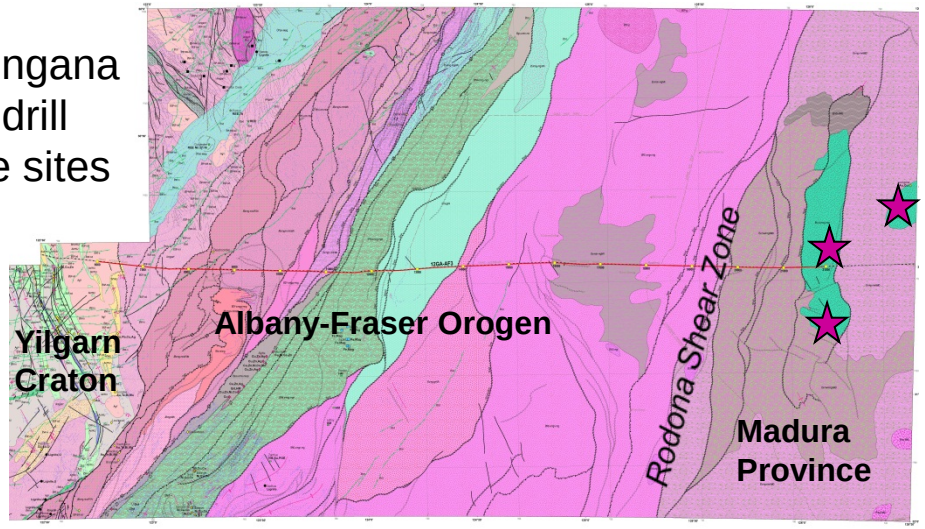
Change to convergent setting and development of the Loongana oceanic magmatic-arc at c. 1410 Ma.

Malcolm Metamorphics are interpreted fore-arc basin sediments, but the bulk of the Arid Basin is still a marginal ocean basin (phase 2 of the Arid Basin).

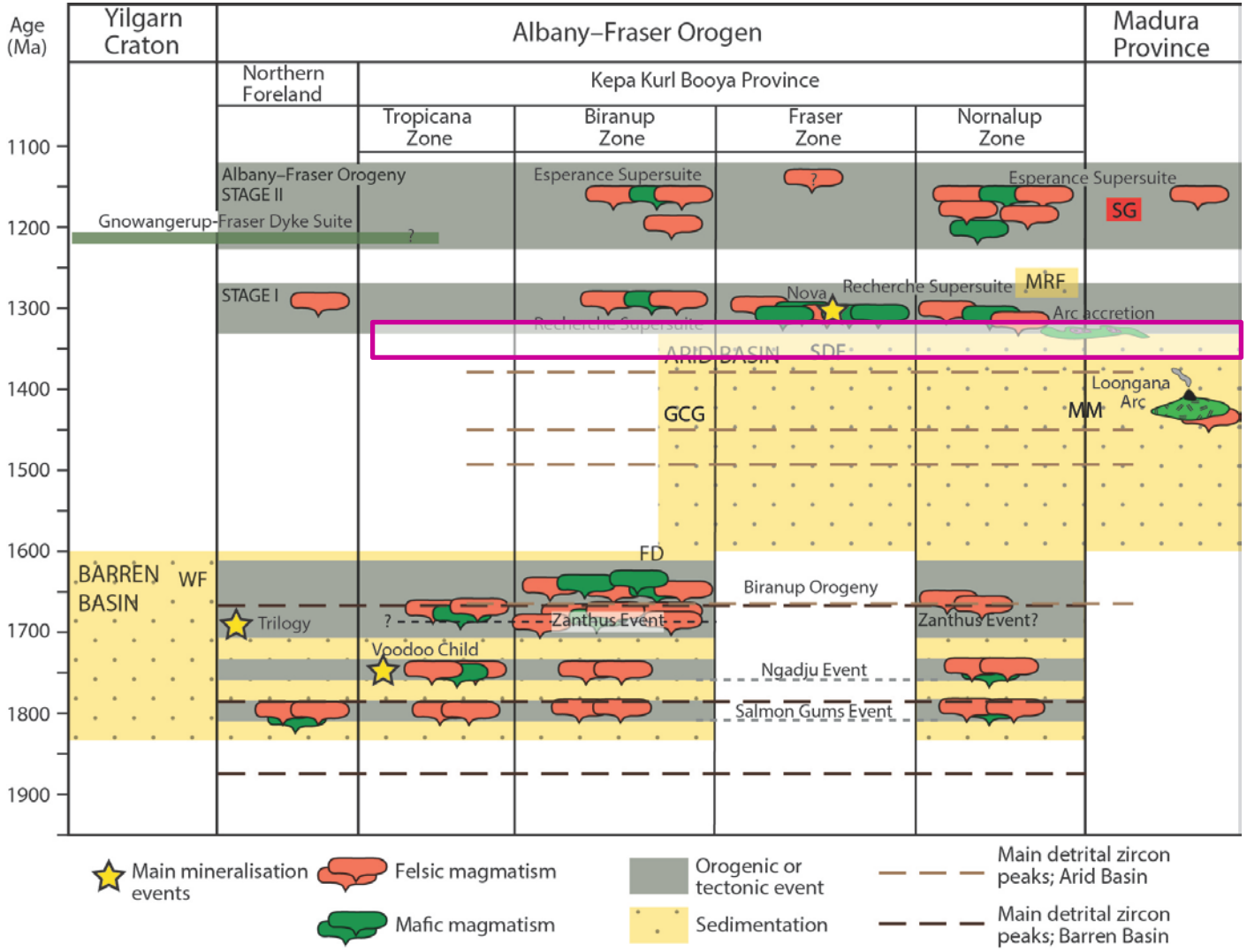


Malcolm Metamorphics

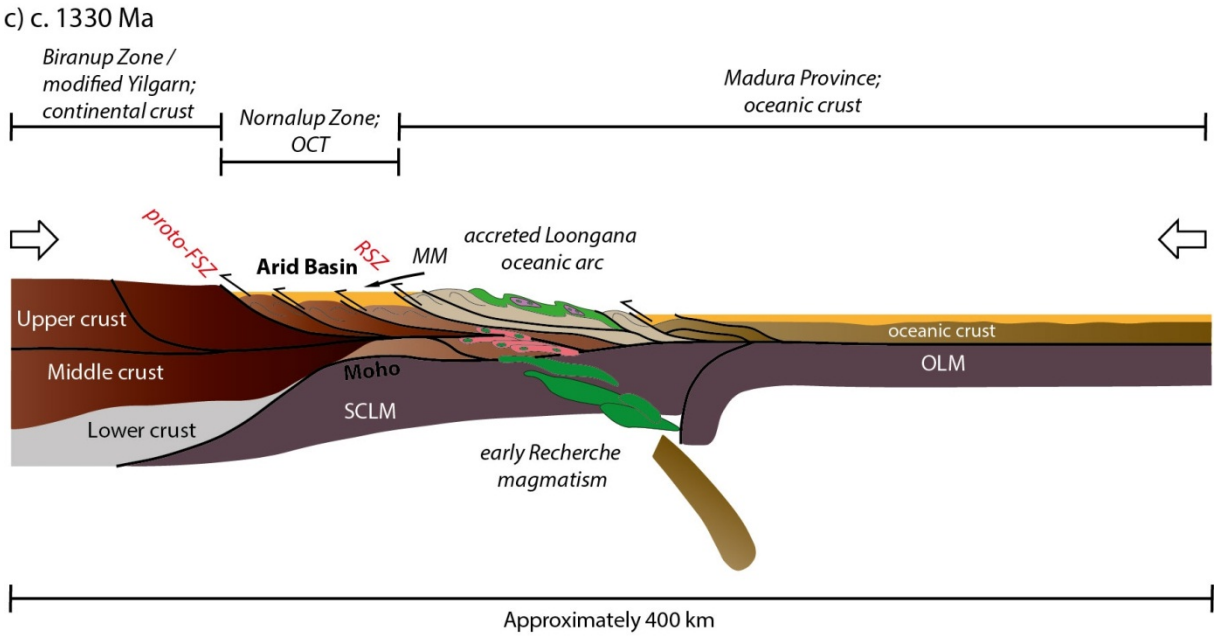
★ Loongana arc drill hole sites



Tectonic events younger than 2000 Ma



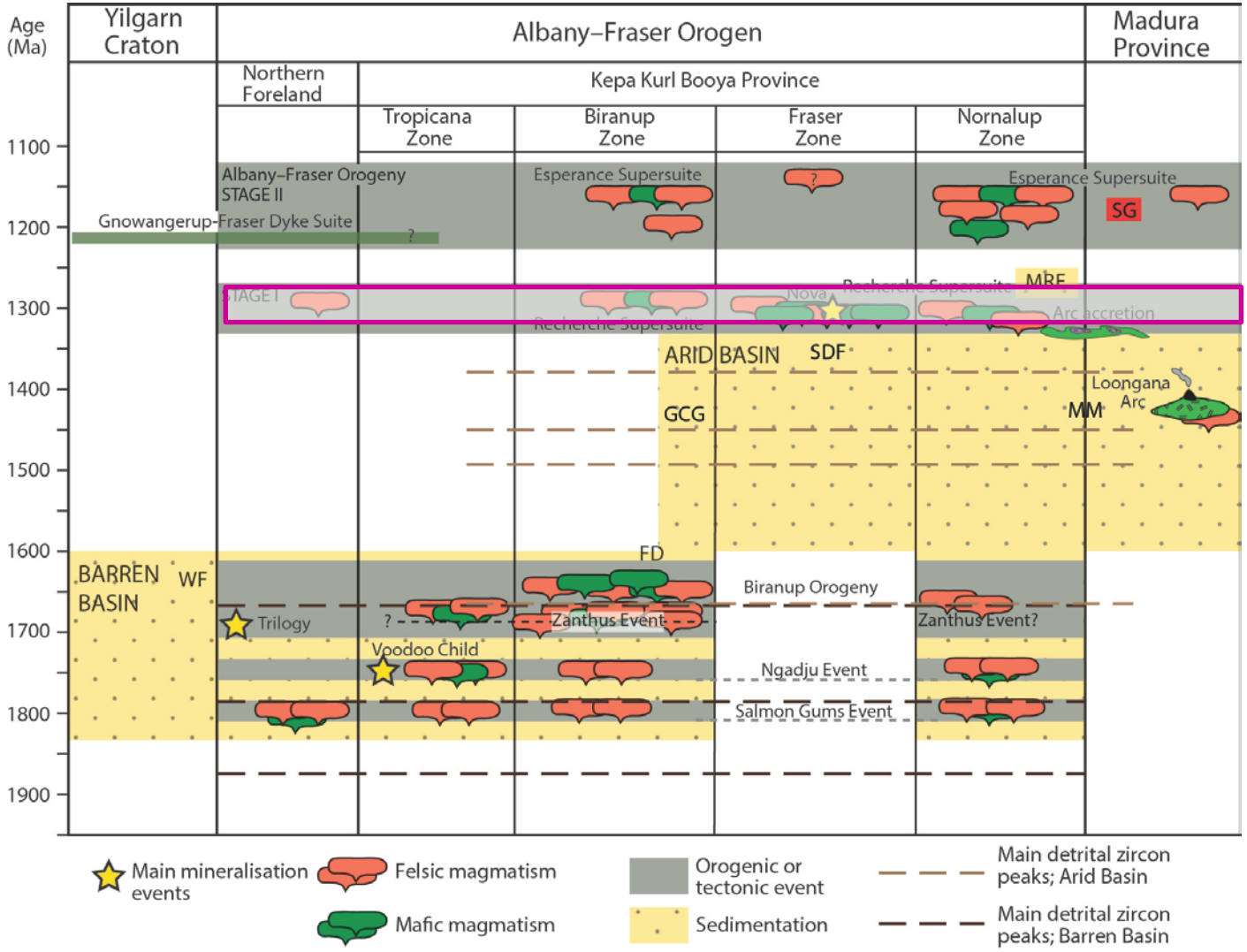
c. 1330 Ma Loongana oceanic-arc accretion and initiation of Stage I



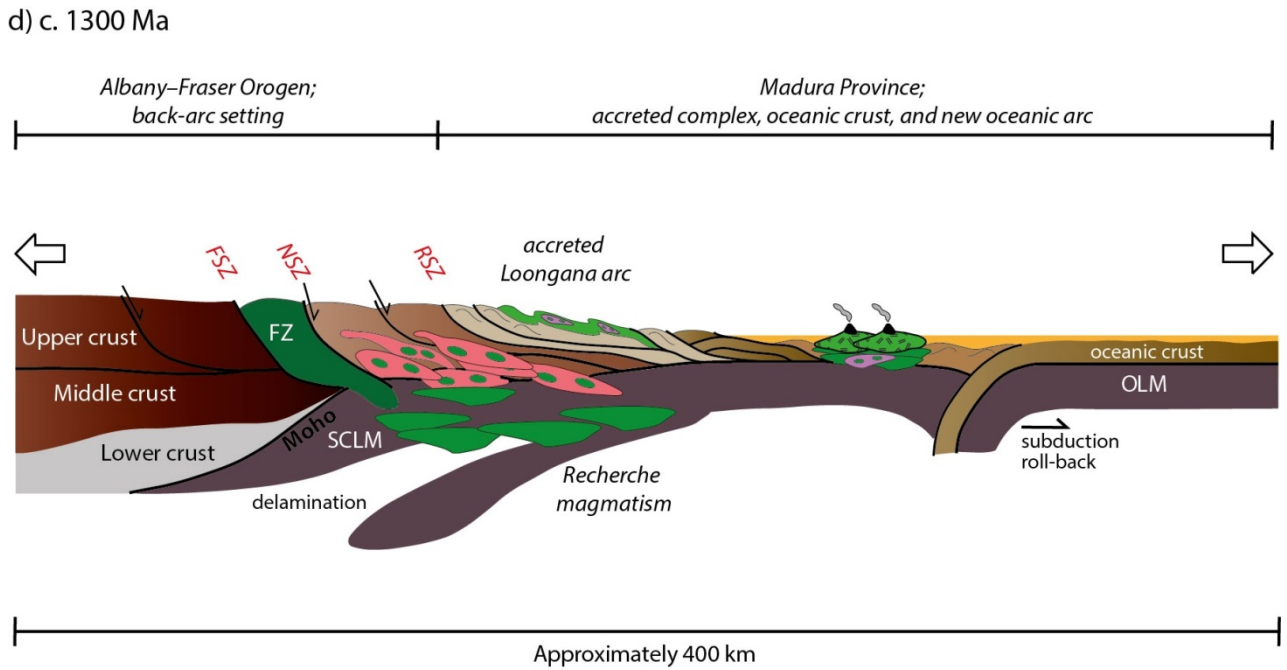
- Closure of the marginal basin, oceanic magmatic-arc accretion and slab detachment triggered the onset of Stage I, and early Recherche Supersuite magmatism.
- Sediments were transferred from the Loongana oceanic magmatic-arc and its environs to the Arid Basin (foreland basin; phase 3 of the Arid Basin).

(see GSWA Report 133 for details).

Tectonic events younger than 2000 Ma



Stage I Albany–Fraser Orogeny at c. 1300 Ma

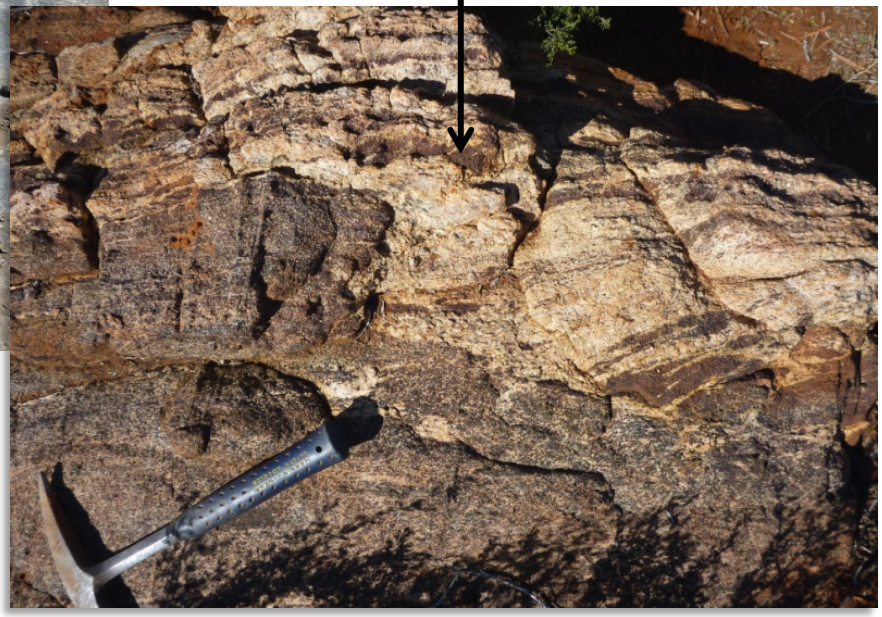


- Renewed subduction dips west beneath the easternmost extent of the orogen and accreted portion of the Madura Province, forming an oceanic magmatic-arc and adjacent back-arc setting.
- Roll-back leads to extension of the back-arc and formation of the Fraser Zone; continued Recherche Supersuite magmatism.

(see GSWA Report 133 for details).

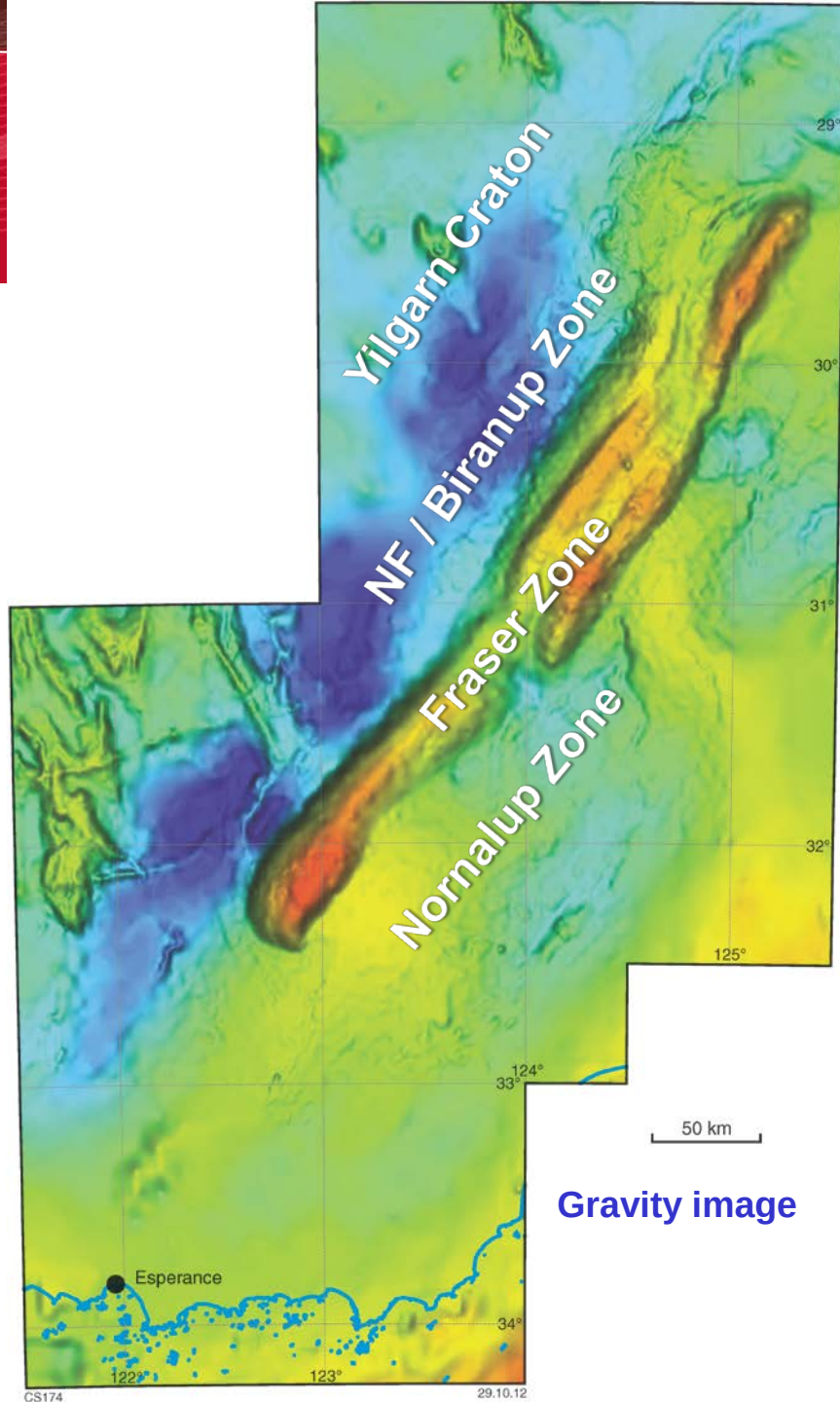
Fraser Zone magmatism: 1305 to 1290 Ma

- Metagabbro occurs as thin (cm-scale) to voluminous (several 100s m) sheets, interlayered with metagranitic rocks (co-magmatic)
- Intrudes sedimentary rocks of the Arid Basin (Snowys Dam Formation)



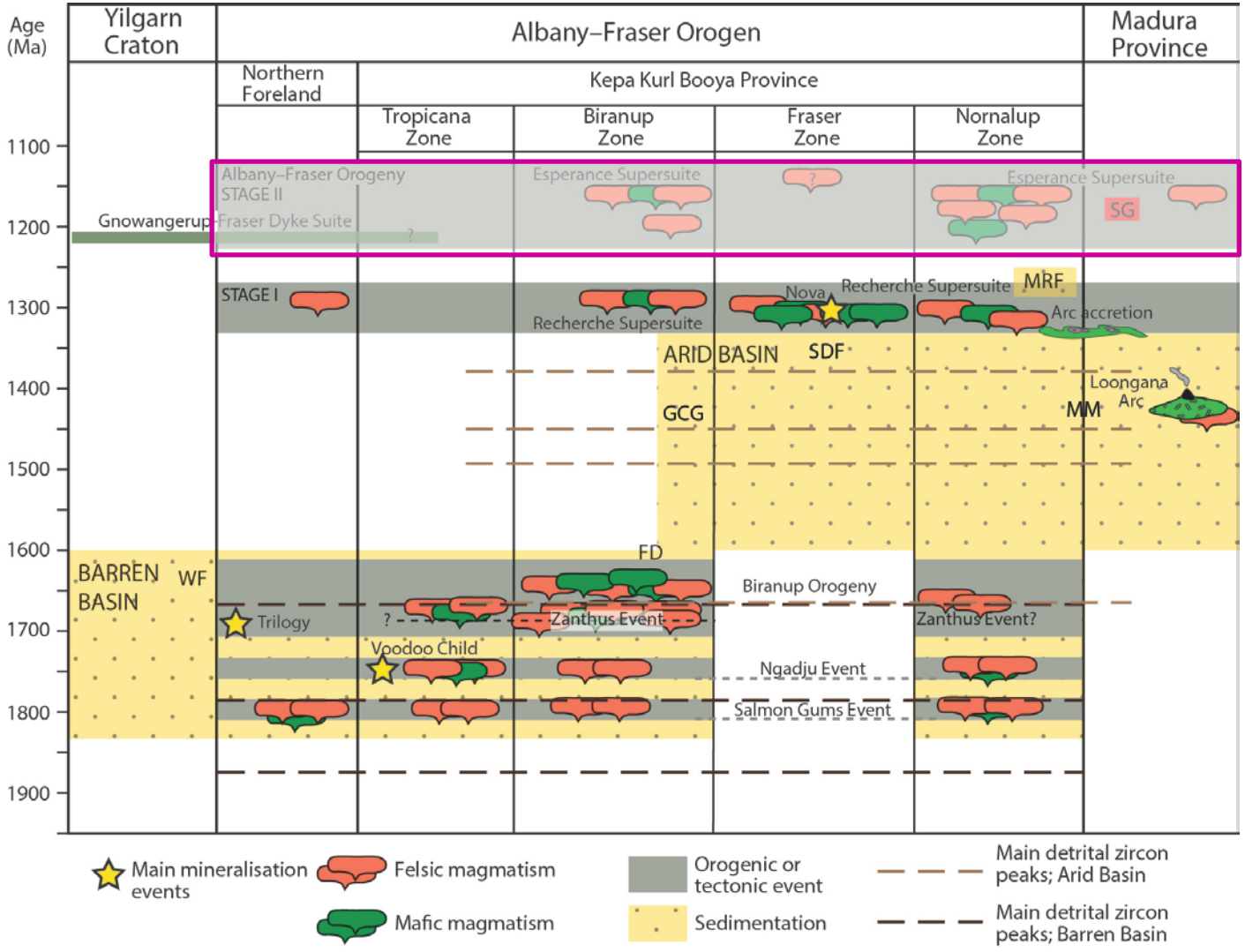
Fraser Zone

- Dense gravity signature suggests dominance of metagabbro
- Peak metamorphic conditions in pelitic gneiss at c. 1290 Ma were about 850°C at pressures of 7–9 kbar (Oorschot, GSWA Record 2011/18; Clark et al., 2014 Prec. Res.)
- Strong gneissic foliation that is tightly to isoclinally folded; cut by late shears



Gravity image

Tectonic events younger than 2000 Ma



Albany–Fraser Orogeny, Stage II: 1225–1140 Ma

Archean Munglinup Gneiss: leucocratic orthogneiss with mafic lenses

Orogen-wide:

- Esperance Supersuite magmatism
- Fold and thrust architecture, exhumation