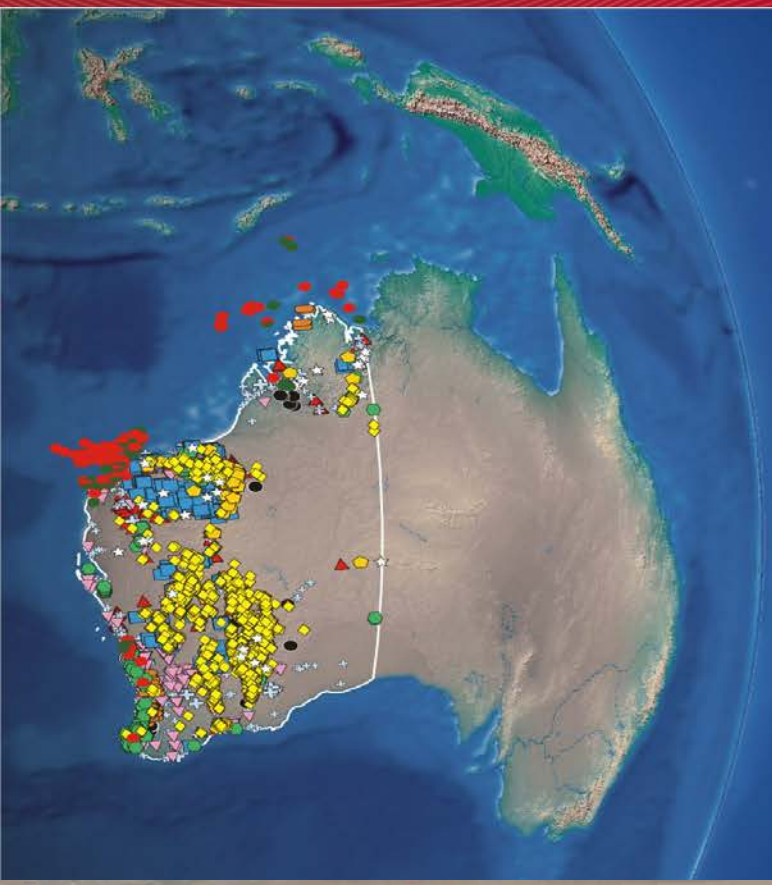
Government of **Western Australia**
Department of **Mines and Petroleum**



The Albany–Fraser deep reflection seismic and MT survey: Implications for mineral systems

Ian Tyler, Catherine Spaggiari, Sandi Occhipinti (CET), Chris Kirkland and Hugh Smithies

Australian Government
Geoscience Australia

Centre for EXPLORATION TARGETING

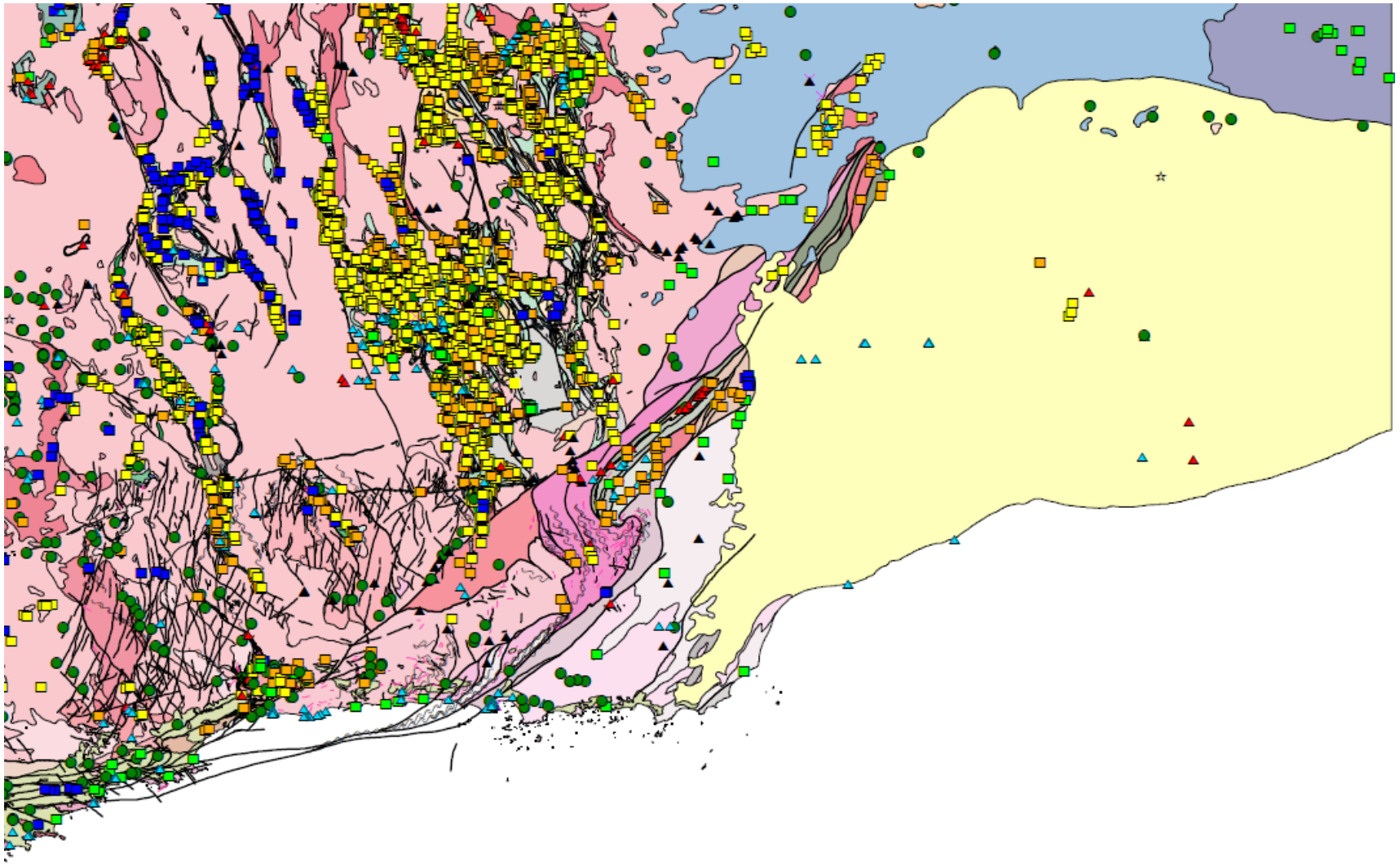
ANSIR NATIONAL RESEARCH FACILITY FOR EARTH SOUNDING

INDEPENDENCE GROUP NL

ANGLOGOLD ASHANTI AUSTRALIA

Geological Survey of Western Australia

Mineral Deposits: MINEDEX



Major Resource Projects

Major Resource Projects

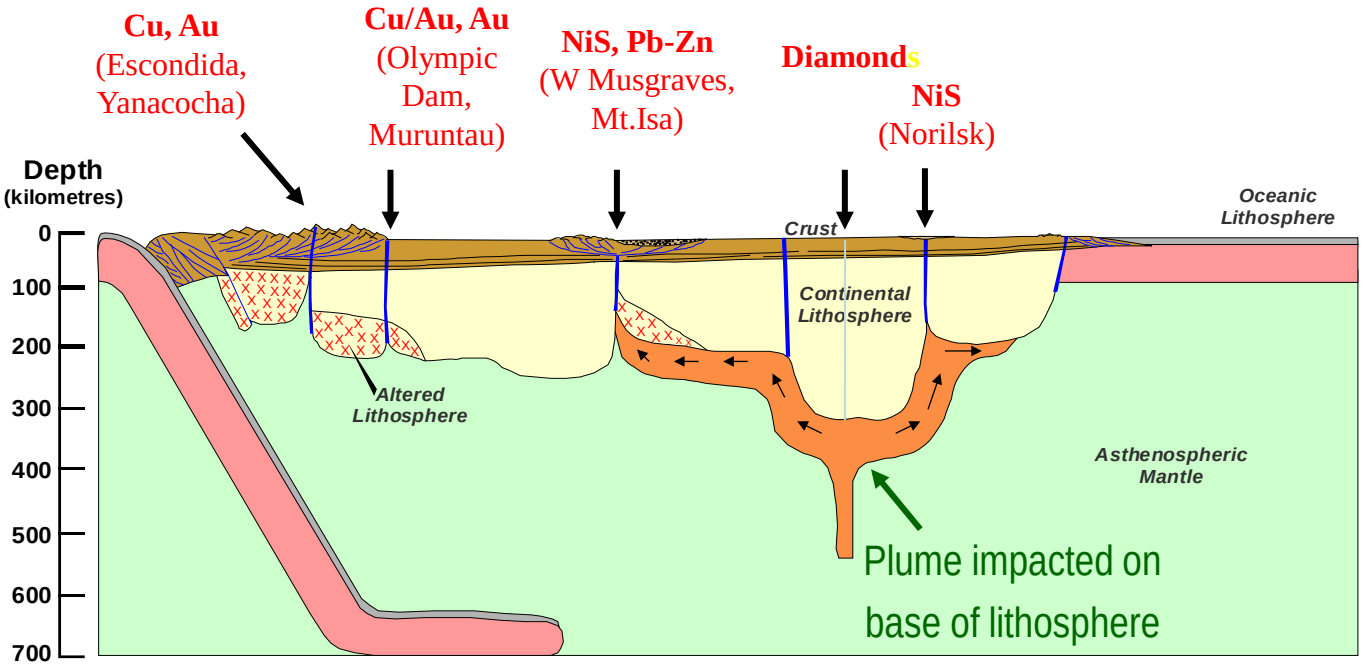
- Tropicana Gold Mine (Tropicana JV: AngloGold Ashanti, Independence Group)
  - 7.89 million ounces Au
    - Discovered 2005
- Nova Ni-Cu-Co (Sirius Resources)
  - 242 kt Ni, 100 kt Cu and 7.7 kt Co
    - Discovered 2012
- Trilogy Pb-Zn-Ag-Cu-Au (Silver Lake Resources)
  - 163 000 oz Au, 9.3 million oz Ag, 65 t Cu
    - Discovered 1997 (Homestake Gold of Australia)
- Southdown magnetite Fe (Grange Resources)
  - 1 256.9 Mt @ 33.7%

Albany–Fraser Orogen

- 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)

AFO is part of the West Australian Craton (WAC)

Metallogenic Settings in Lithospheric Context



MANTLE STRUCTURES IN KEY SETTINGS

Giant magmatic & hydrothermal ore deposits controlled by mantle structures and combined mantle-crustal processes

Minerals Targeting International PL

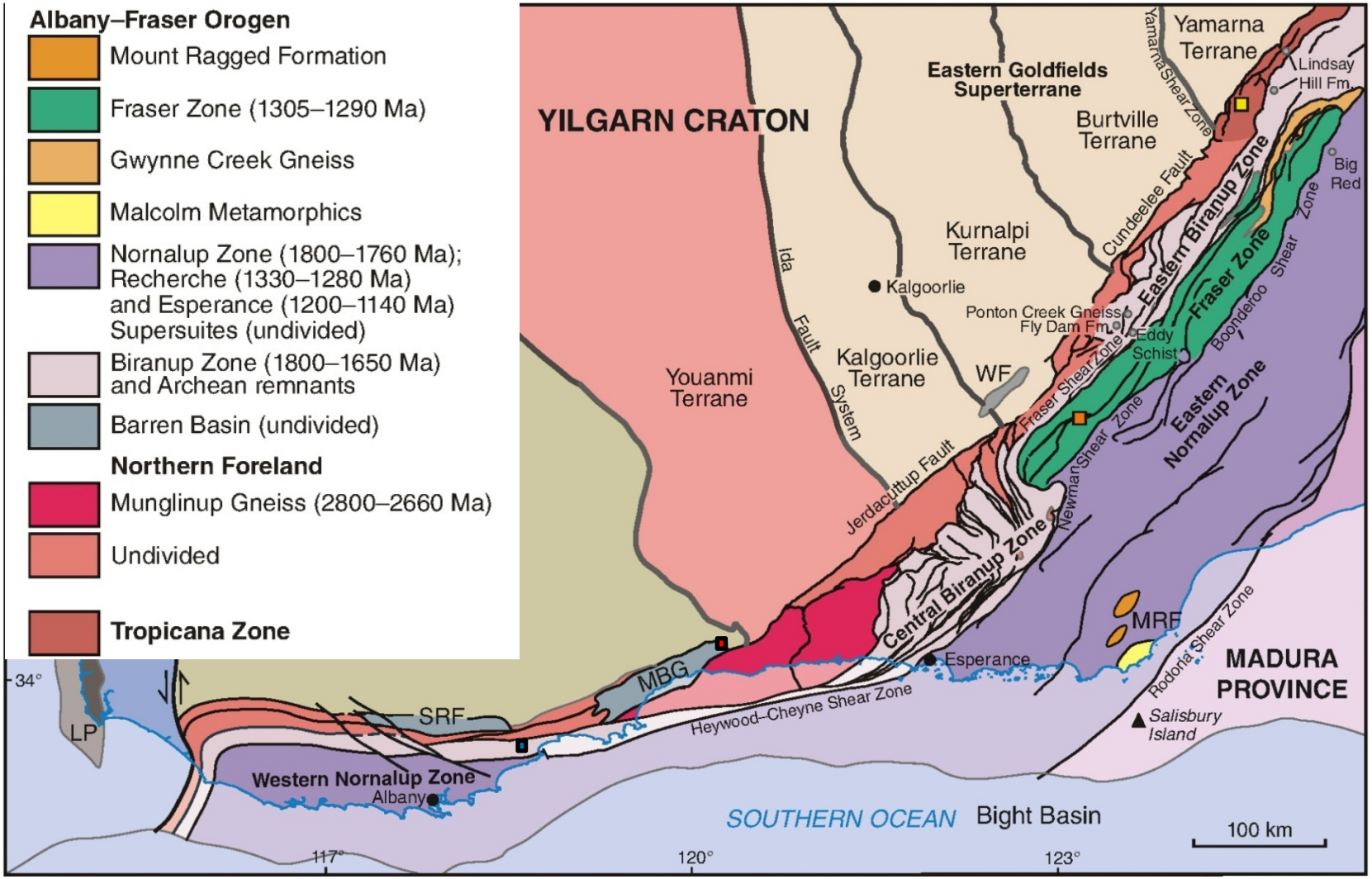
Mineral Systems: Yilgarn margin and Albany–Fraser Orogen

1. Neoarchean (c. 2500 Ma) thrust-related shear zone Au hosted in amphibolite to granulite facies ortho and paragneisses (Tropicana, Tropicana east);
2. Paleoproterozoic (c.1760 Ma) intrusion-related Au-Ag (Voodoo Child);
3. Paleoproterozoic stratabound (c. 1700 Ma) sedimentary clastic-hosted Pb-Zn-Ag-Cu-Au (Trilogy);
4. Paleoproterozoic (1800-1600 Ma) magnetite iron ore (Southdown);
5. Mesoproterozoic (c. 1300 Ma) orthomagmatic mafic intrusion-related Ni-Cu-Co (Nova).

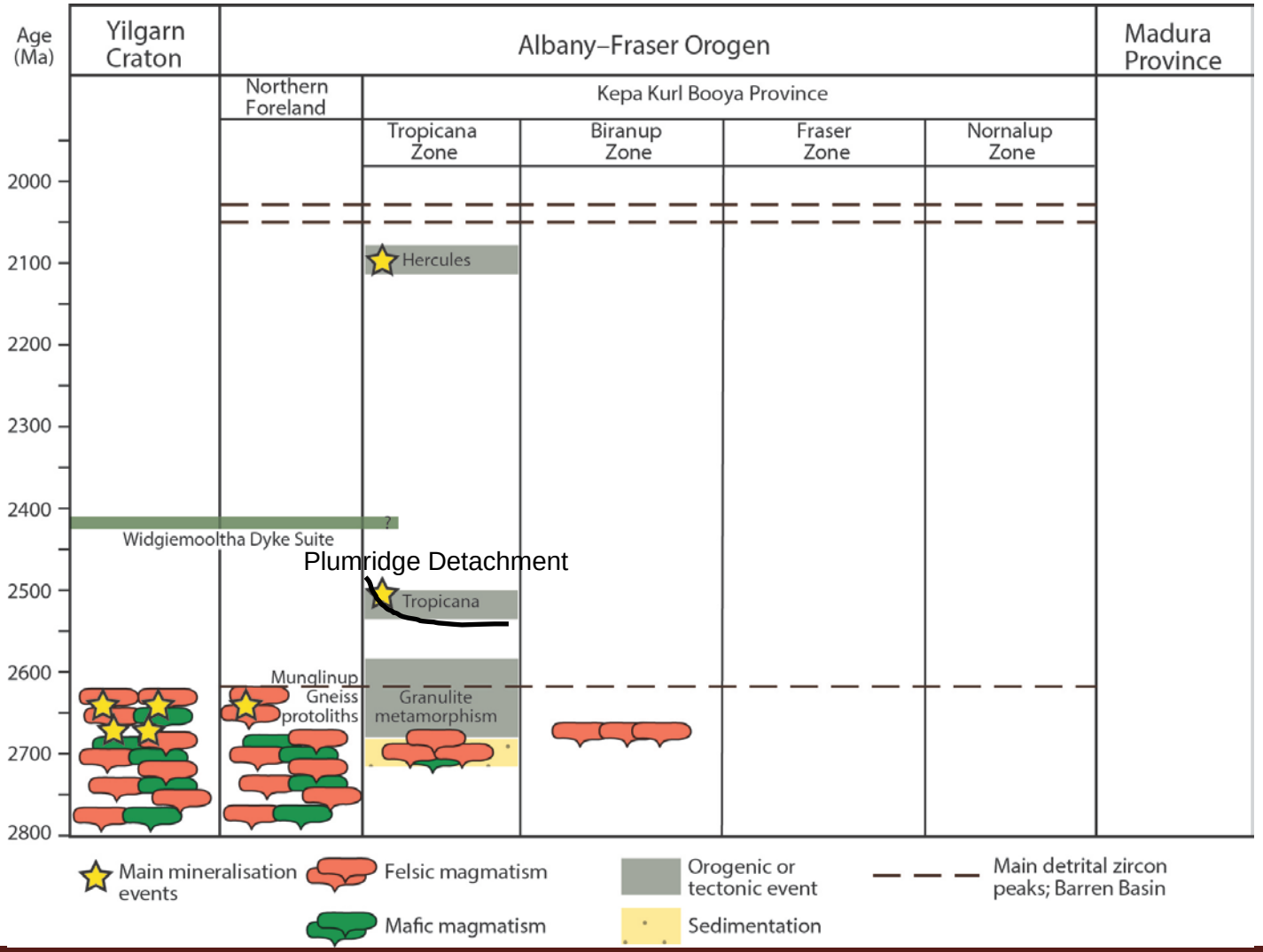
Mineral Systems: Yilgarn margin and Albany–Fraser Orogen

- Magmatic
  - Neoarchean c. 2700 Ma sanukitoid-related gold/orogenic lode-gold
  - Proterozoic (c. 1800, 1660, 1210 Ma) mafic intrusion-related Ni
  - Proterozoic intrusion-related Au-Cu (c. 1800, 1660, 1300 Ma)
  - Esperance Supersuite (1200–1140 Ma)
    - Sn-W
    - IOCG
- Proterozoic shear-related Au (c. 1800, 1690, 1300, 1200–1140 Ma)
- Proterozoic Basins (1800–1600, 1600–1330 Ma)
  - VMS
  - SEDEX

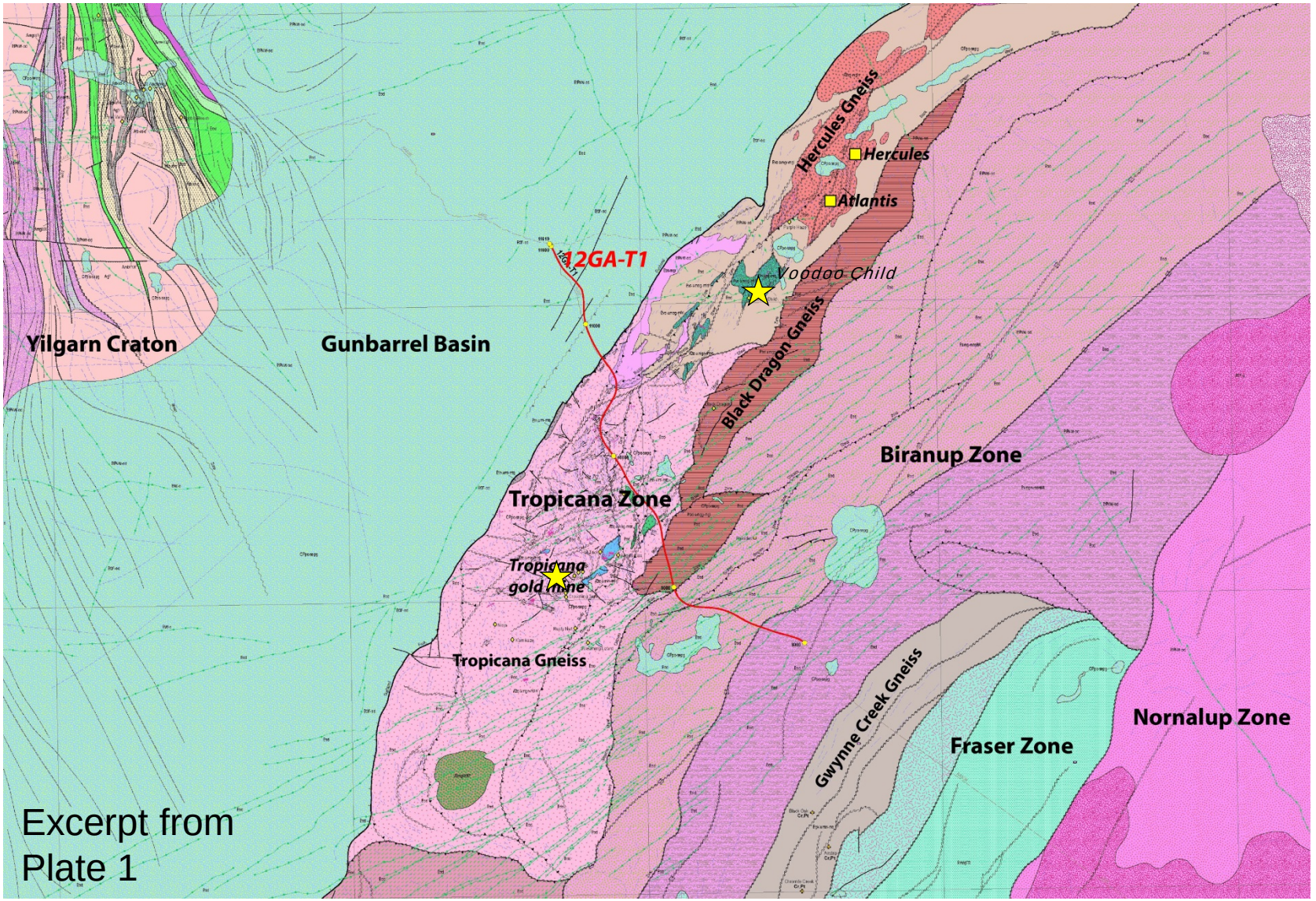
Albany–Fraser Orogen



Tectonic events older than 2000 Ma

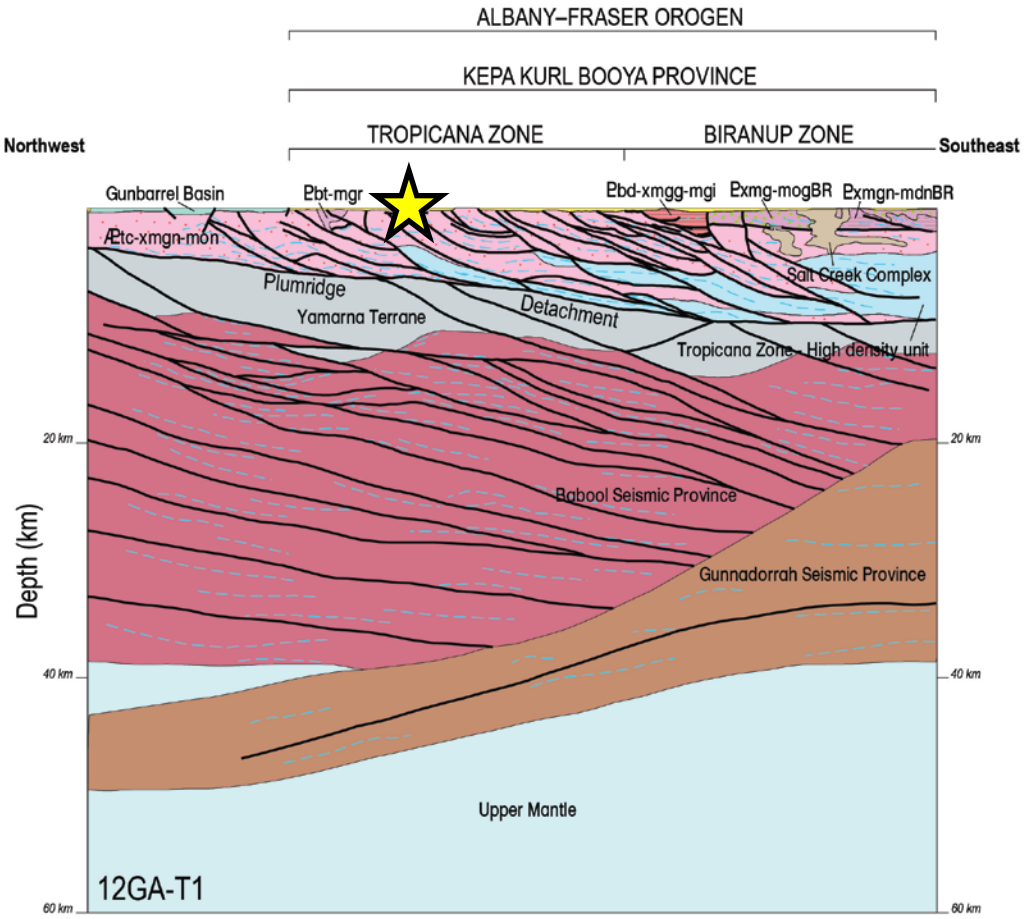


Tropicana Zone: Tropicana (Tropicana JV) and Tropicana East (Beadell Resources)



Excerpt from Plate 1

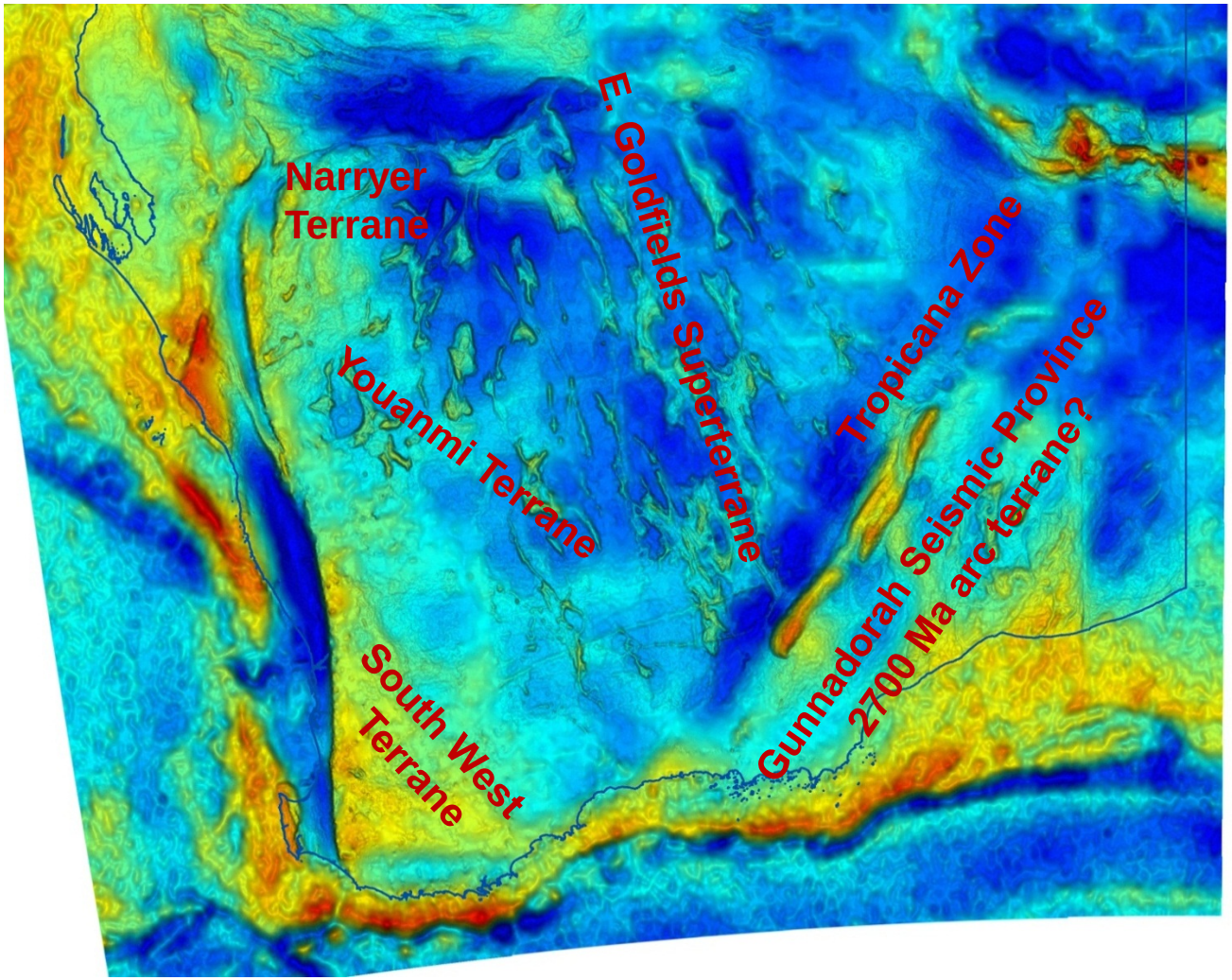
Tropicana Zone: 12GA–T1



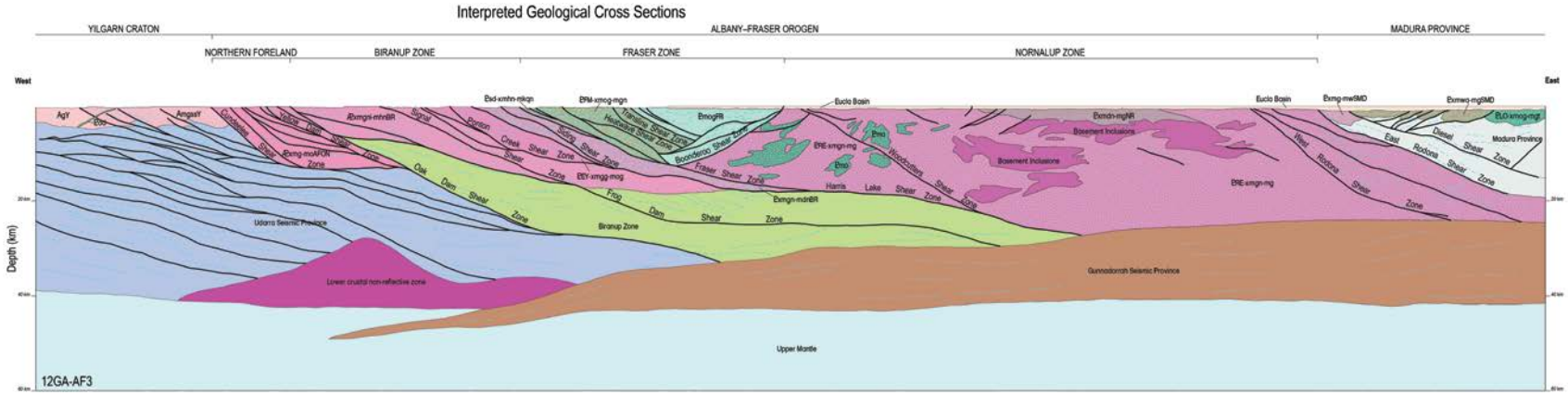
Where did the Tropicana Zone come from?

- Parautochtonous
  - 2520 Ma thrust on Plumridge Detachment onto Yamarna Terrane
- c. 2720 Ma sanukitoids
  - (metasomatised mantle above subducting slab)
  - Same age as EG komatiites
- Tectonic setting: SE Yilgarn Craton margin
  - Continental margin/arc terrane
  - Granulite facies in mid-crust during c. 2650 Ma Au event in EG
  - Link to Gunnadorrah Seismic Province?

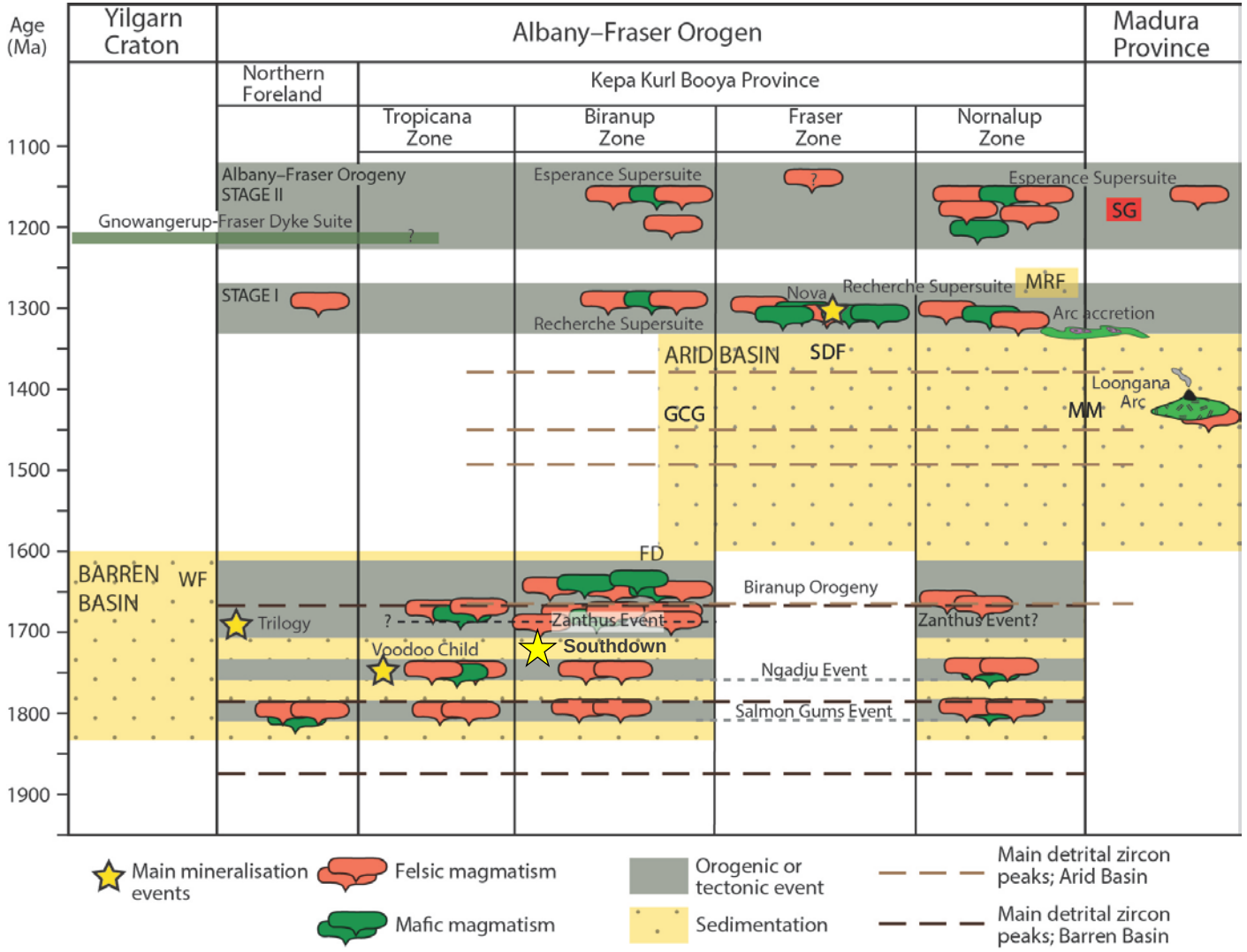
Tropicana Zone



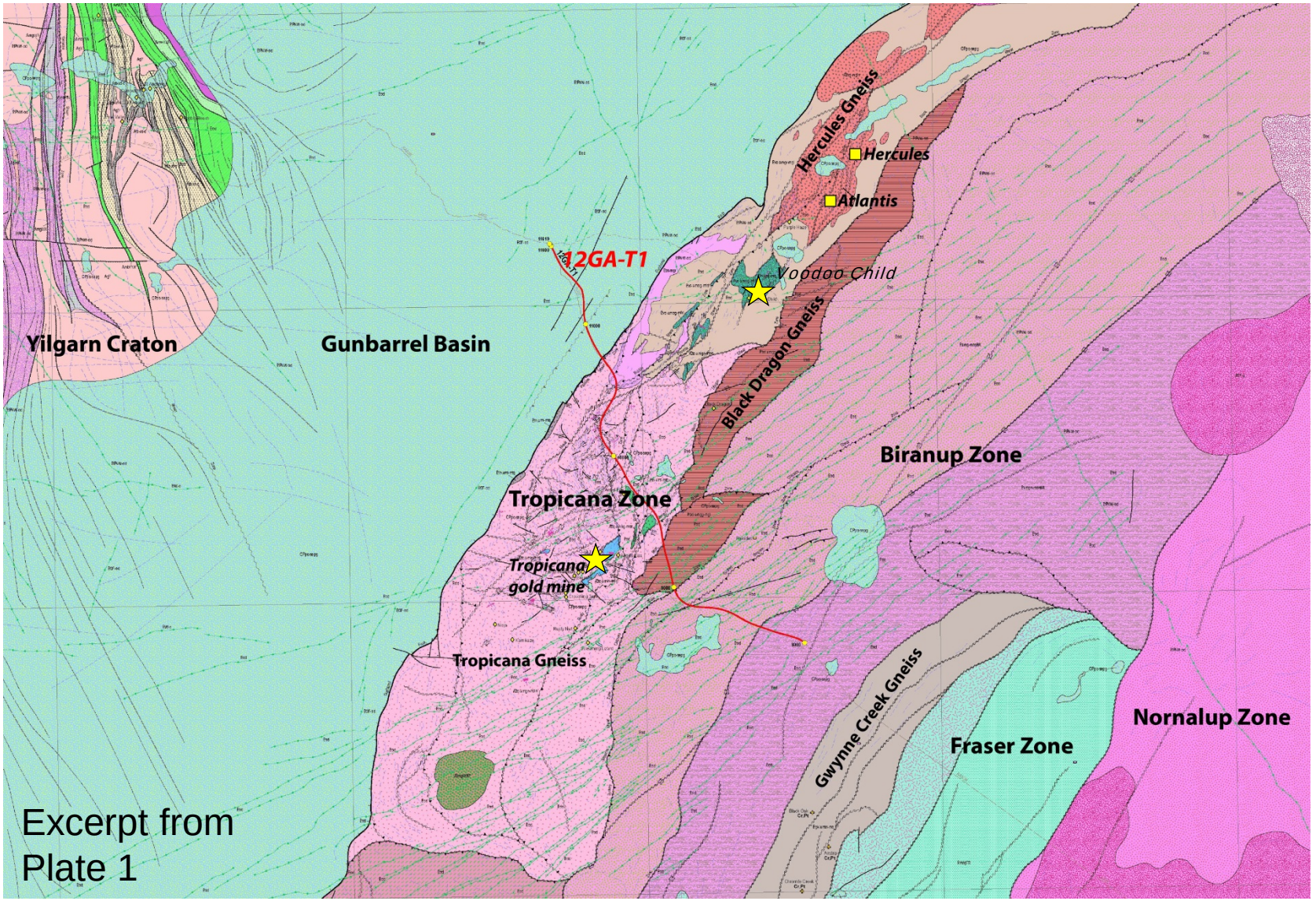
12GA–AF3


Interpreted Geological Cross Sections
YILGARN CRATON
ALBANY–FRASER OROGEN
MADURA PROVINCE
NORTHERN FORELAND
BIRANUP ZONE
FRASER ZONE
NORNALUP ZONE
West
East
Depth (km)
Eucla Basin
Basement Inclusions
Woodarra Seismic Province
Biranup Zone
Gunnadorrah Seismic Province
Upper Mantle
Lower crustal non-reflective zone
12GA-AF3

Tectonic events younger than 2000 Ma



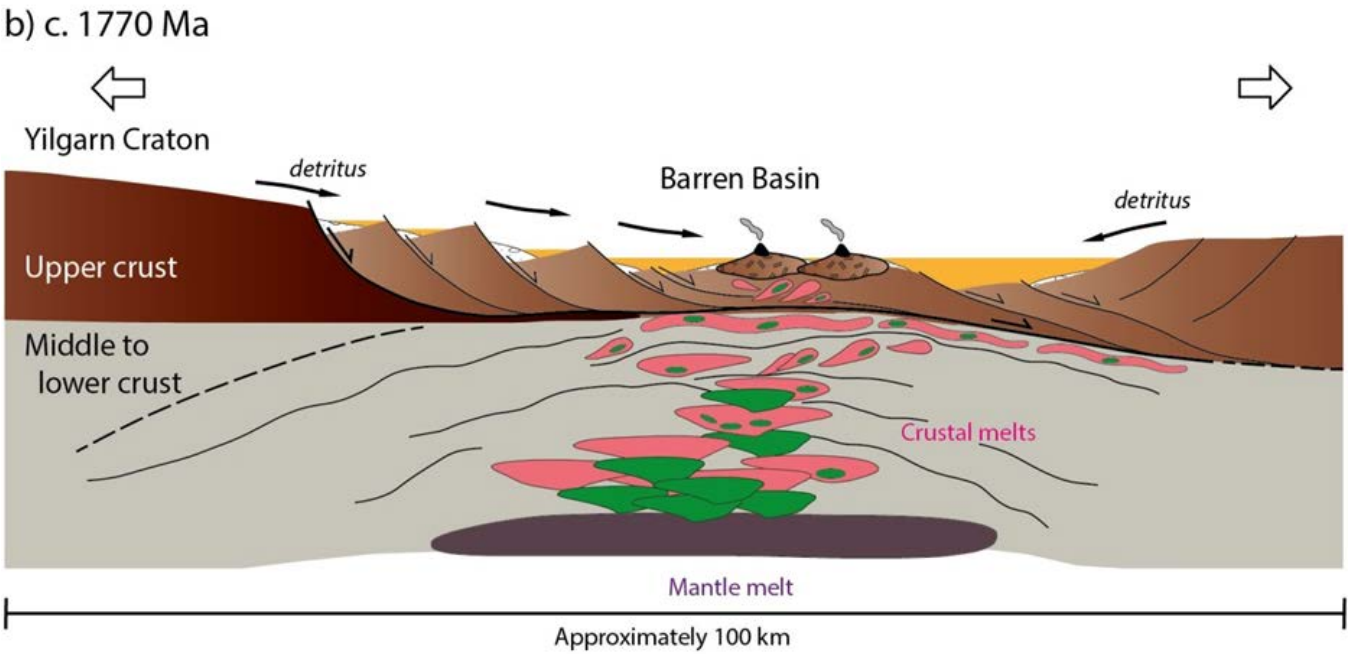
Tropicana Zone: Voodoo Child (AngloGold Ashanti) — Ngadju Event



Excerpt from Plate 1

Voodoo Child Au-Ag

- Intrusion-related (T Less, 2013)
  - Dacitic volcanics

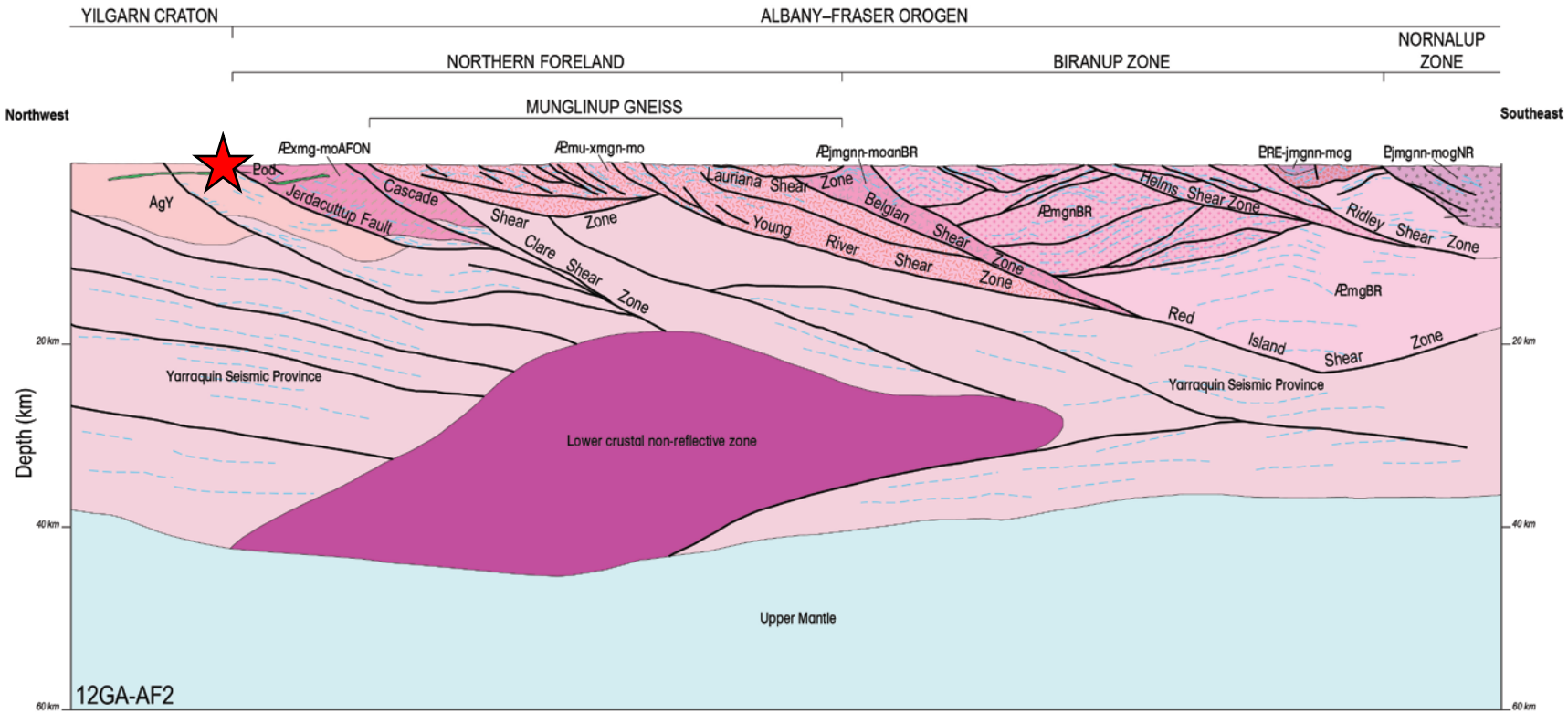


Trilogy (Au-Cu-Ag-Pb-Zn) and Southdown (magnetite Fe)

Trilogy (Silver Lake Resources): SEDEX?

- c. 1700 Ma clastic-hosted stratabound sedimentary deposit (Sampson and Bourne, 2001)
  - graphitic phyllites
- Polymetallic massive sulfide mineralization
  - Pb-Zn-Ag sulfides
  - Cu-Au stringers

Jerdacuttup Fault: Yilgarn Youanmi Terrane/Northern Foreland boundary

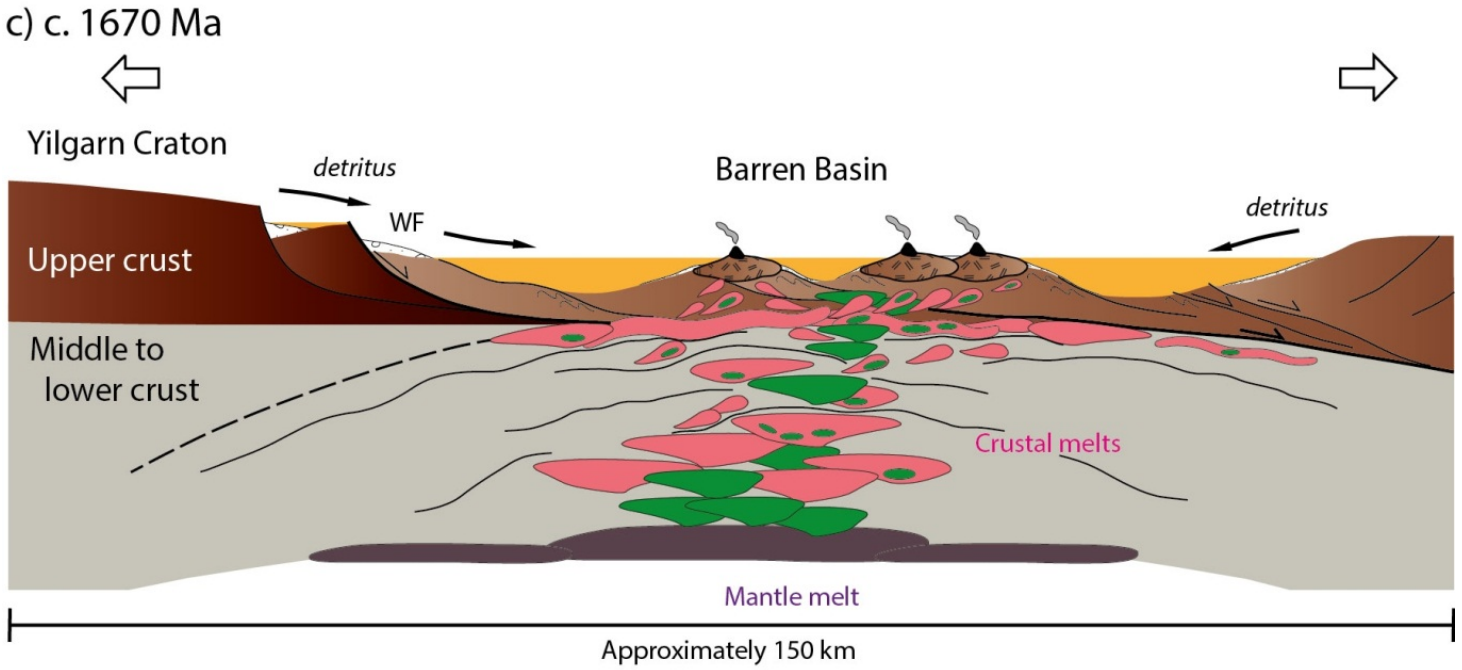


Southdown magnetite Fe (Grange Resources)

- Biranup Zone
  - Metamorphosed iron-rich sedimentary rocks
  - Granulite Facies
    - Magnetite (+pyroxene, +garnet)

Barren Basin

- Fe-rich sedimentary rocks
- SEDEX and VMS



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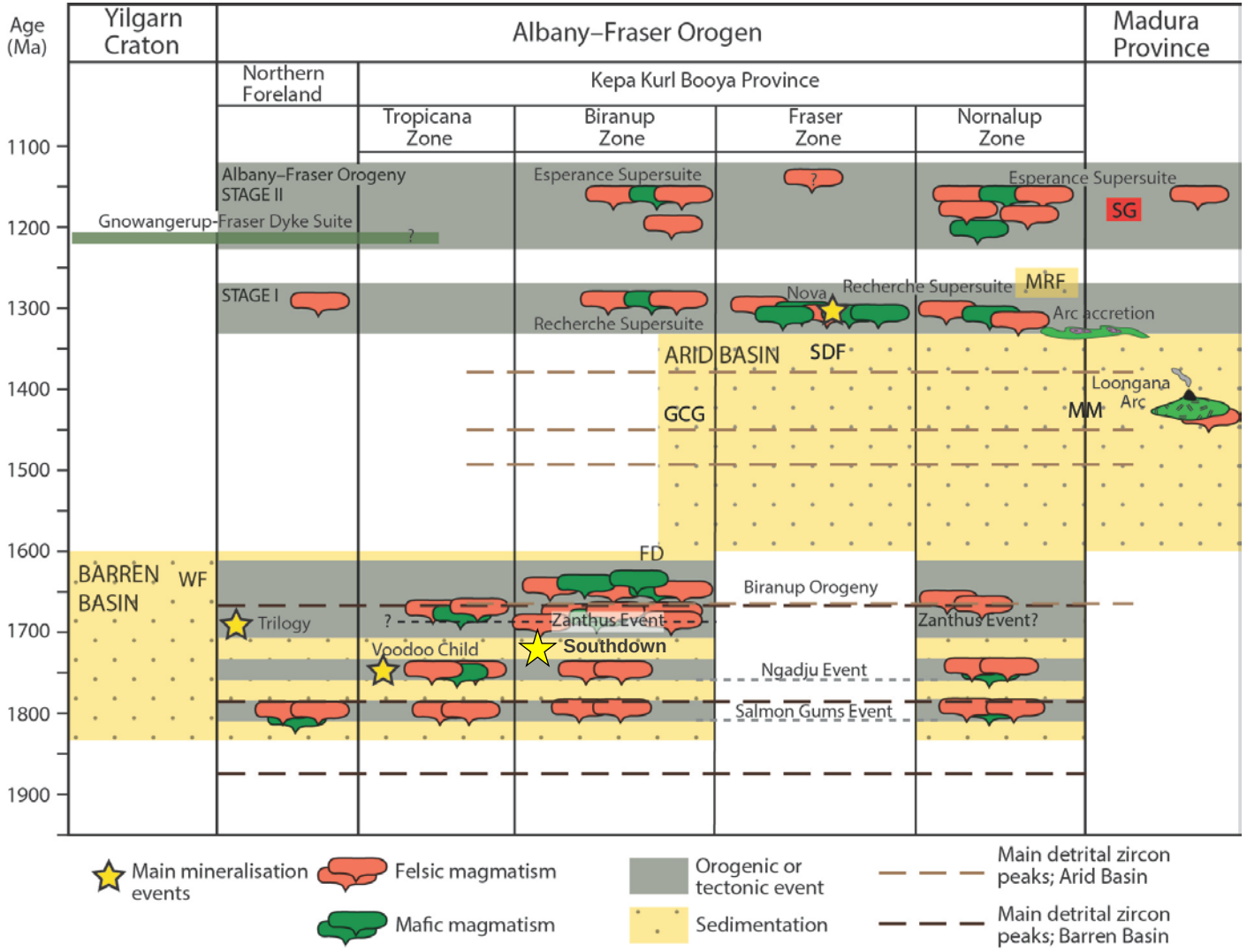
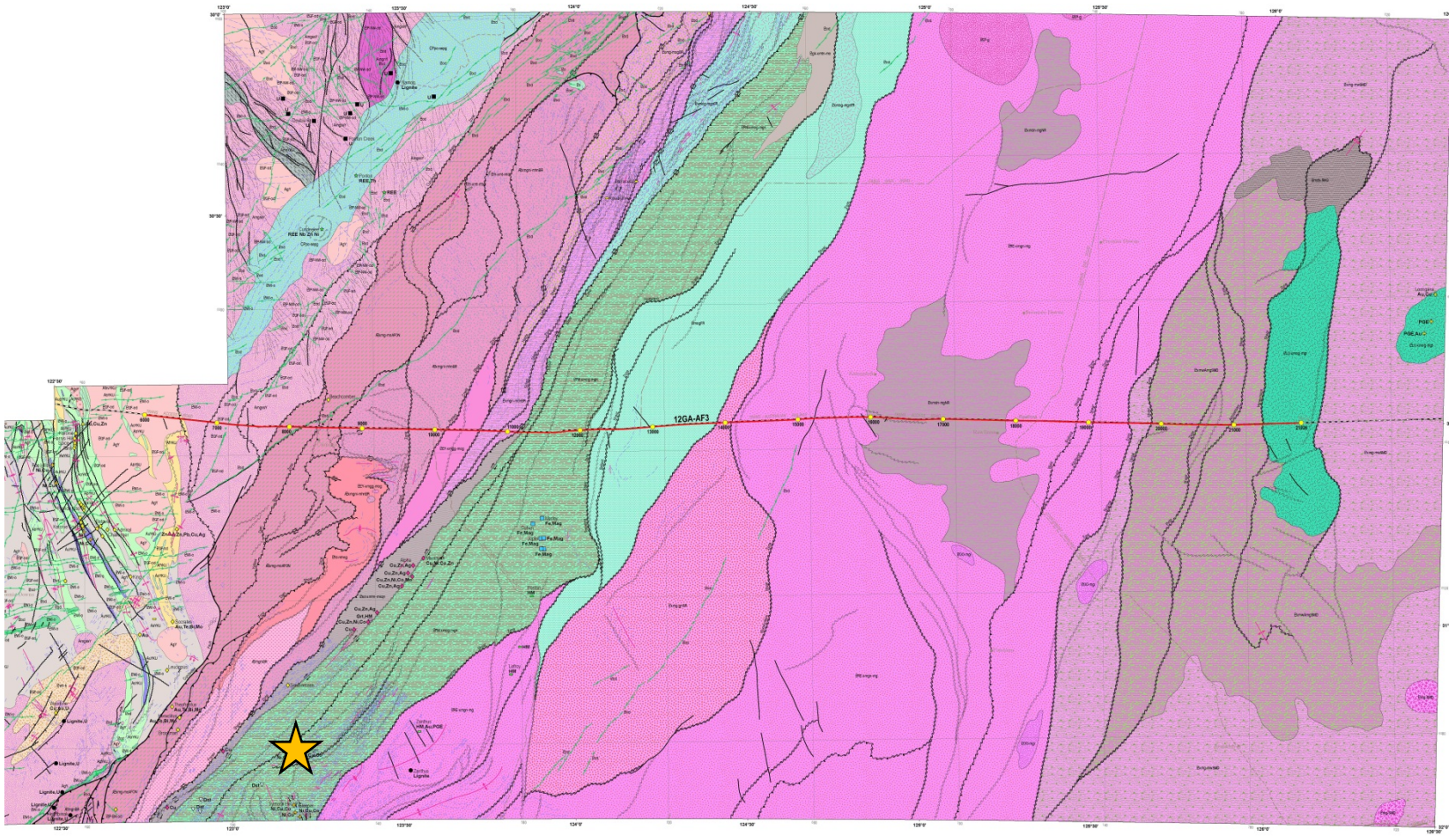


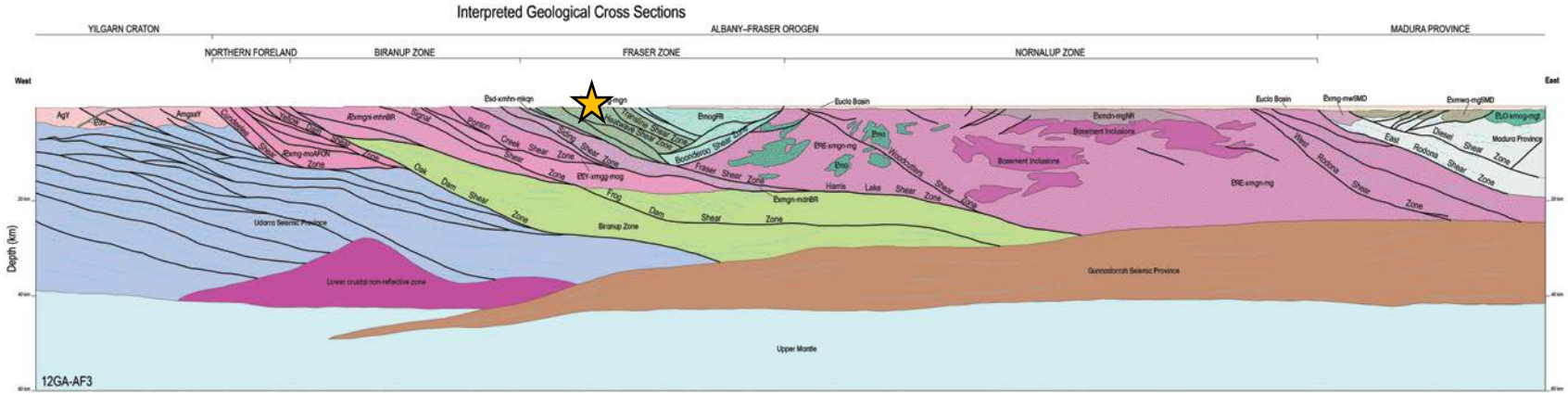
Nova (Sirius Resources)

From Mark Bennett's presentation at CET Discovery Day, February 2014

Mesoproterozoic (c. 1300 Ma) orthomagmatic mafic intrusion-related Ni-Cu-Co



12GA–AF3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NORNALUP ZONE
West
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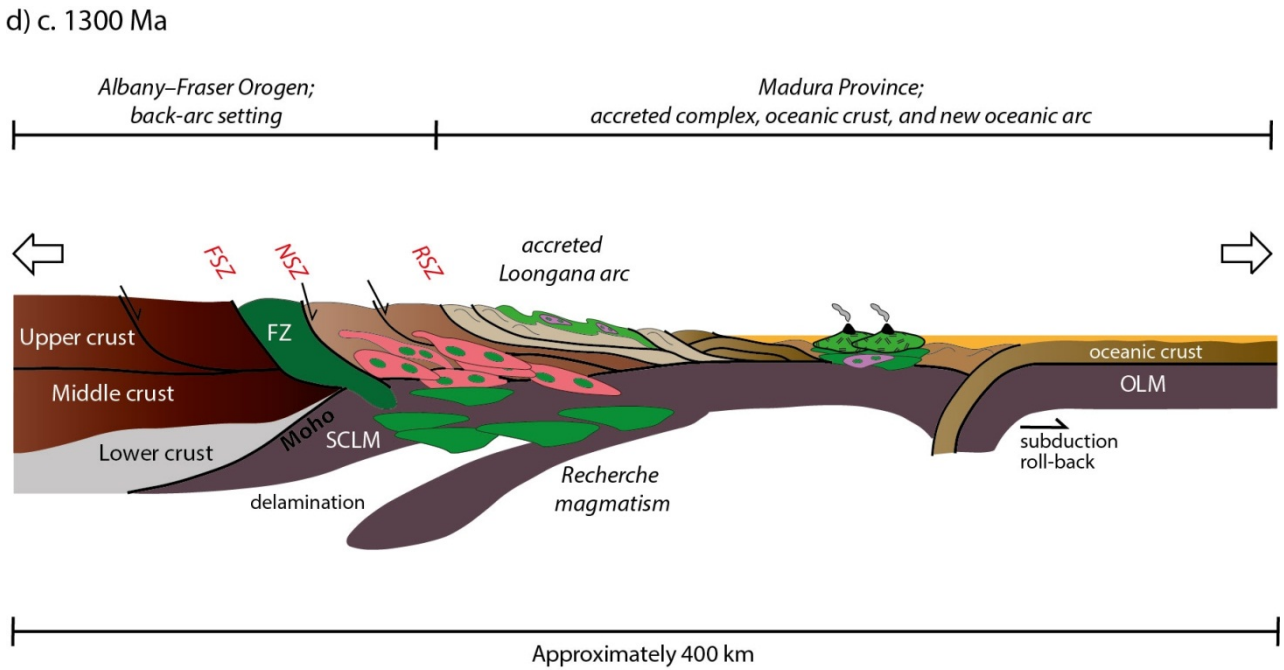
Depth (km)
Eucla Basin
Eucla Basin
Basement Inclusions
Basement Inclusions
Harris Lake Shear Zone
Woodarra Shear Zone
Fraser Shear Zone
Boondarra Shear Zone
Transitional Shear Zone
Northern Shear Zone
Cleo Dam Shear Zone
Frog Dam Shear Zone
Biranup Zone
Udara Seismic Province
Lower crustal non-reflective zone
Gunnadorrah Seismic Province
Upper Mantle
Madura Province
12GA-AF3

Mesoproterozoic (c. 1300 Ma) orthomagmatic mafic intrusion-related Ni-Cu-Co

- Primary magmatic nickel sulphide
  - pyrrhotite, pentlandite and chalcopyrite
- Gabbroic mafic granulites above easterly dipping shear zones
- Thrust from deeper in the crust, after intrusion in lower crustal hot zone
- Link to Gunnadorrah Seismic Province?

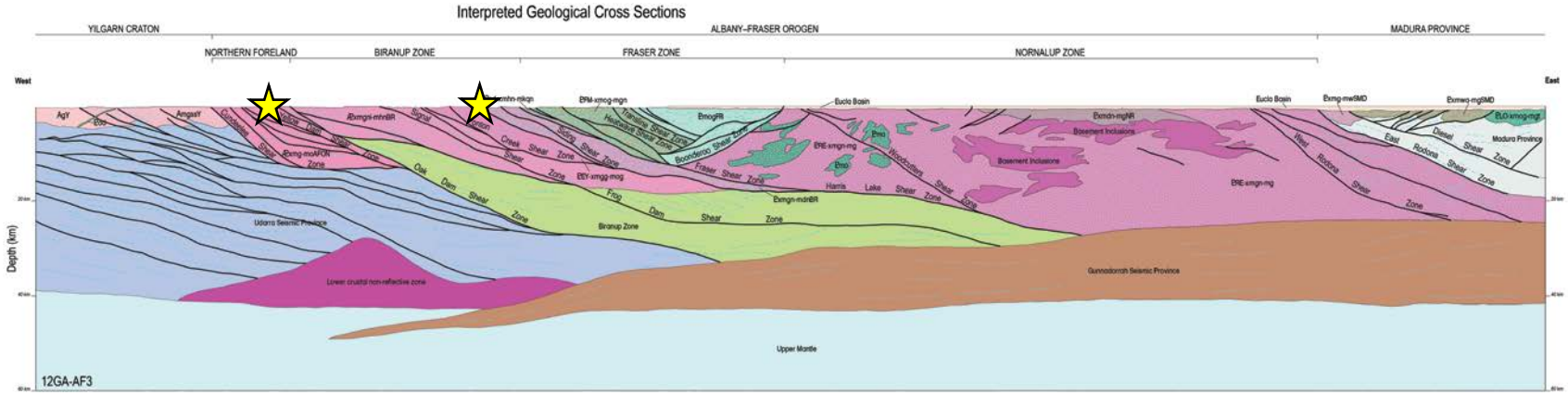
Mesoproterozoic (c. 1300 Ma) orthomagmatic mafic intrusion-related Ni-Cu-Co

- Emplaced during Albany–Fraser Stage I



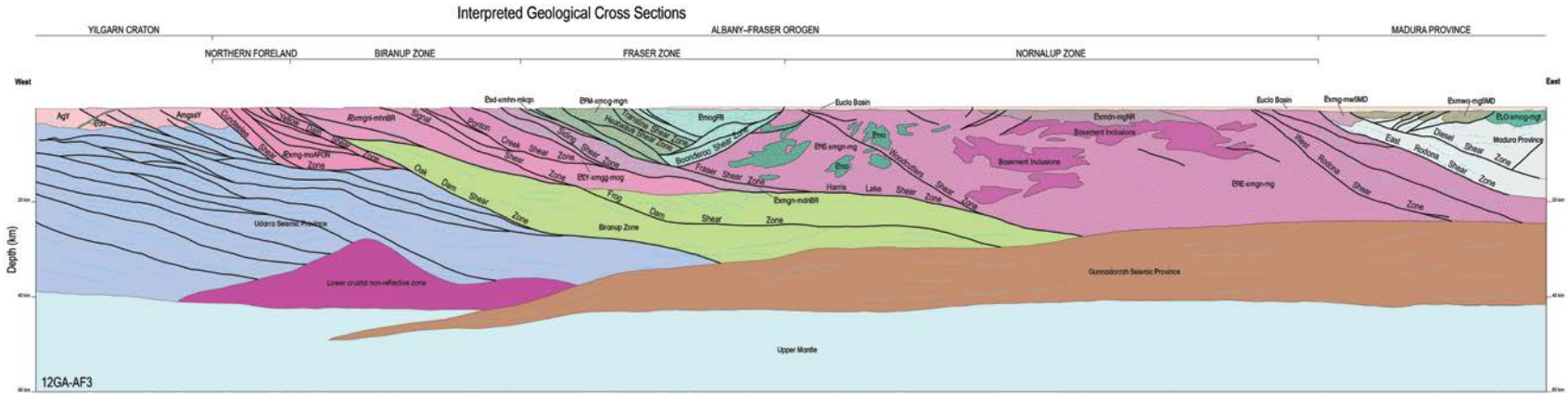
Proterozoic shear-related Au

- Beachcomber
- Corvette



Proterozoic intrusion-related deposits

- Eddy Suite
- Recherche and Esperance Supersuites
- Marnda Moorn large igneous province



Future EIS work to further define large-scale crustal architecture

- Eucla–Gawler reflection seismic and MT line
  - Reflection seismic acquisition completed
  - MT acquisition
- Eucla stratigraphic drilling
  - Two holes May–June
- Passive seismic (ARC Linkage with ANU)
  - 1st deployment in November 2013

Sutures east of the Albany–Fraser Orogen: Rodona Shear Zone?