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

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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
Tectonic events older than 2000 Ma

<table>
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<tr>
<th>Age (Ma)</th>
<th>Yilgarn Craton</th>
<th>Albany–Fraser Orogen</th>
<th>Madura Province</th>
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<td>Main mineralisation events</td>
<td>Felsic magmatism</td>
<td>Orogenic or tectonic event</td>
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Tropicana Zone: Tropicana (Tropicana JV) and Tropicana East (Beadell Resources)
Tropicana Zone: 12GA–T1
Where did the Tropicana Zone come from?

- Parautochthonous
  - 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
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
Tectonic events younger than 2000 Ma

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- **Main mineralisation events**
- **Felsic magmatism**
- **Mafic magmatism**
- **Orogenic or tectonic event**
- **Sedimentation**
- **Main detrital zircon peaks; Arid Basin**
- **Main detrital zircon peaks; Barren Basin**
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
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?