Identification and chemical fingerprinting of a Mesoproterozoic Large Igneous Province (LIP) in Western Australia

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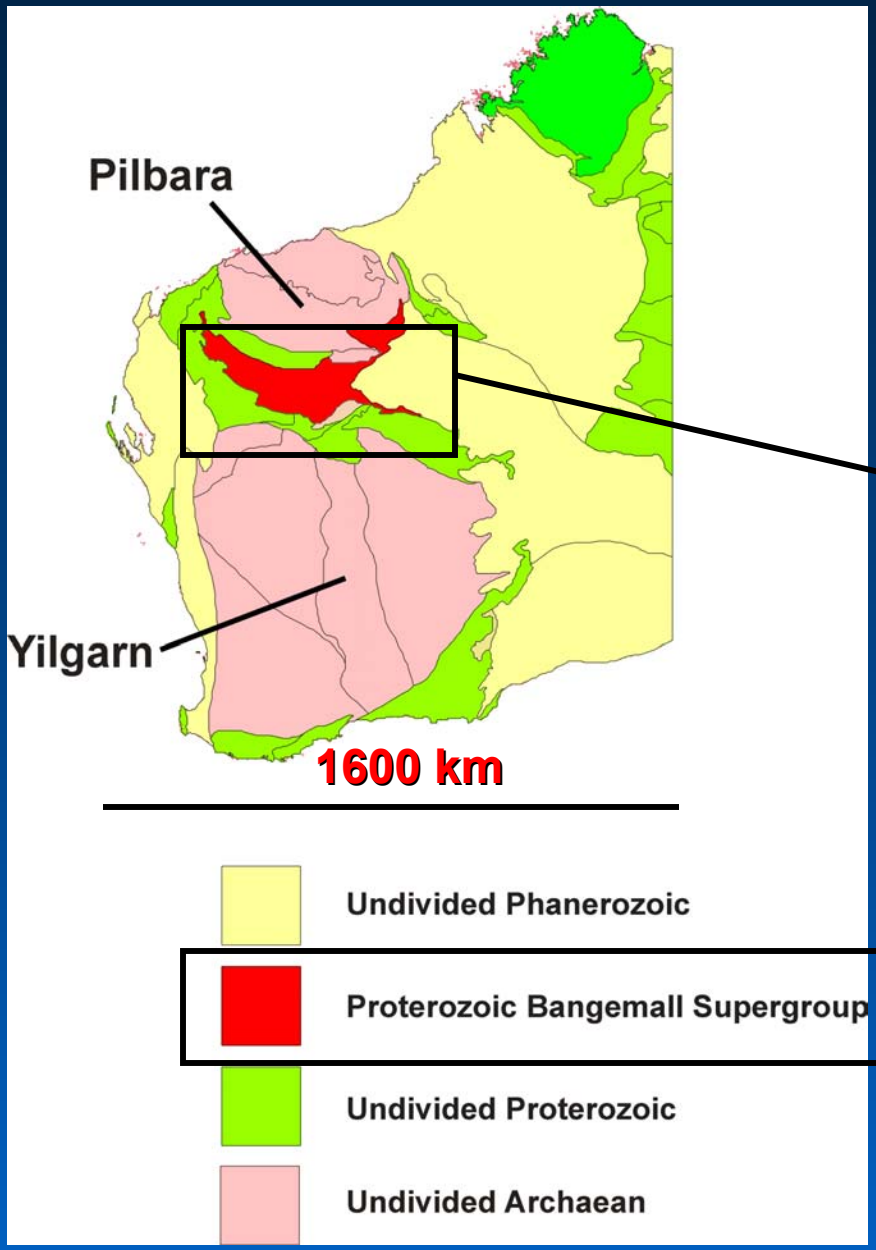
Importance of LIPs

- **Related to mantle plumes => information on mantle composition and dynamics**
- **Modification of biosphere, atmosphere**
- **Some host world-class mineral deposits (e.g. Noril'sk; Lightfoot and Hawkesworth, 1997)**
- ***Pre-Phanerozoic LIPs:***
  - **Can be hard to identify, as erupted products may have been removed by erosion and tectonism**
  - **Usually preserved as sill or dyke complexes, or layered intrusions**

Scope of talk

- **Extent and chemical fingerprint of 1070 Ma igneous event in Western Australia, preserved as sills intruding Proterozoic sedimentary rocks of the Bangemall Supergroup (BSG)**
- **Extent of 1070 Ma event elsewhere in Australia**
- **Put 1070 Ma event in global context**



Simplified geology of Western Australia

- Proterozoic Capricorn Orogen sandwiched between Archaean Pilbara and Yilgarn cratons
- Capricorn Orogen contains Bangemall Supergroup (BSG)
- BSG covered by younger sediments to east

Bangemall Supergroup (BSG) chronology

- **Older EDMUND Group and younger COLLIER Group sedimentary rocks**

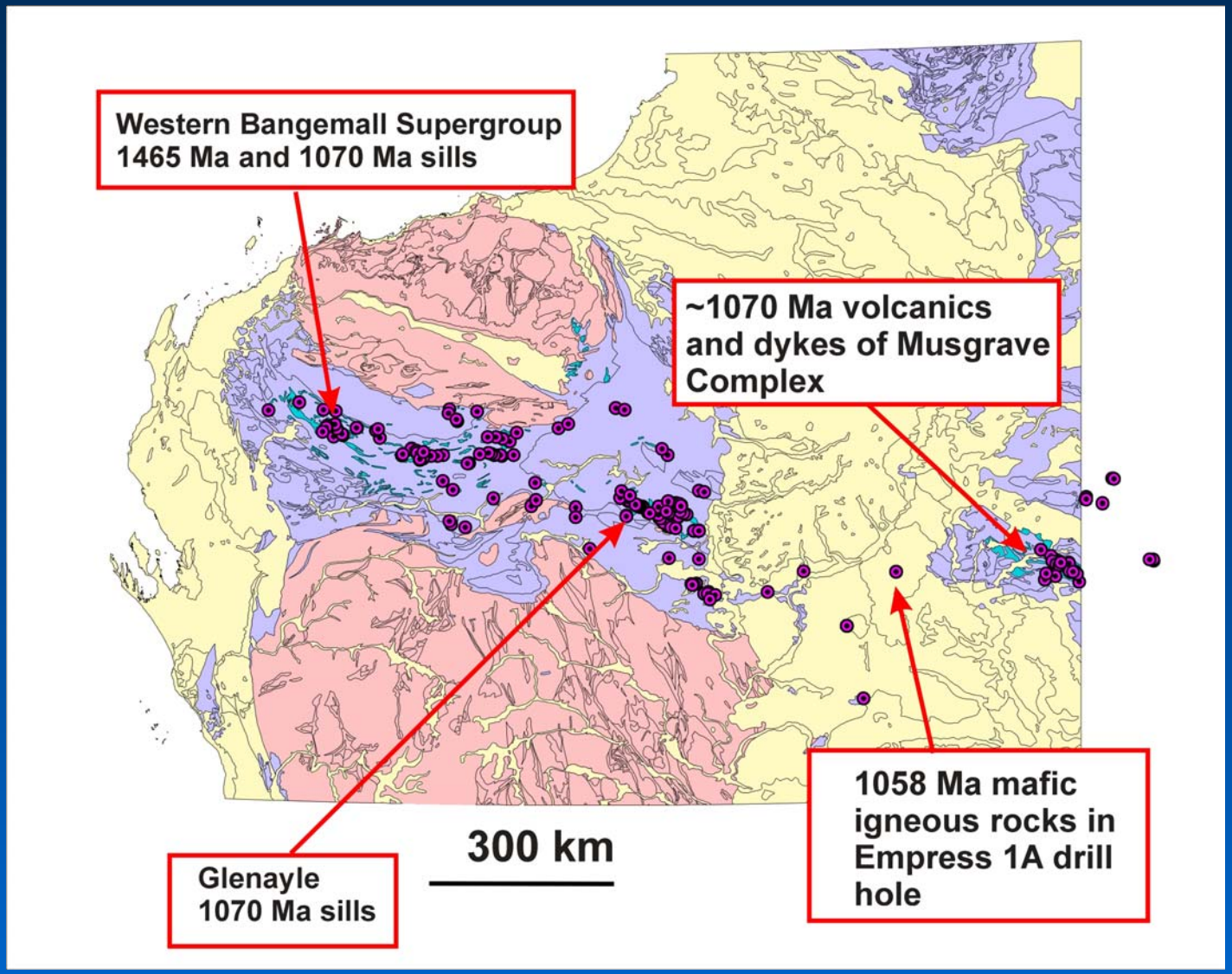
- **U-Pb SHRIMP detrital zircon ages:**
  - **Edmund Group younger than 1688 Ma**
  - **Collier Group younger than 1352 Ma**

- **BSG intruded by dolerite sills dated at ~1465 Ma and ~1070 Ma**

⇒ Edmund Group could contain both 1465 and 1070 Ma sills

⇒Collier Group can contain only 1070 Ma sills

Extent of 1070 Ma igneous activity in Western Australia



Some questions

- Are all the 1070 Ma sills comagmatic?
- How extensive is the 1465 Ma event?
- Can the 1070 and 1465 Ma sills be distinguished geochemically?

- $\Rightarrow$ How extensive is the 1070 Ma LIP?

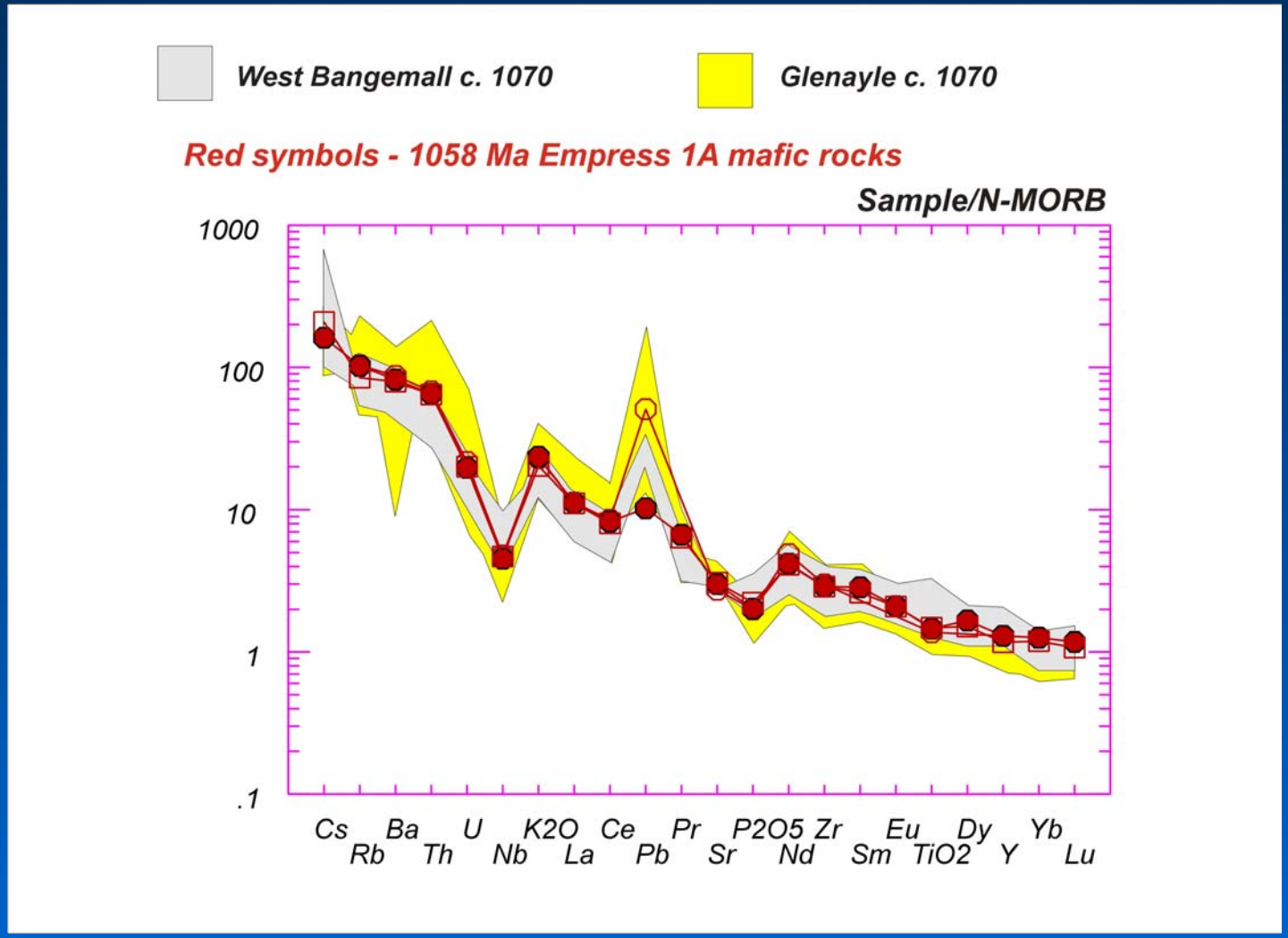
Why use geochemistry?

- Separating sill emplacement events using geochronology relies on SHRIMP dating of zircon or baddeleyite
- Paleomag — of limited use, due to alteration and overprinting
- Petrography — non-definitive

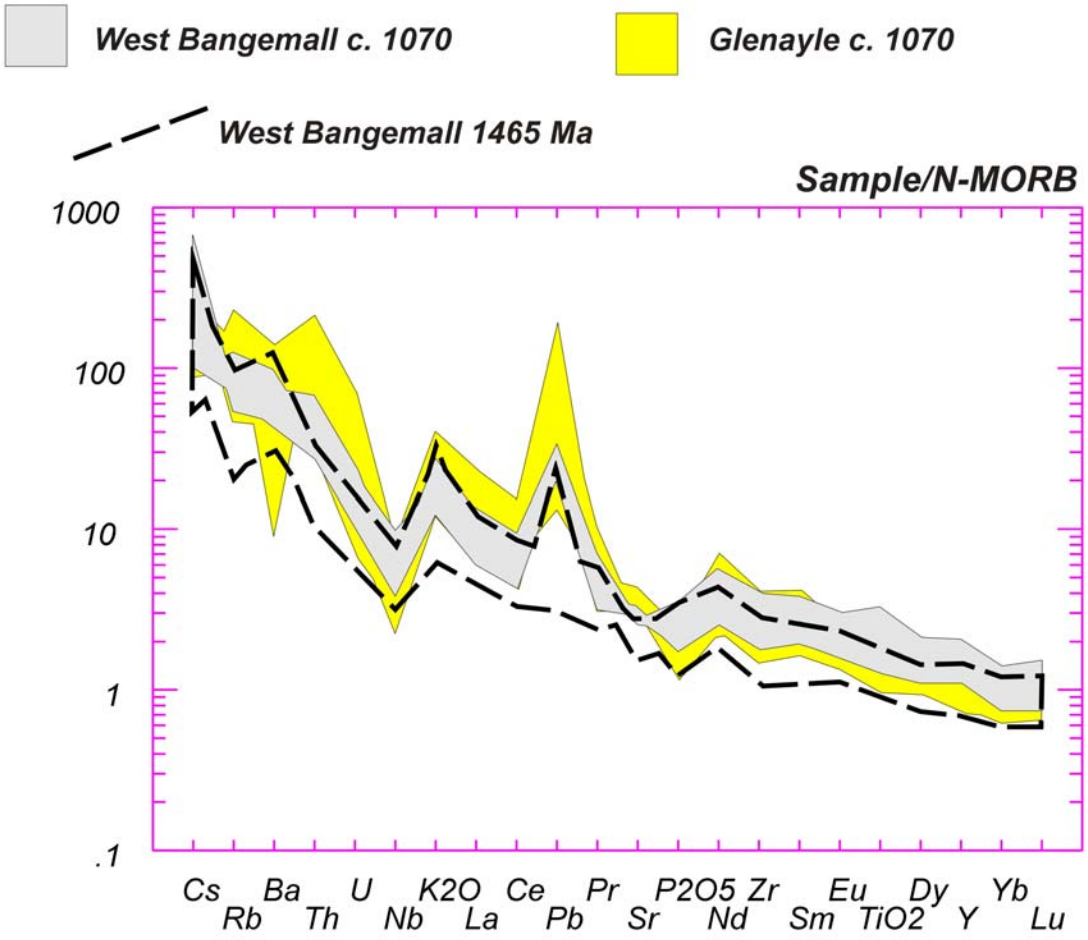
Geochemical dataset

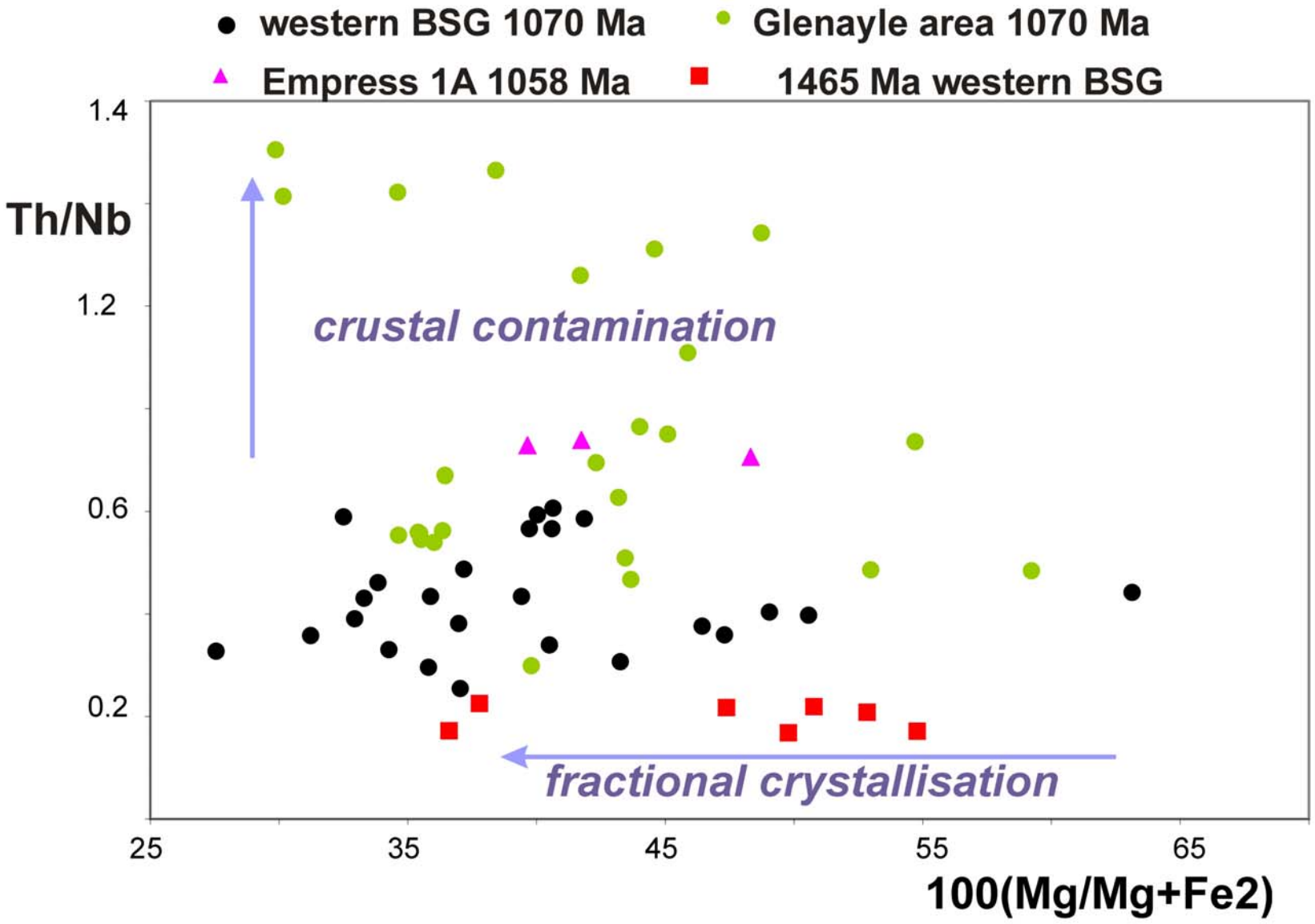
- 1070 Ma igneous event — dated sills, plus sills intruding the younger Collier Group (west BSG, Glenayle area, Empress 1A drill hole)
- 1465 Ma igneous event — dated sills (west BSG)
- Sills intruding the Edmund Group — i.e. could be either 1070 or 1465 Ma sills (west BSG)

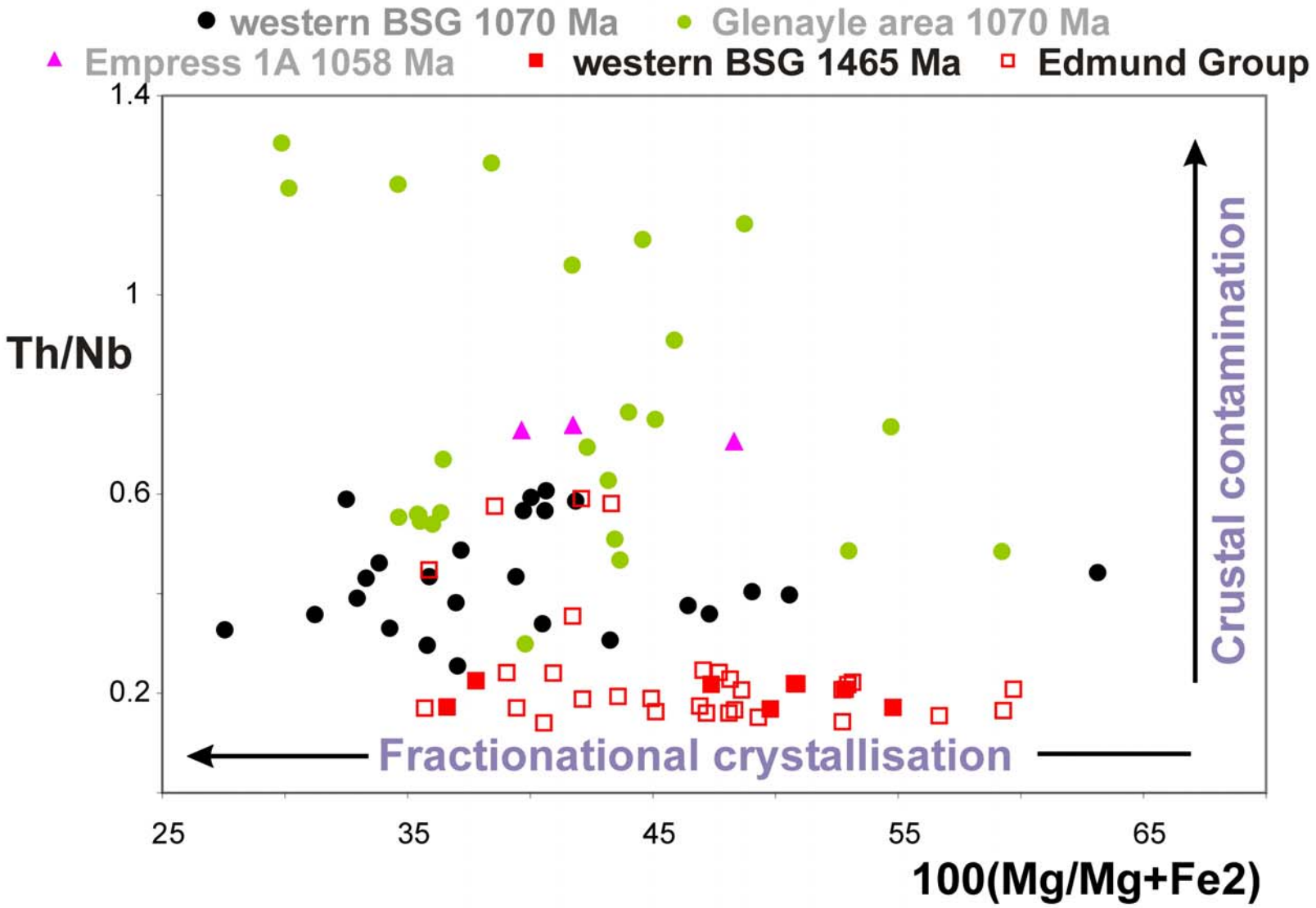
Bangemall Supergroup 1070 sills and Empress 1A mafics (1058 Ma)



Bangemall Supergroup 1070 and 1465 sills




western BSG 1070 Ma
Glenayle area 1070 Ma
Empress 1A 1058 Ma
1465 Ma western BSG
Th/Nb
1.4
1.2
0.6
0.2
crustal contamination
fractional crystallisation
25
35
45
55
65
100(Mg/Mg+Fe2)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Crustal contamination
Fractionational crystallisation
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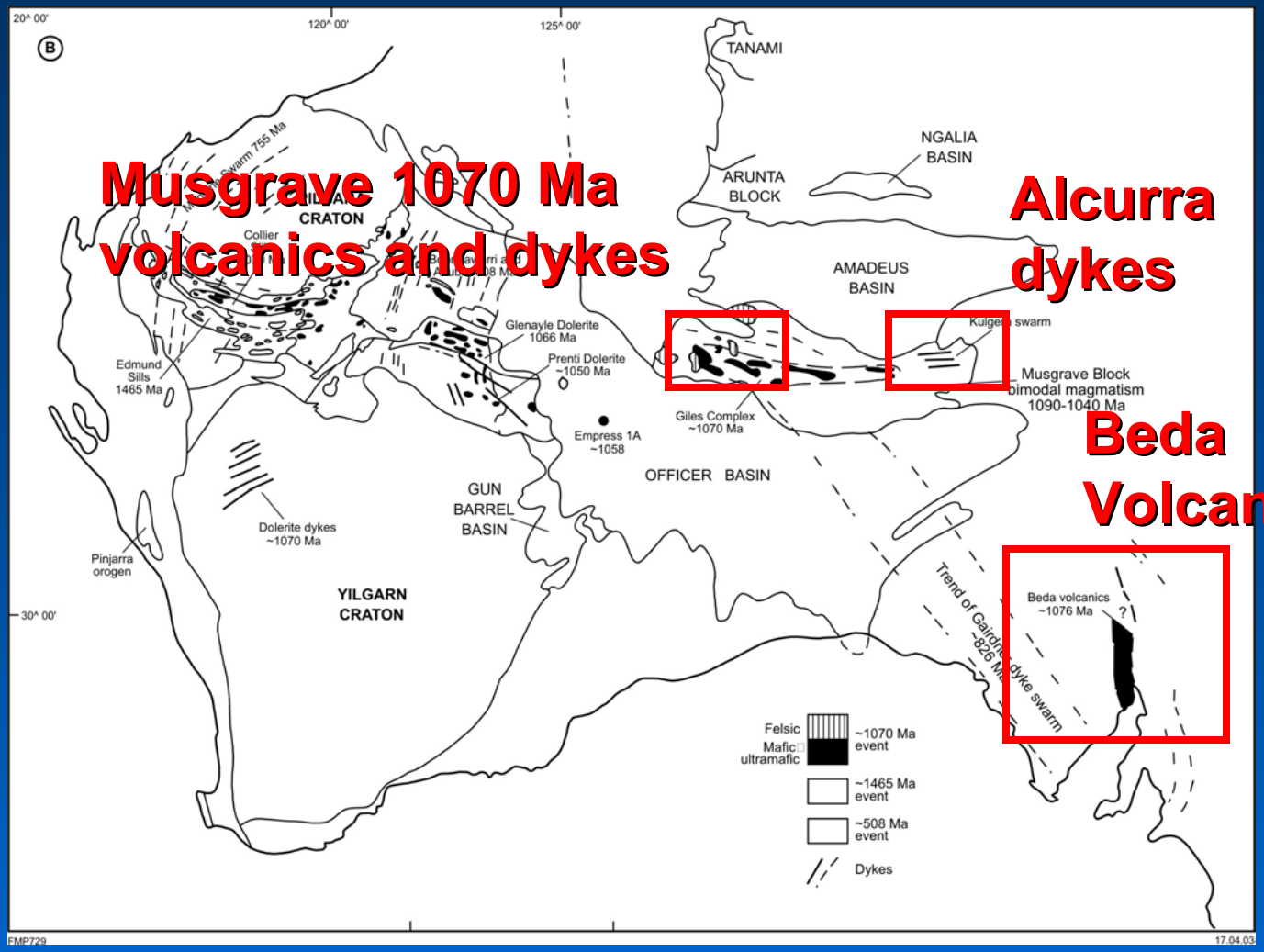
100(Mg/Mg+Fe2)

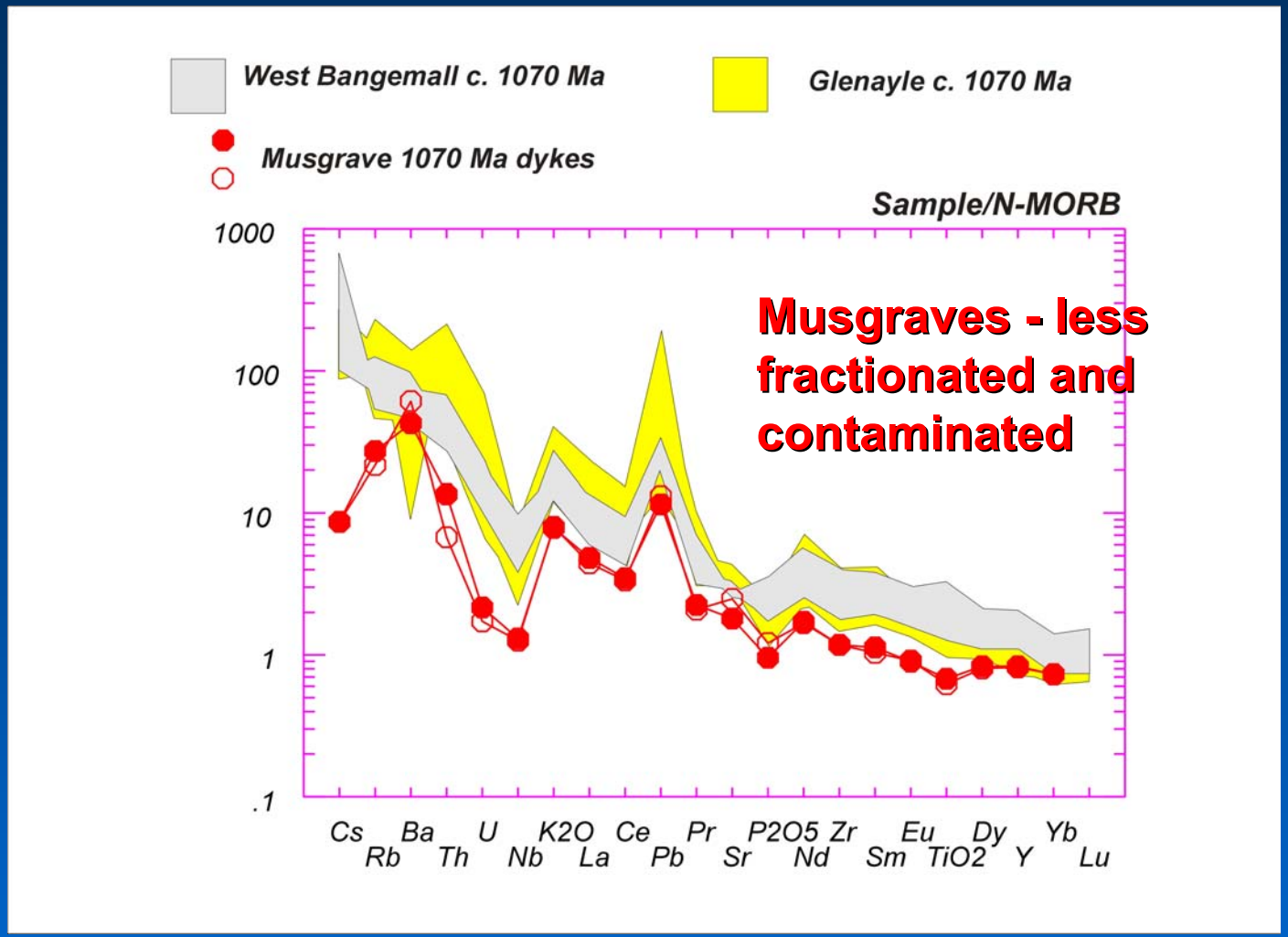
Separation of sill intrusion events

- 1070 Ma mafic igneous rocks (largely sills) have a coherent chemistry, with variations due to crustal contamination
- 1465 Ma sills are compositionally different
- Most 1465 Ma sills intruded into older Edmund Group, and 1070 Ma sills intruded into younger Collier Group
- ⇒ *close temporal relationship between sedimentation and sill emplacement*

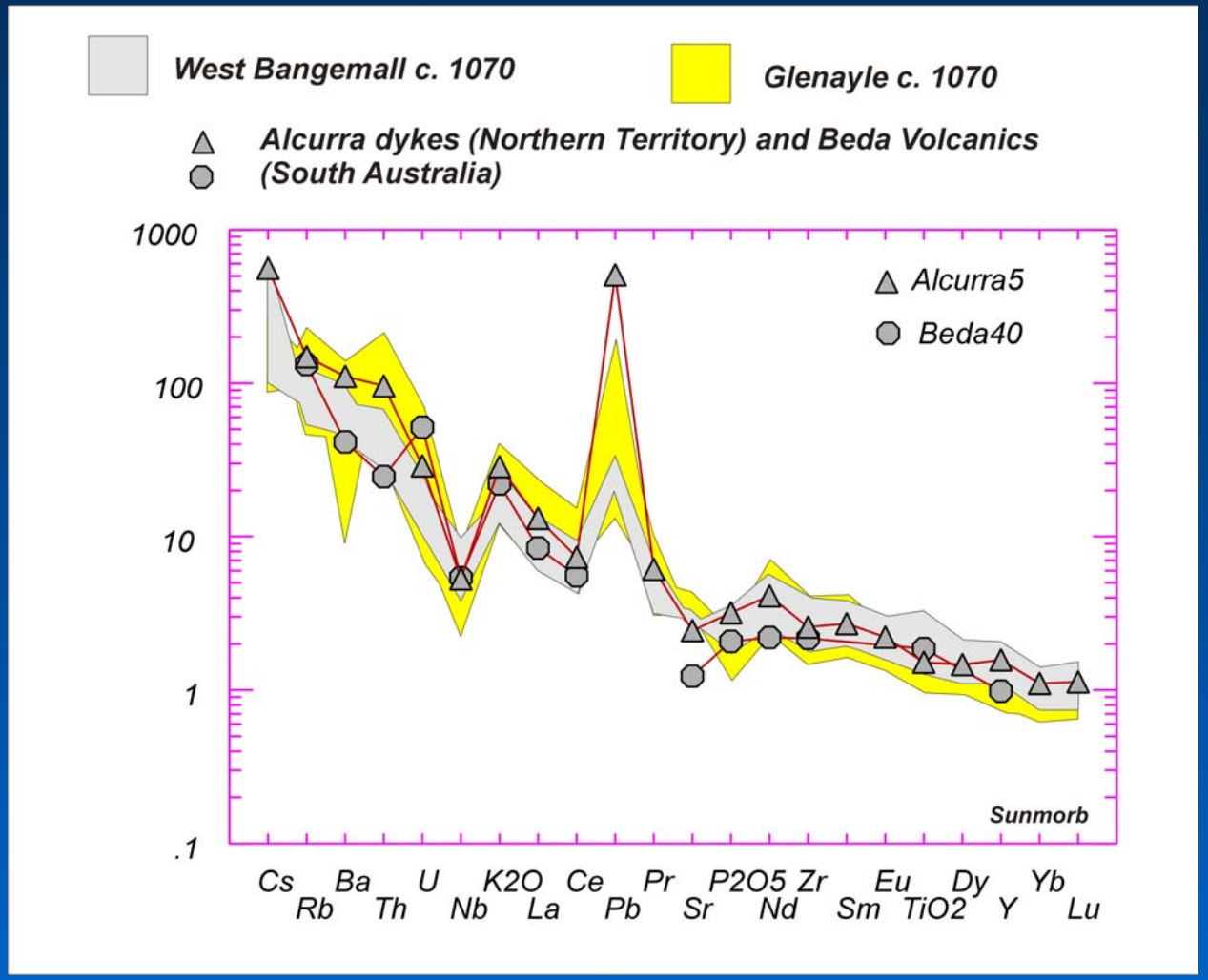
1070 igneous activity beyond Western Australia



West Bangemall 1070 Ma sills and 1078 Ma Musgrave dykes

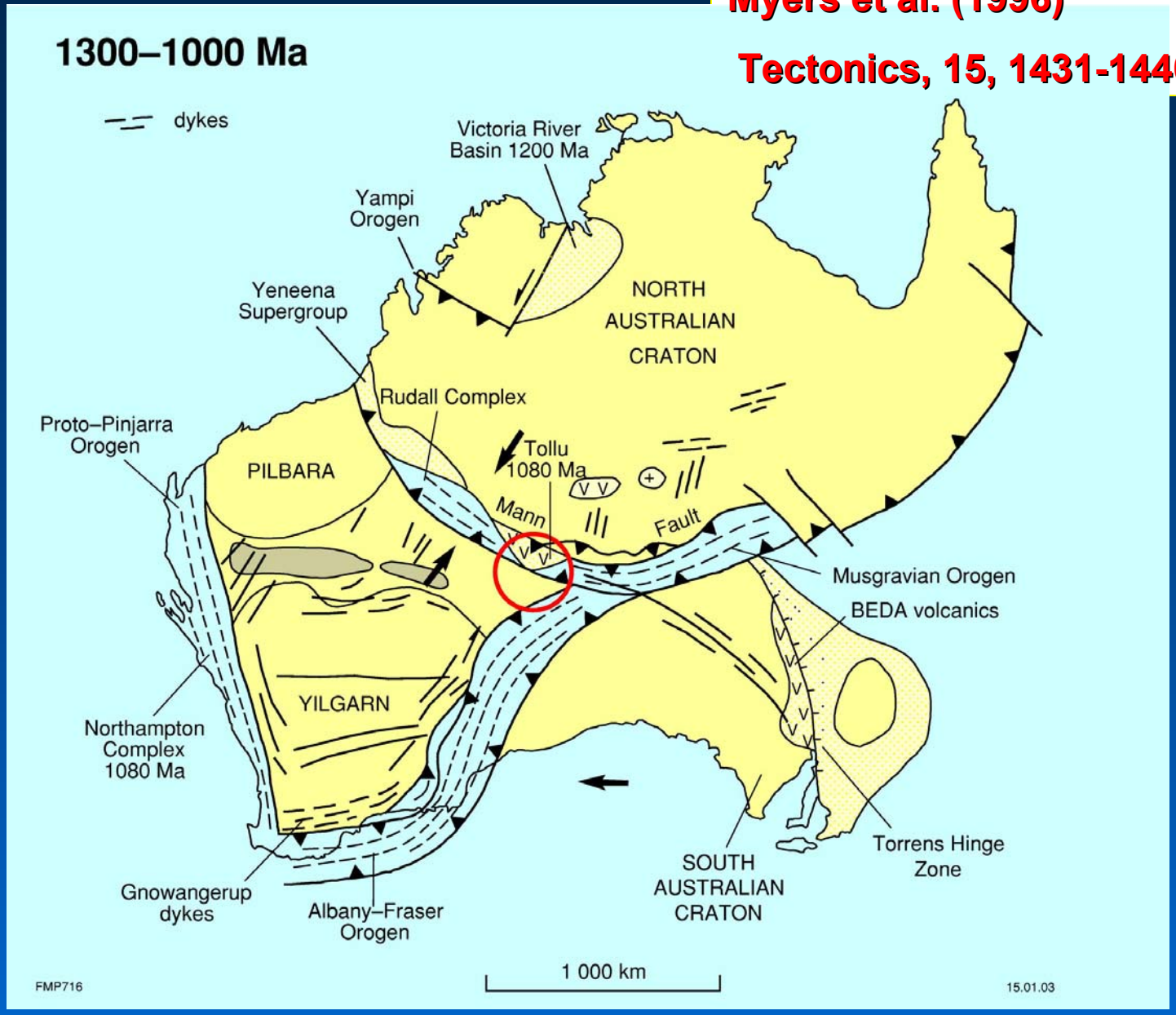


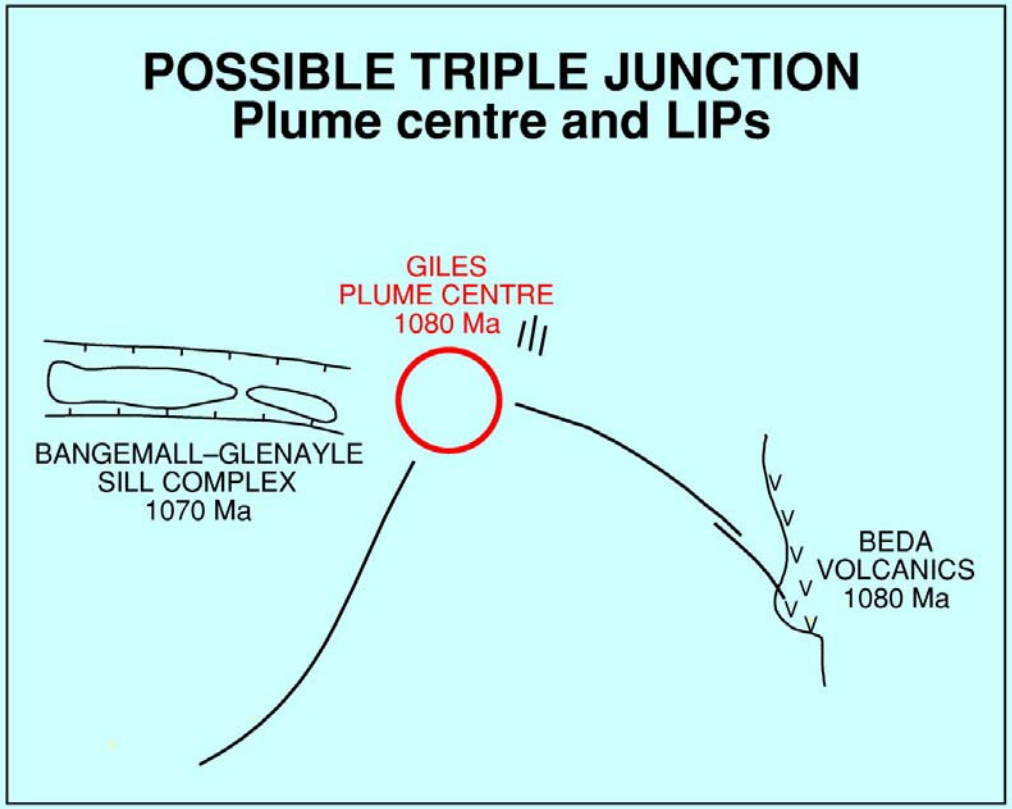
1070 Ma event in the Northern Territory and South Australia



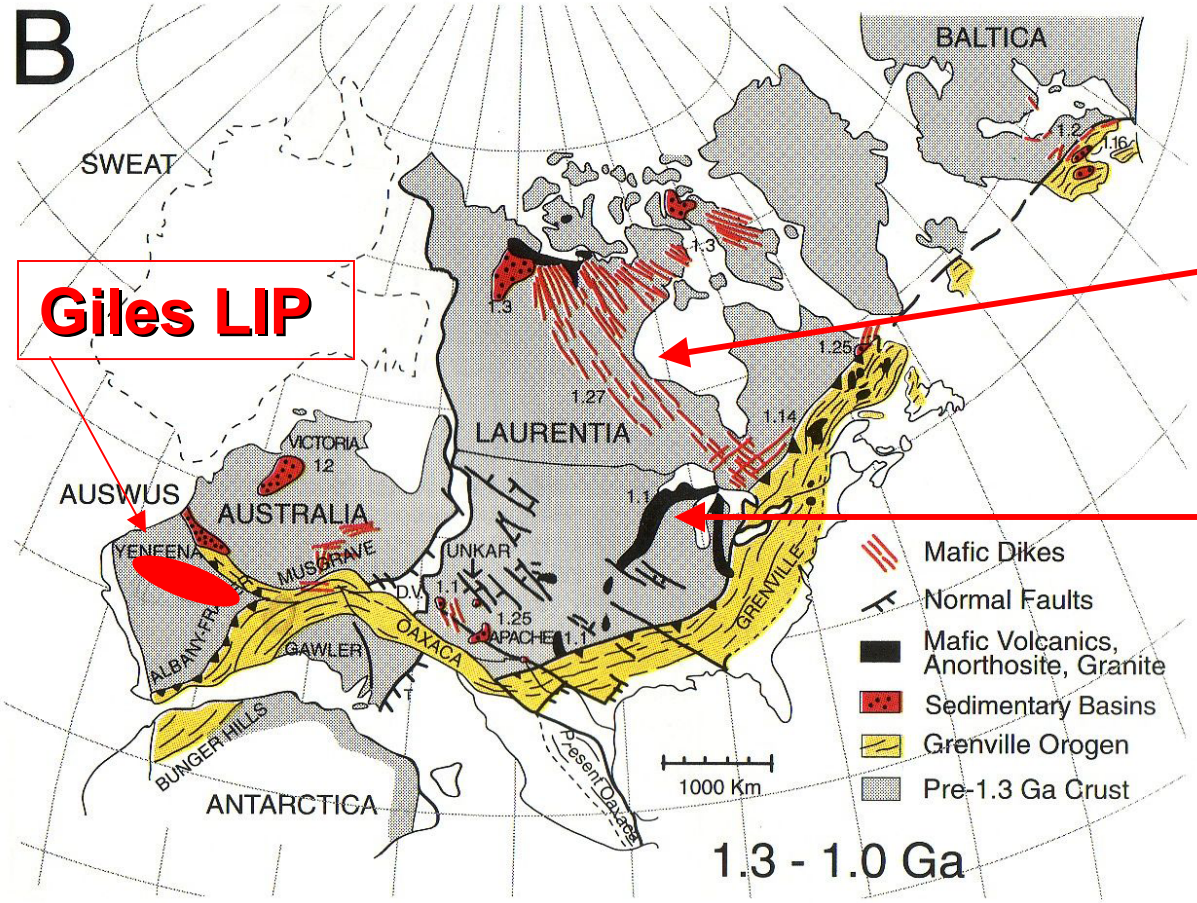
Myers et al. (1996)

Tectonics, 15, 1431-1446




POSSIBLE TRIPLE JUNCTION
Plume centre and LIPs
GILES
PLUME CENTRE
1080 Ma
BANGEMALL–GLENAYLE
SILL COMPLEX
1070 Ma
BEDA
VOLCANICS
1080 Ma

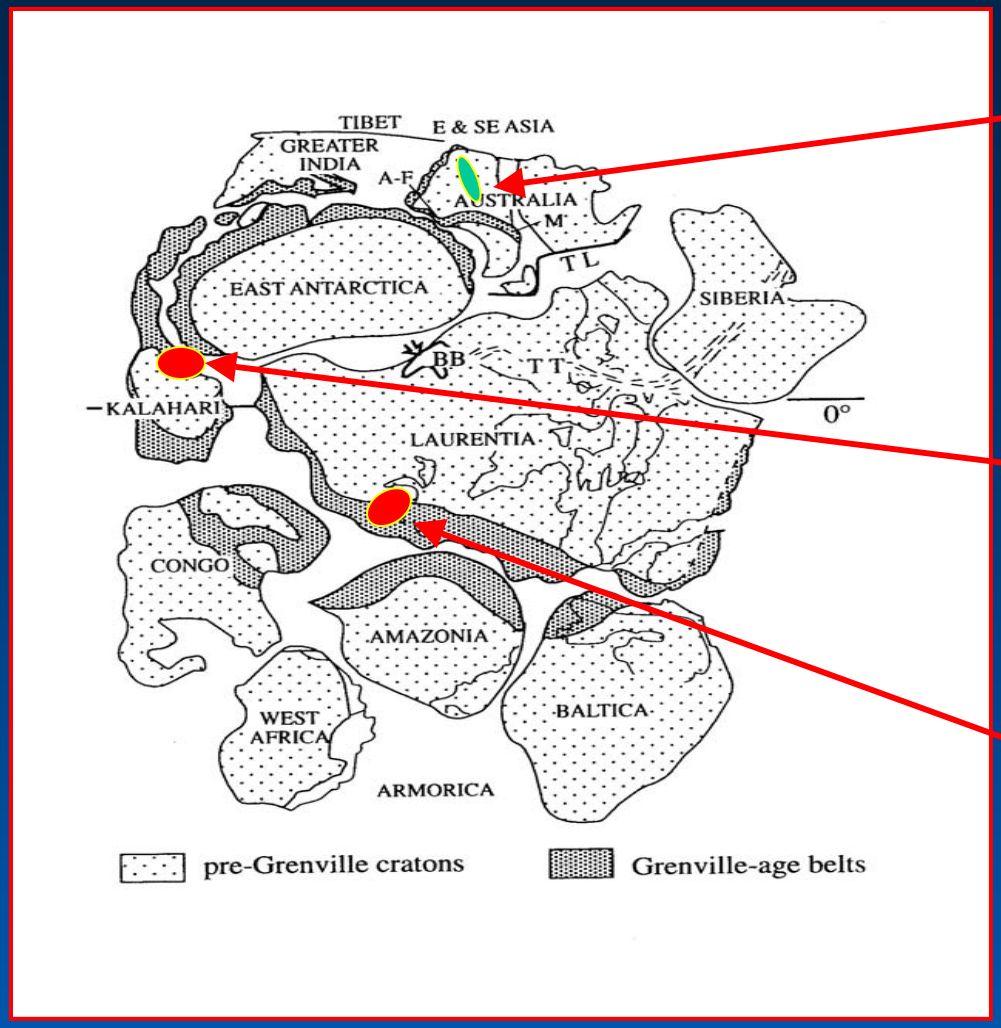
Global context — 1100 – 1050 Ma activity



Mackenzie dyke swarm

Keeweenawan

(Karlstrom et al. (1999), GSA Today, 9, 1-10)



Giles LIP

Umkondo

Keeweenawan

Rodinia reconstruction after Li et al., 1995, Geology, v. 23: 407-410

Conclusions

- Geochemistry is a useful tool in identifying the 1070 Ma event in Western-Central Australia (Giles LIP)
- Giles LIP is part of a more extensive Grenville age event
- Association of Giles LIP with plume event indicates potential for magmatic sulfide and PGE mineralization