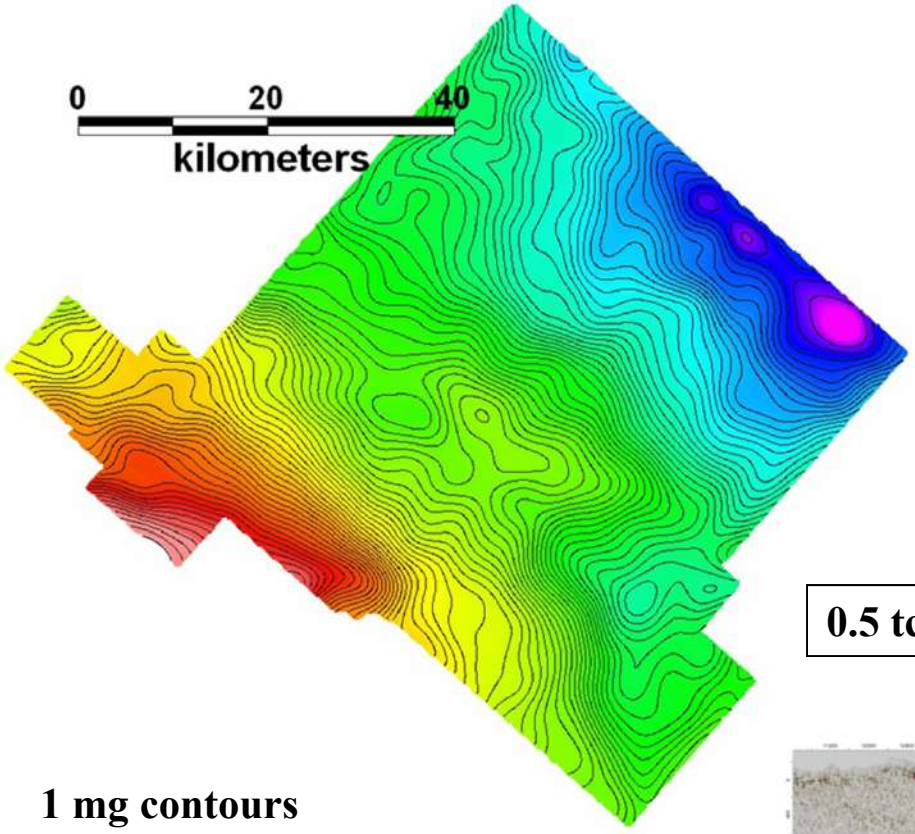
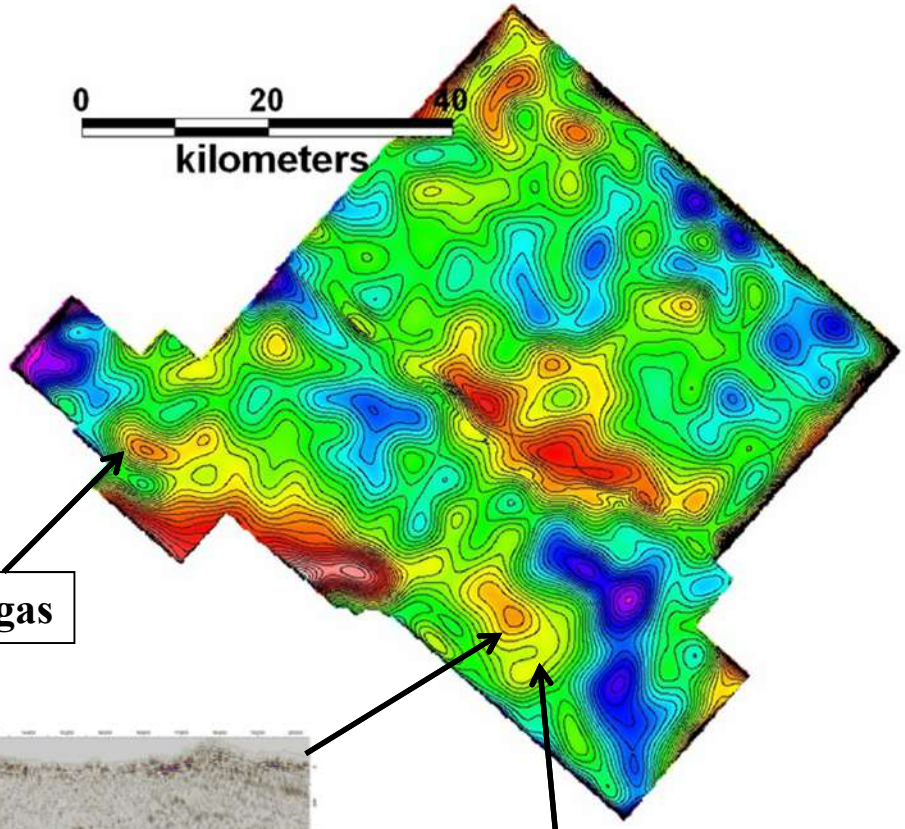
AIRBORNE GRAVITY

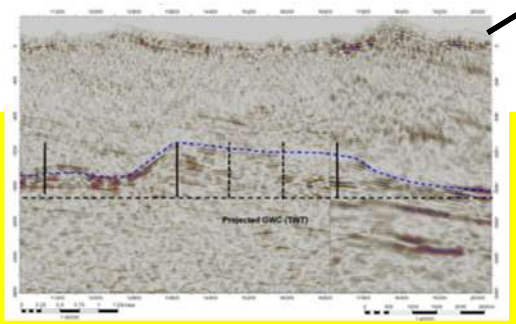
VERTICAL DERIVATIVE



1 mg contours



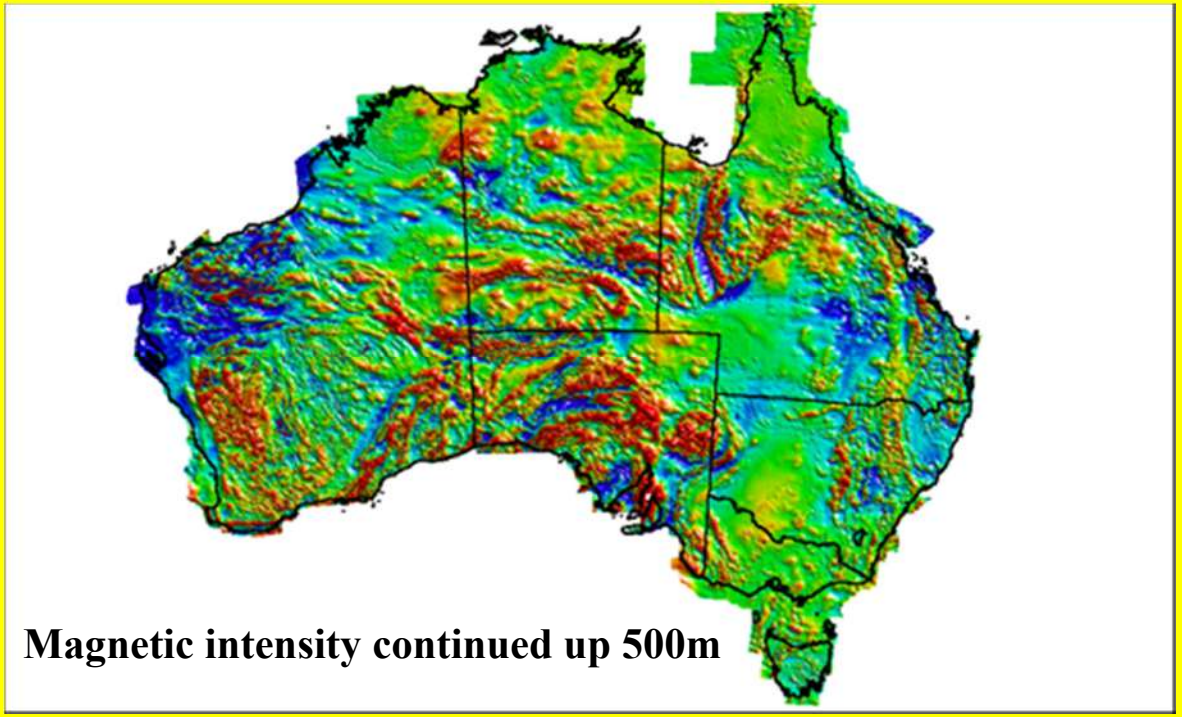
0.5 tcf gas



10 tcf gas
70 k boe/day
US$33.5 billion

MAPPING IGNEOUS ACTIVITY ASSOCIATED WITH MANTLE PLUMES AND RIFTS TO TARGET MINERAL DEPOSITS

SOME, POSSIBLY DIFFERENT, IDEAS FOR NEW EXPLORATION APPROACHES



Magnetic intensity continued up 500m

Presented by –

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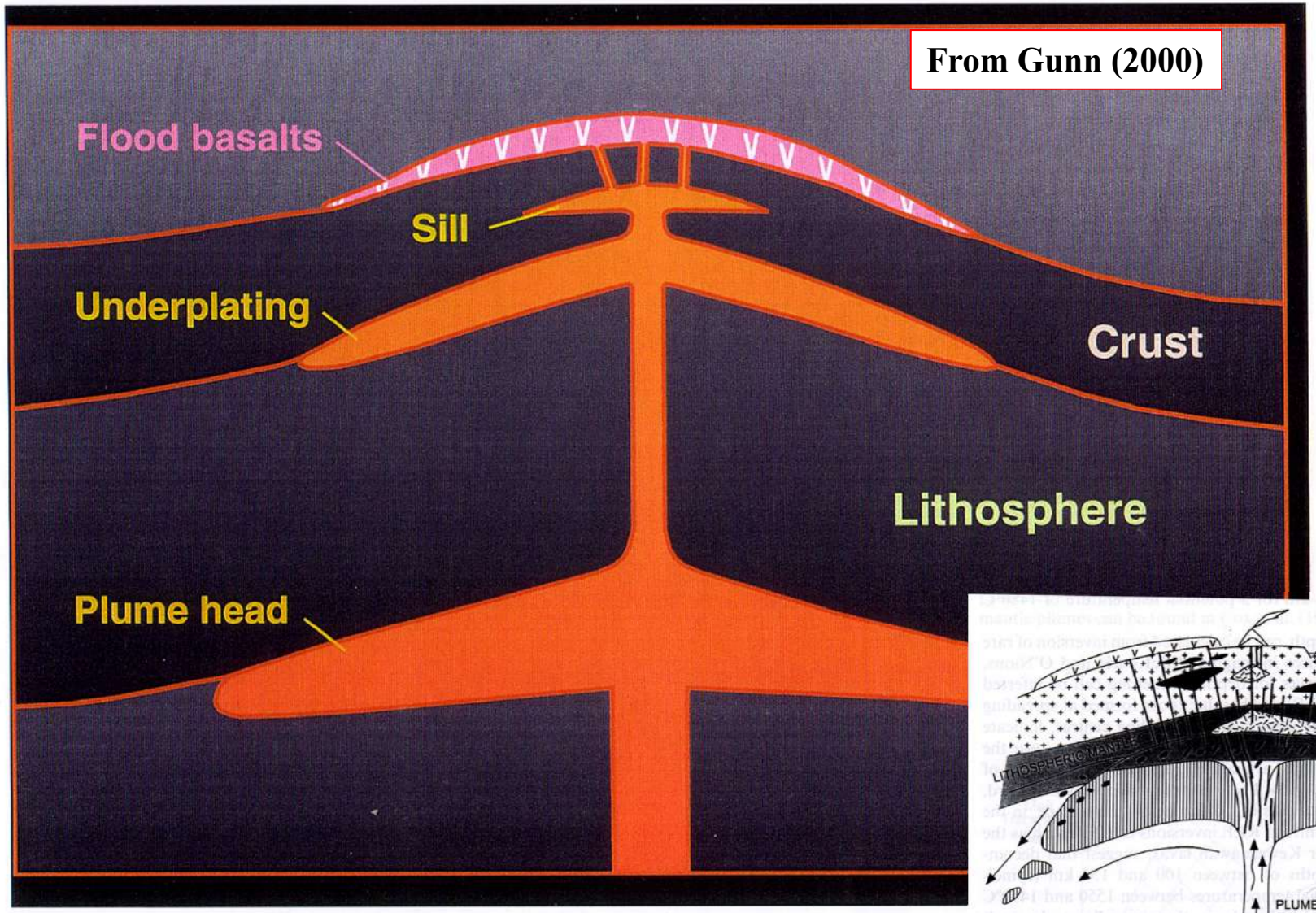
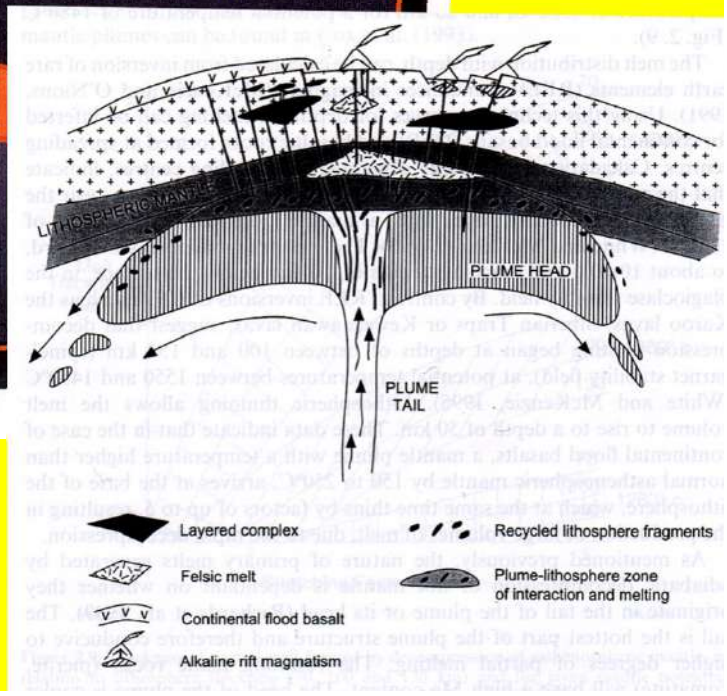
NSW 2088 Australia
Tel: +612 9968 1209
Email: gunngeo@iprimus.com.au

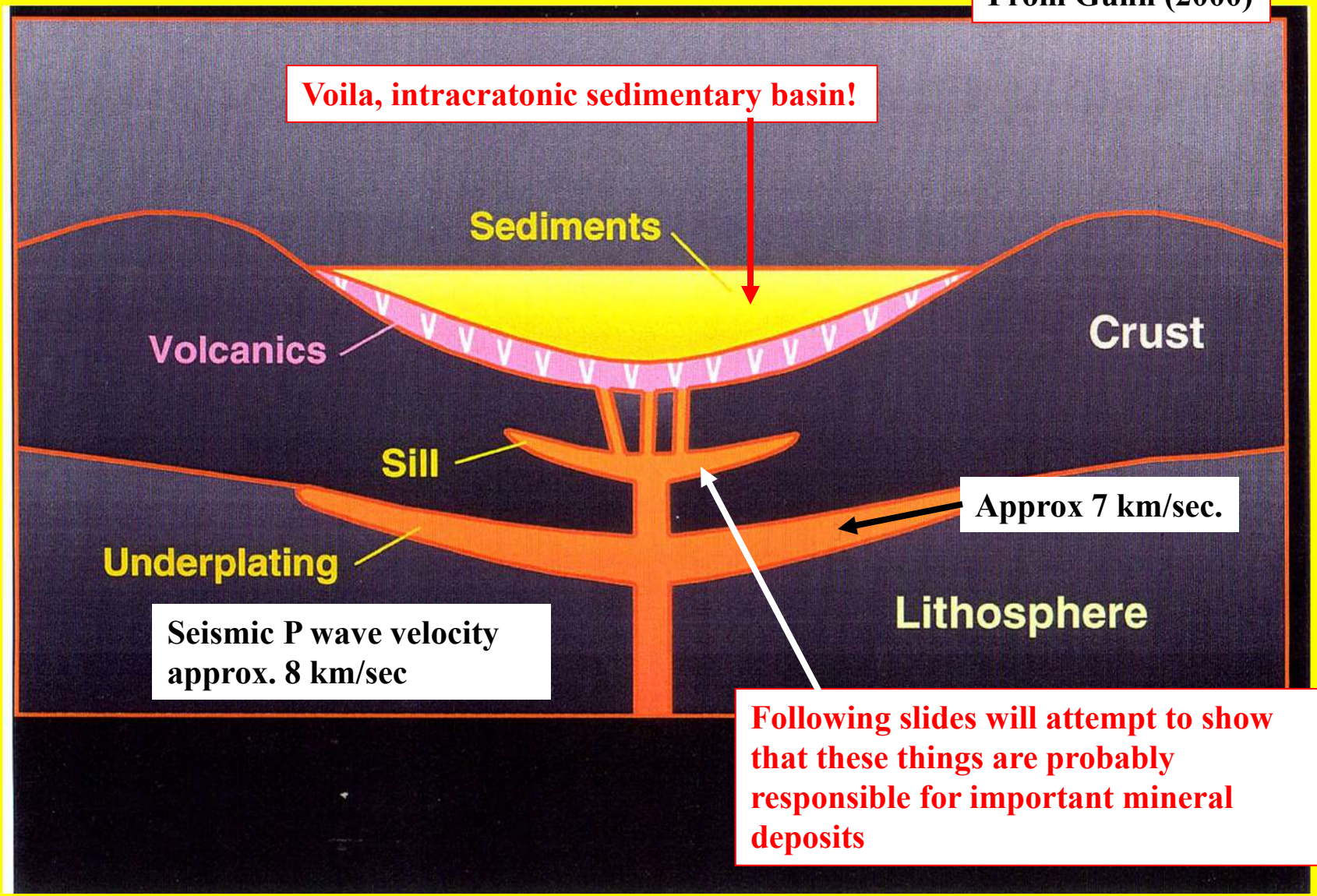
From Gunn (2000)





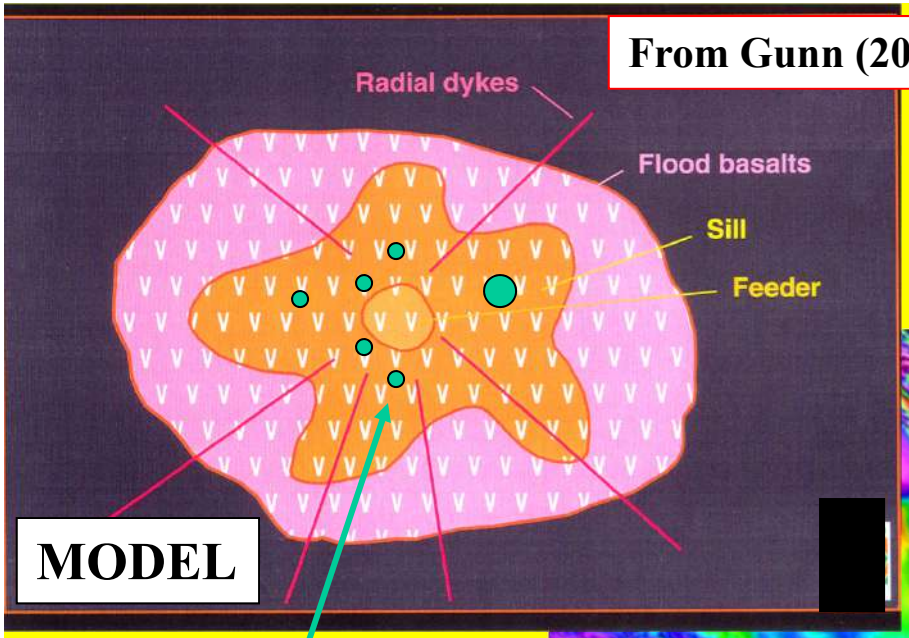
P. Gunn's model of a mantle plume (generally consistent with most current models e.g. Pirajno (2000) to the right)

From Gunn (2000)



Subsidence due to cooling, shrinkage, becoming denser weight of intrusions, sediments etc.

PLAN VIEWS OF MAGNETIC DATA



Plume track along WA-SA border

S.A

Flood basalts and/or sills

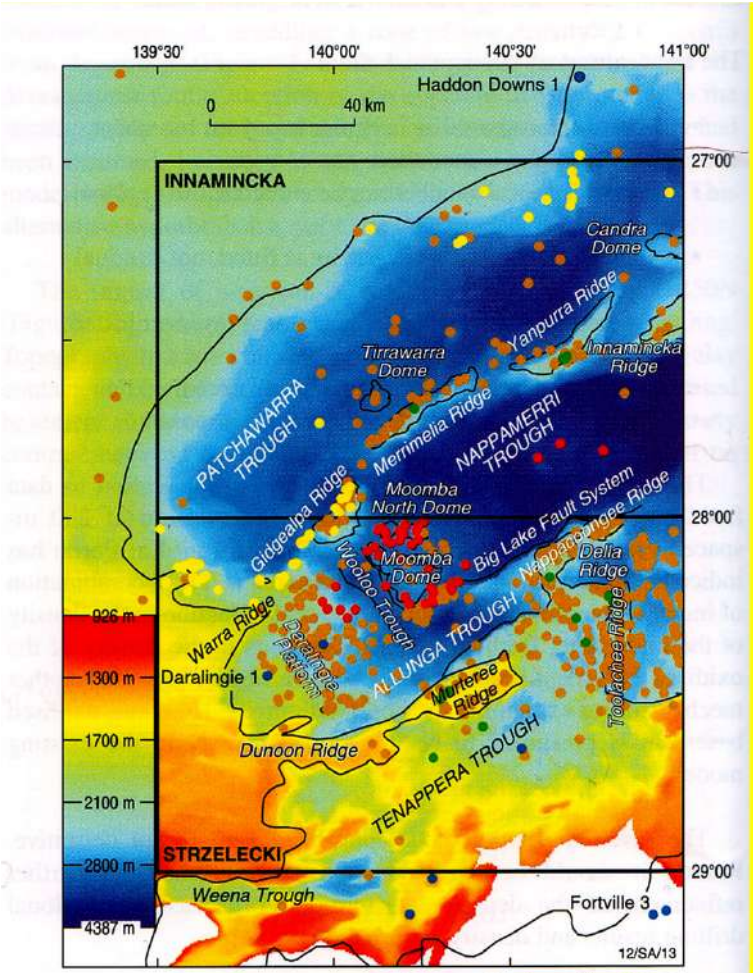
Other plume positions

Intrusive plugs and volcanoes

Dykes

Flood basalts

Reversely magnetised gabbro 50 km in diameter



Depth to basement of Patchawarra Trough, Cooper Basin, South Australia

Figures from Meixner, Gunn et al. (2000)

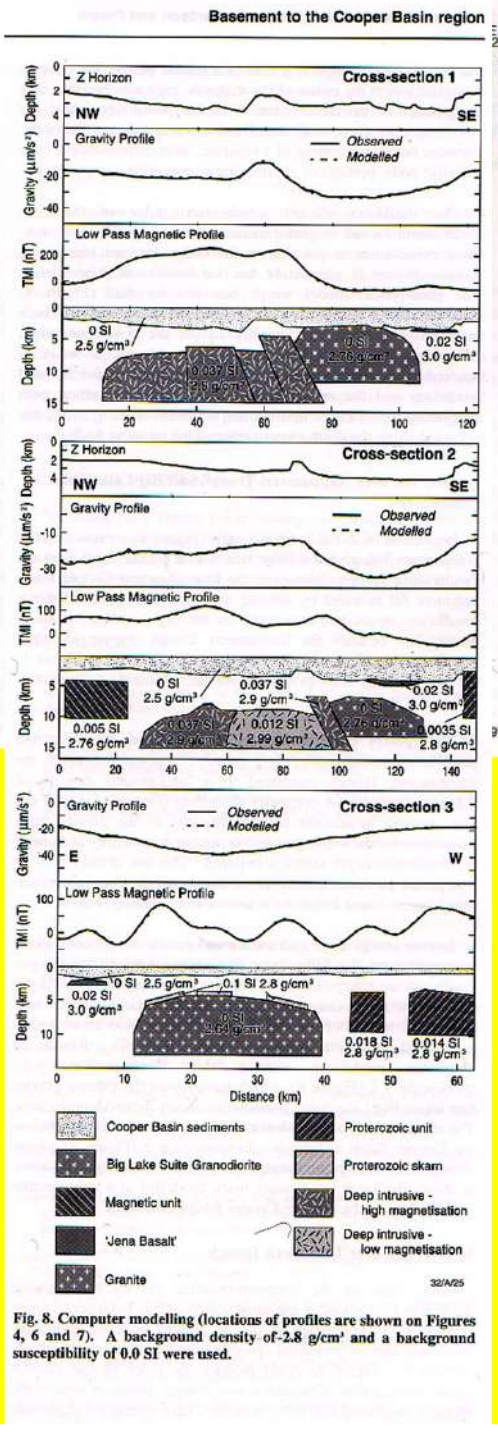
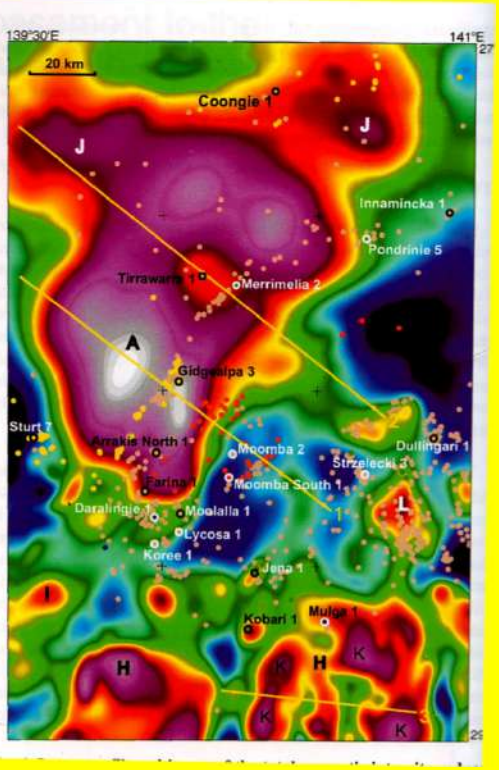
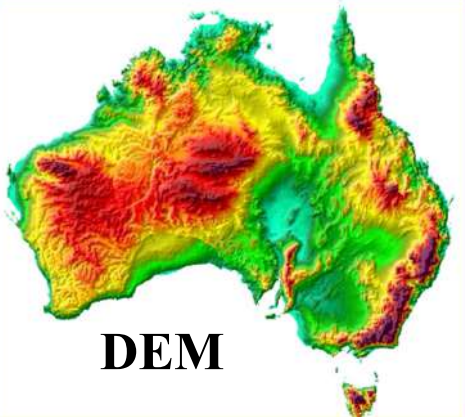


Fig. 8. Computer modelling (locations of profiles are shown on Figures 4, 6 and 7). A background density of 2.8 g/cm³ and a background susceptibility of 0.0 SI were used.

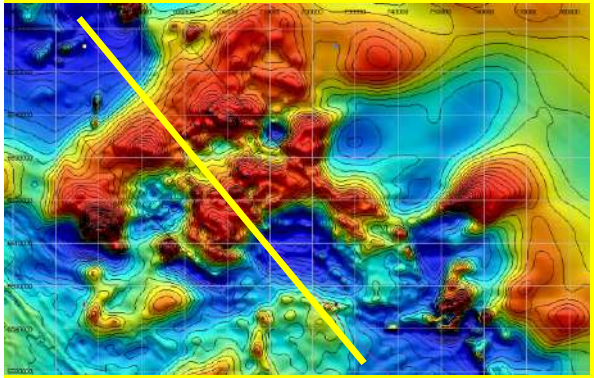


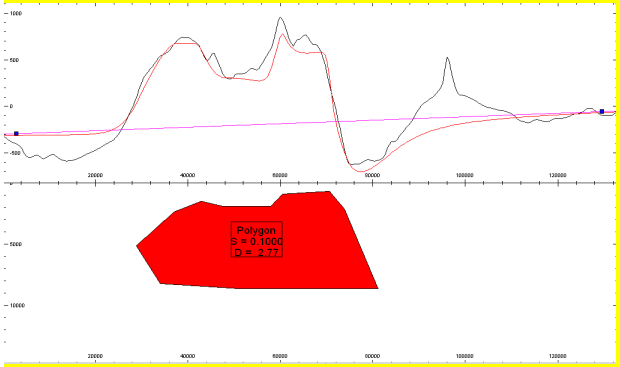


DEM

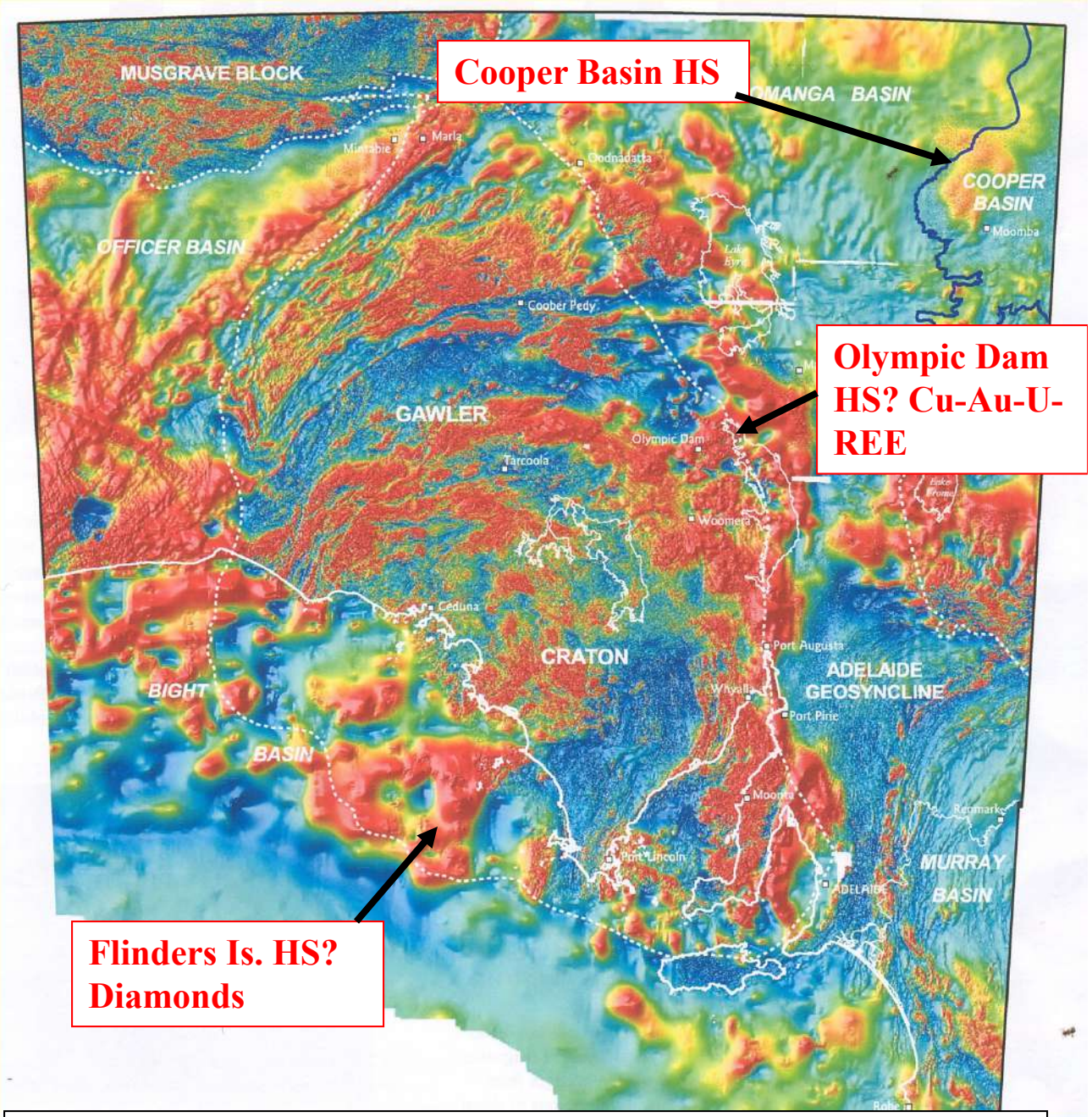
Removed at request of author
Subject: Suspect mantle plume in Gulf of Carpentaria

Magnetic intensity of Olympic Dam area

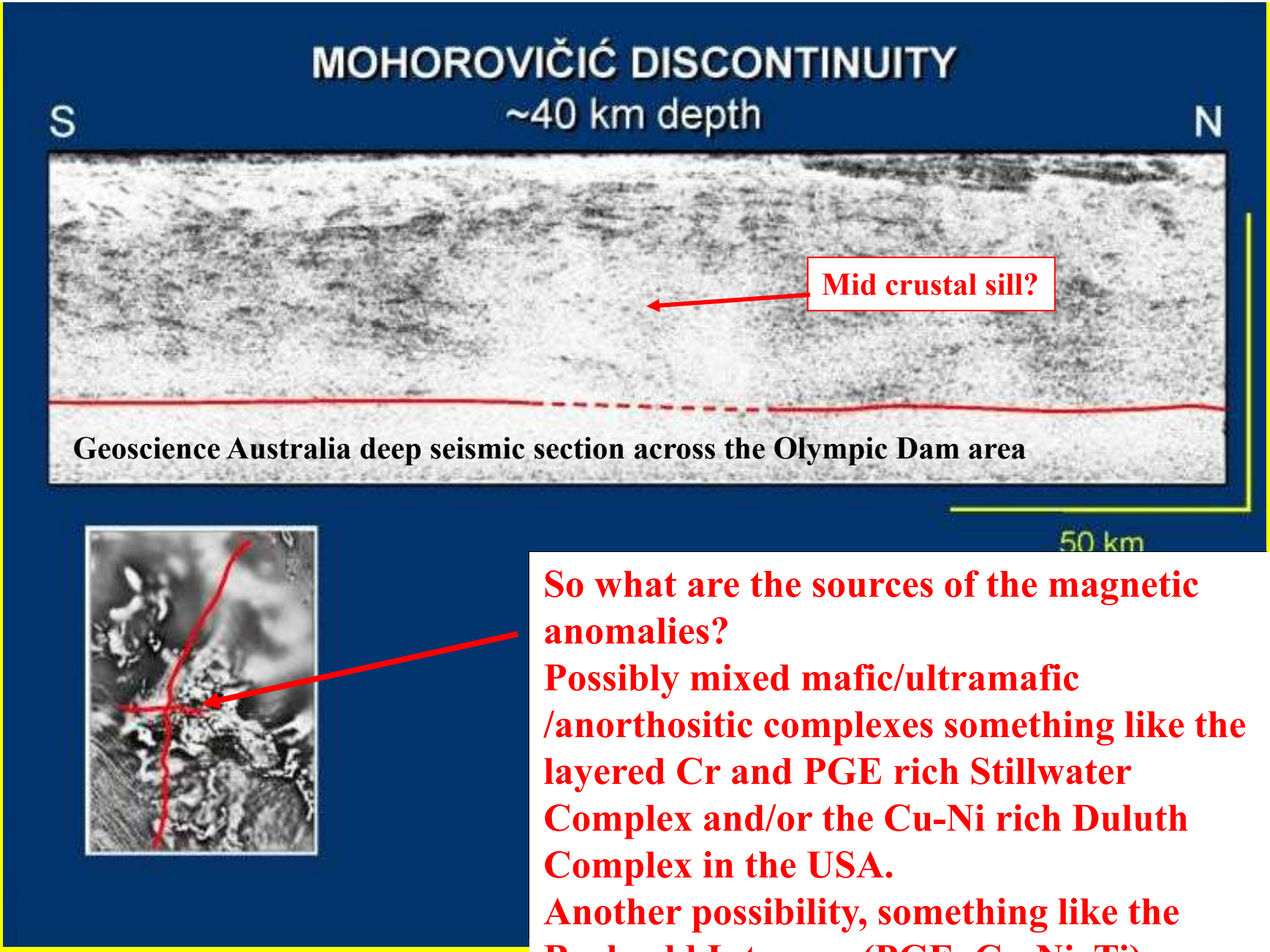




Model



Magnetic intensity of South Australia

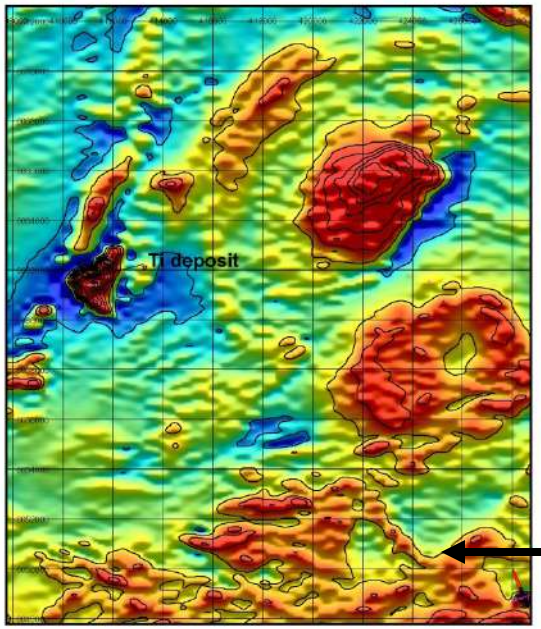


Geoscience Australia deep seismic section across the Olympic Dam area

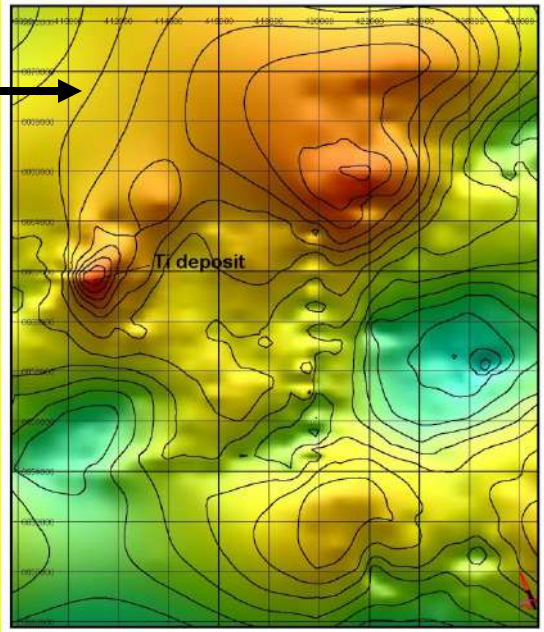
So what are the sources of the magnetic anomalies?

Possibly mixed mafic/ultramafic /anorthositic complexes something like the layered Cr and PGE rich Stillwater Complex and/or the Cu-Ni rich Duluth Complex in the USA.

Another possibility, something like the Bushveld Intruson (PGE, Cr, Ni, Ti).



Bouguer gravity with 1 milligal contours



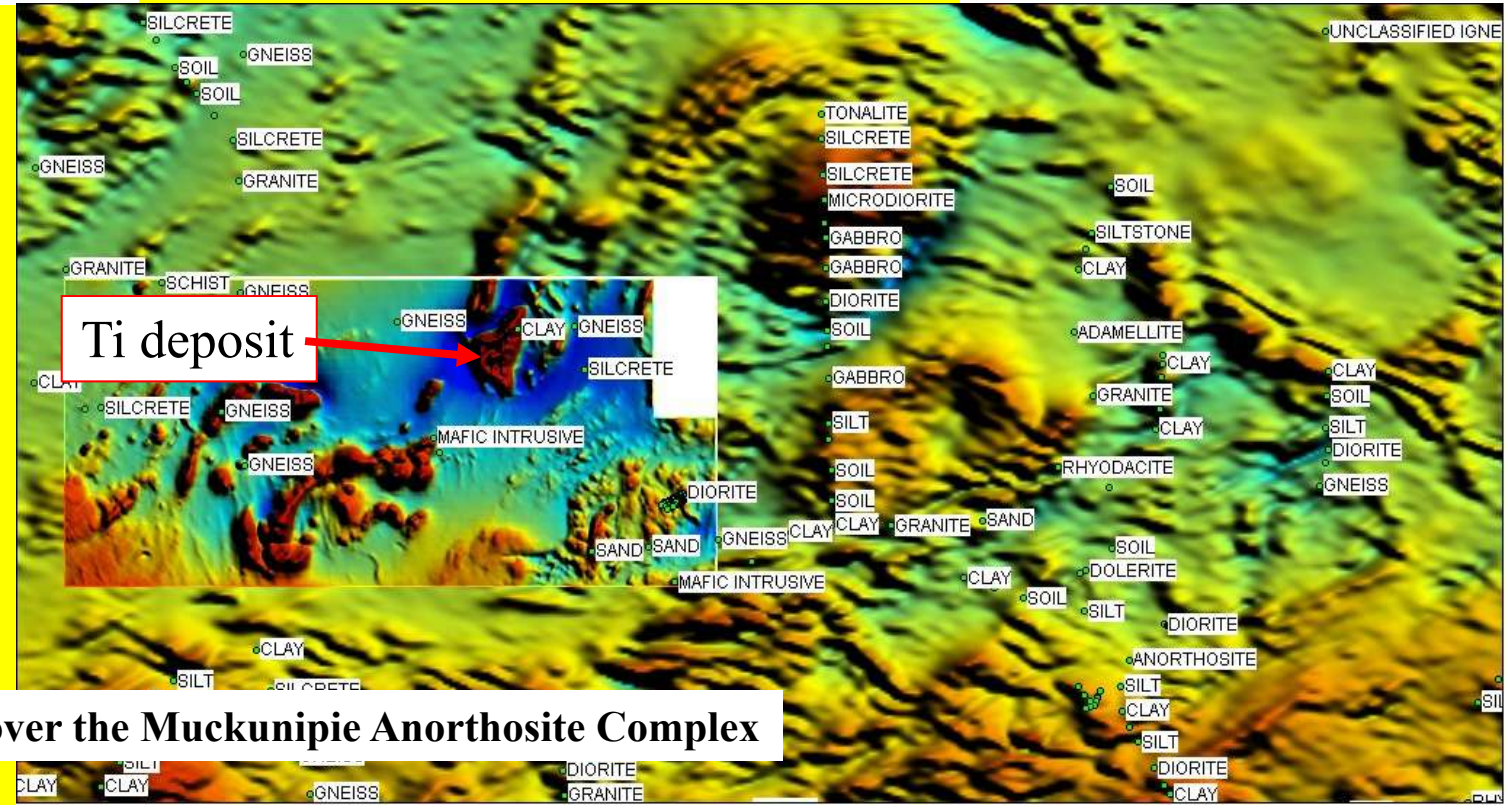
DEPOSIT TYPE

Hard rock Ti in anorthosites

c.f. Lac Tio, Quebec

RTP magnetic intensity with 500 nt contours

2 km grid squares



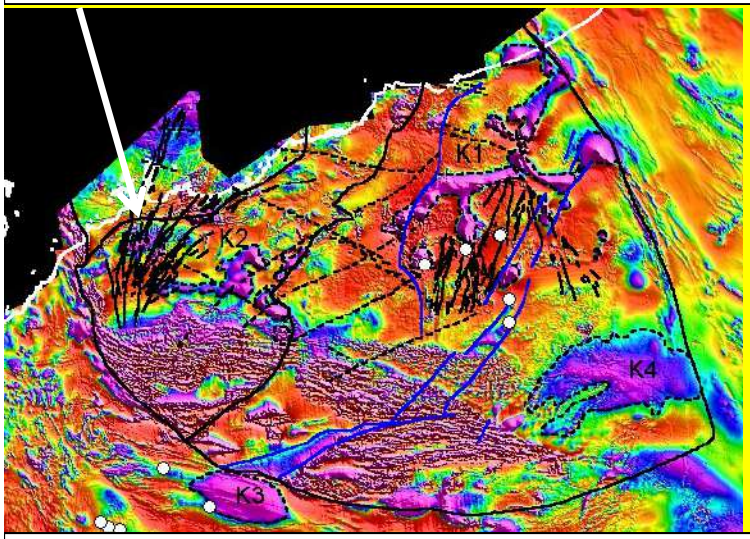
Magnetic intensity over the Muckunipie Anorthosite Complex

MacKenzie Hotspot in Canada

Dykes radiating from MacKenzie Hotspot

Trend of diamond mines in Slave Province

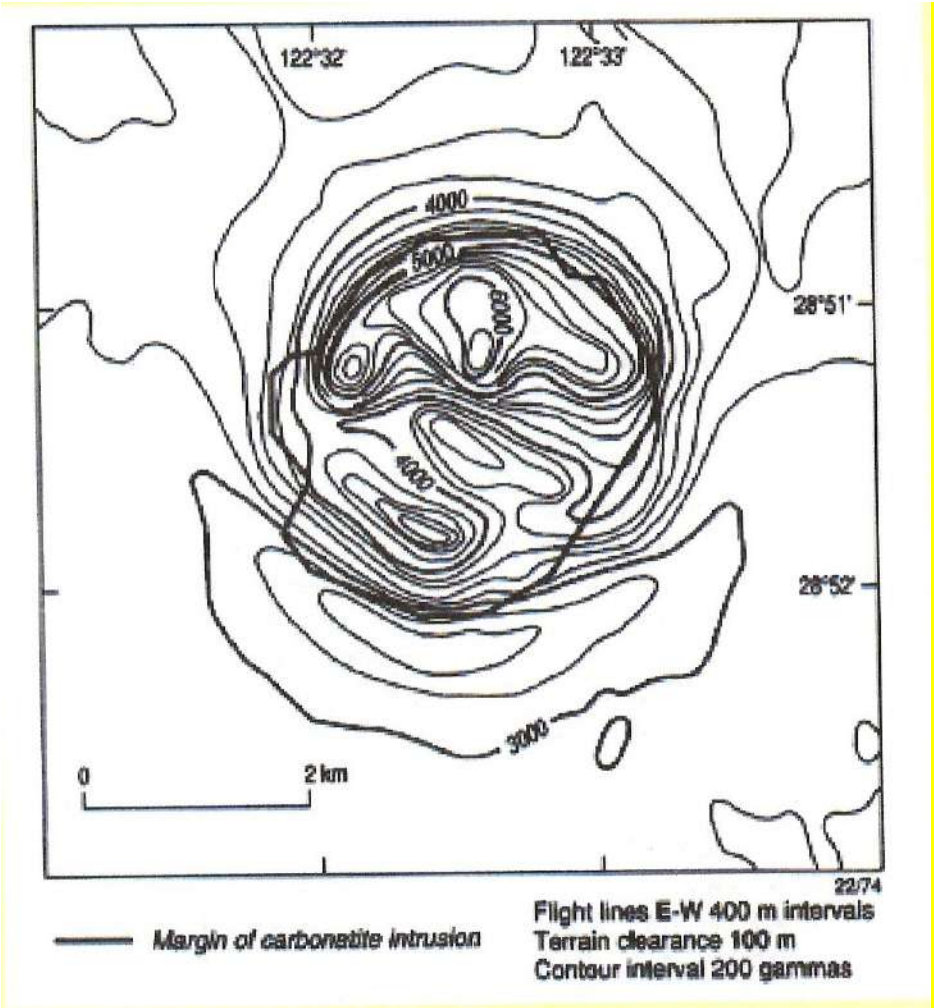
Kimberlites with diamonds found here



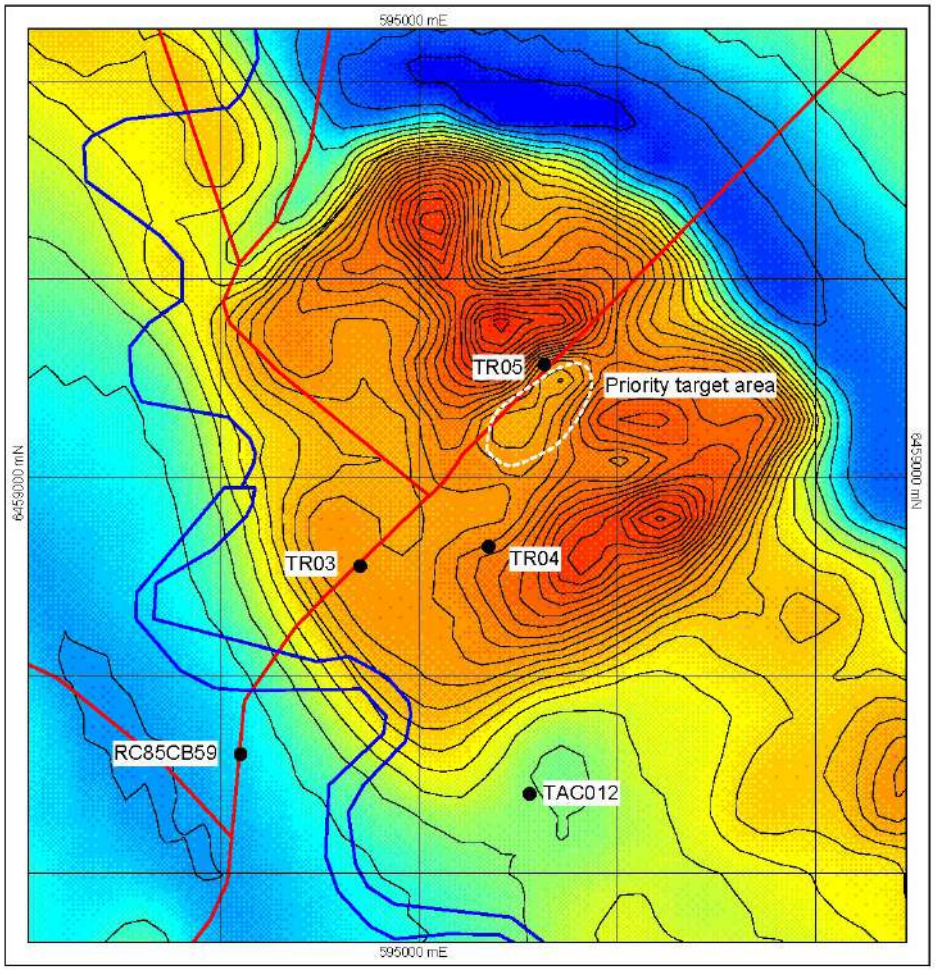
Magnetic intensity of the Pilbara Craton

FIGURE 15.5 The 1.2 Ga Mackenzie and Sudbury dyke swarms, the Muskox intrusion and continental margin flood basalts in relation to their suggested zones of spreading in the northern and southern Canadian shield (after Osmani, 1991, reproduced by permission from Queen's Printer for Ontario)

Major dyke swarms can be used to identify mantle plume locations.
In this example there appears to be a correlation between the centre of the dyke swarm the locations of diamond bearing kimberlites.



Magnetic response of the Mt Weld carbonatite from Duncn and Willet (1990)



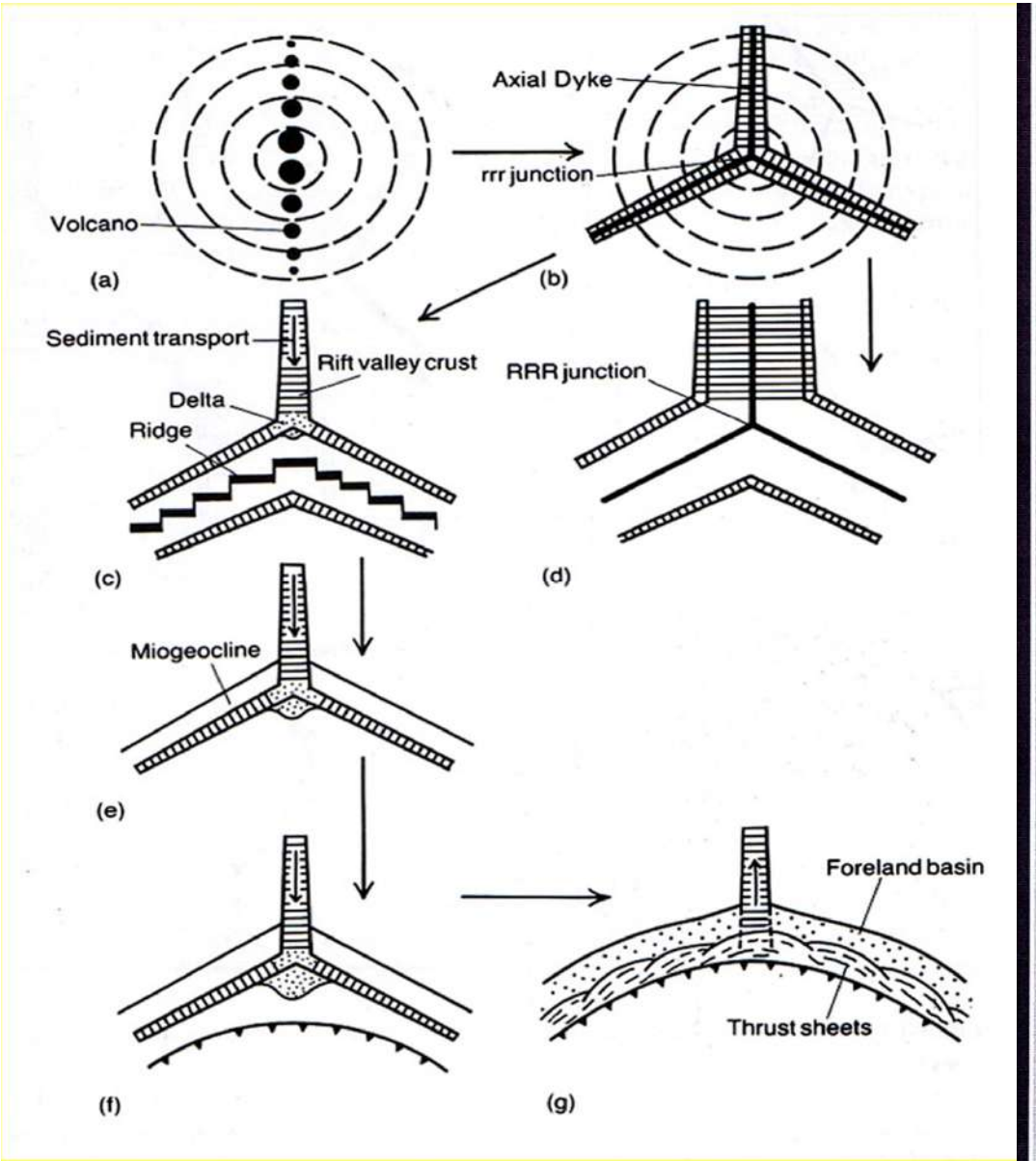
Unhappily not a carbonatite but a zoned carbonated peridotite.

DEPOSIT TYPE:
Carbonatites containing Cu, REE, U, phospate and Ti.

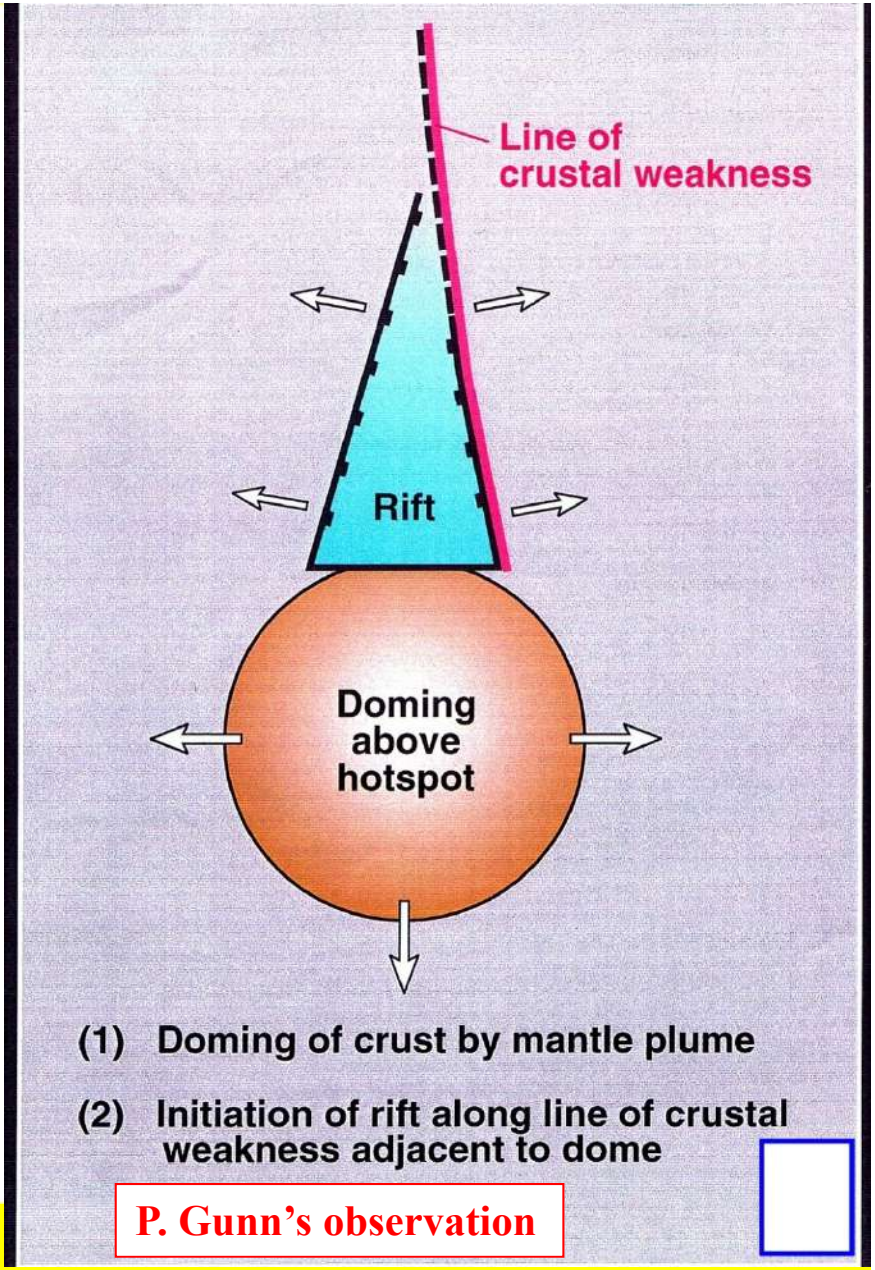
MINERAL DEPOSITS THAT APPEAR TO BE ASSOCIATED WITH MANTLE PLUMES:

1. **Cu-FeO-Au-U-REE (Olympic dam)**
2. **Hard rock Ti in anorthosites c.f. Lac Tio, Quebec**
3. **Diamonds in kimberlite pipes.**
4. **Cu in breccia pipes (c.f the Messina deposits, South Africa, Redbank, Qld.)**
5. **Ni-Cr-PGE in layered intrusions**
6. **Ni in anorthosites, c.f. Voisey's Bay**
7. **Ni in feeders to flood basalts c.f. Norilsk**
8. **Carbonatites (Cu, REE, U, phosphate)**
9. **Alaskan-type peridodite intrusions containing PGE e.g. Fifield, NSW**
10. **Etc.**

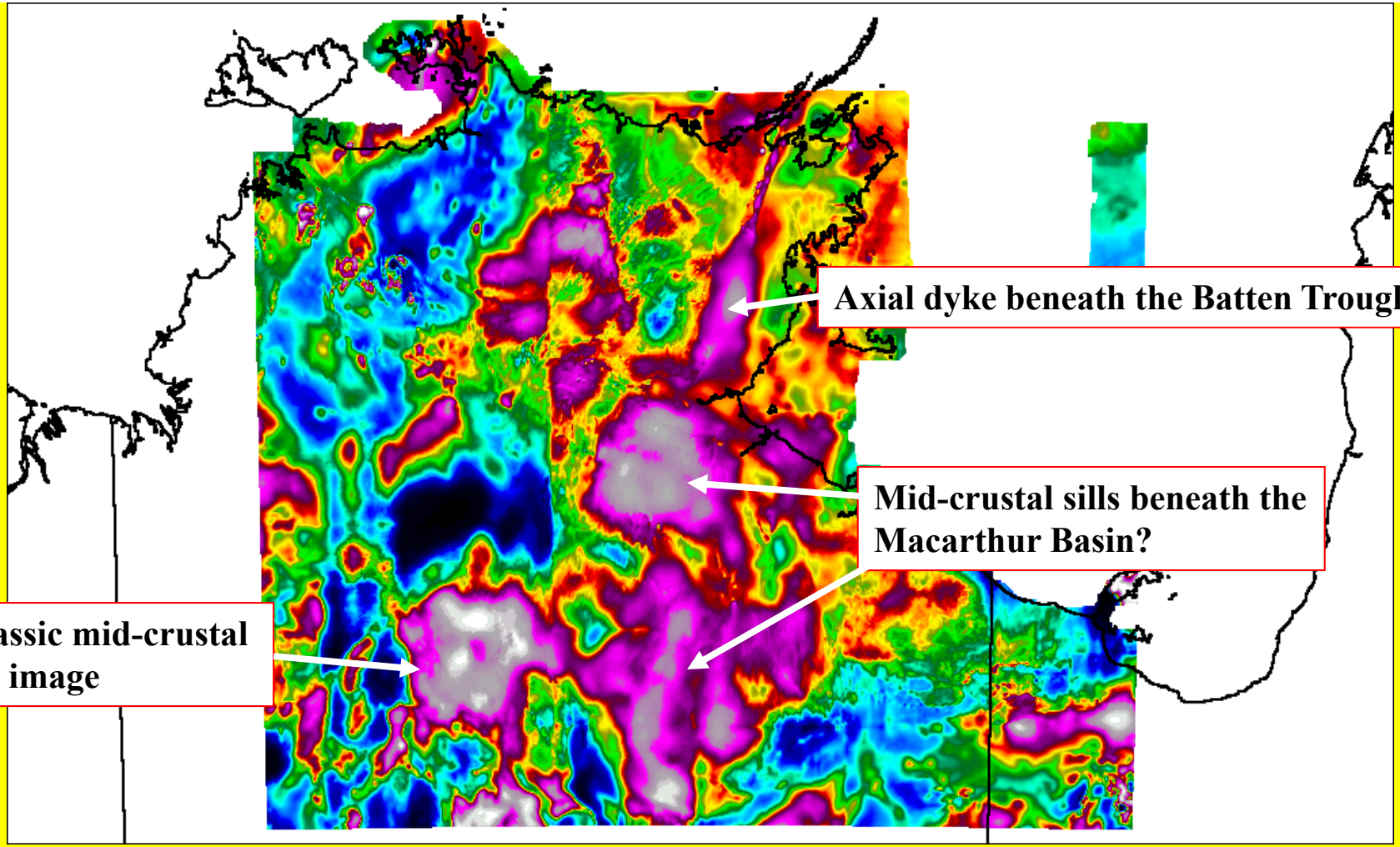
Note: most of these deposit types can be directly targeted using aeromagnetic data



Formation of a triple junction above a mantle plume dome - Burke and Dewey (1973)



P. Gunn's observation



Magnetic intensity reduced to pole and continued up 1000m

Schematic evolution of a rift
From Gunn (1997)

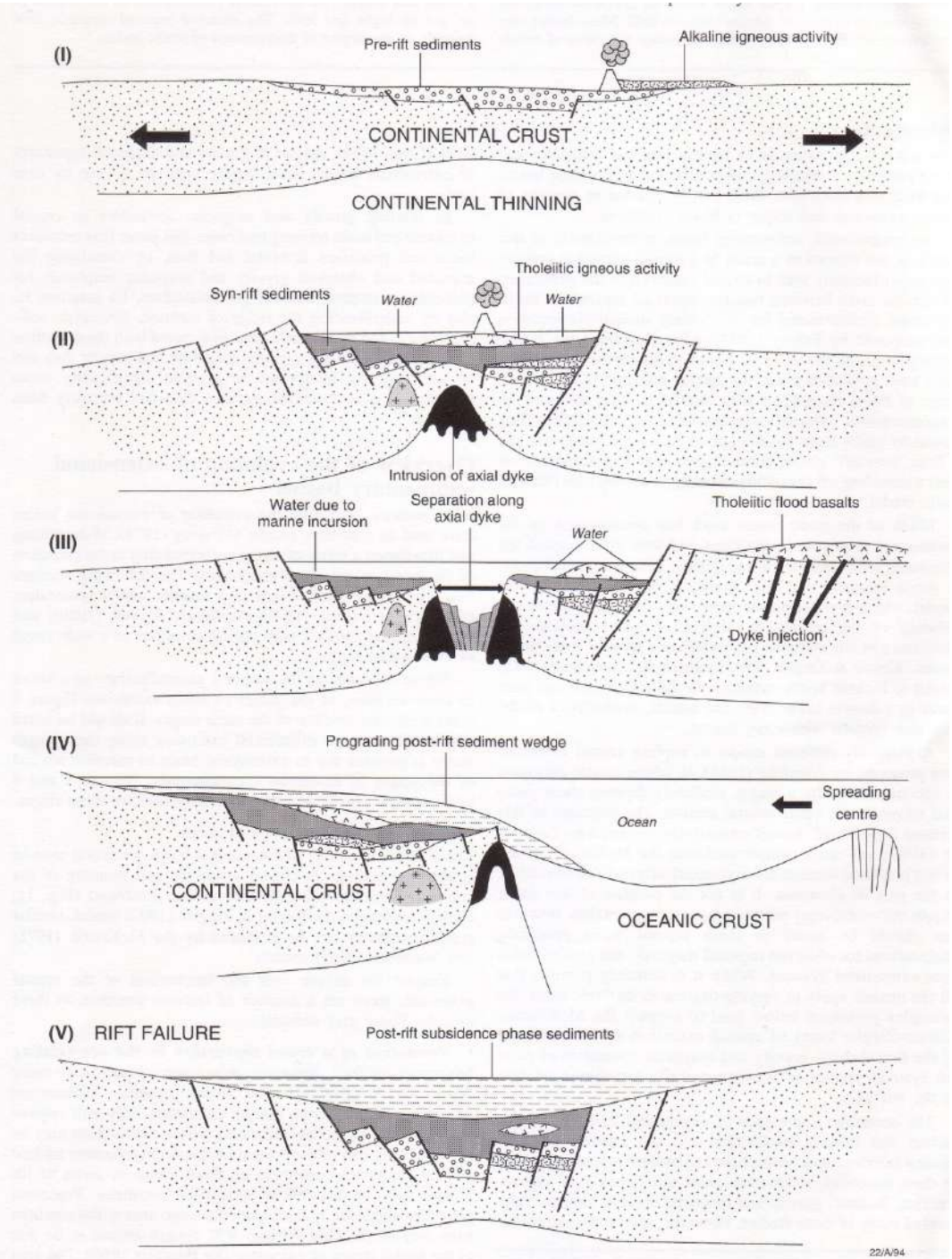


Figure 1. Stages of crustal extension (see text for an explanation of details).

Plan view
Rift system
From Gunn (1997)

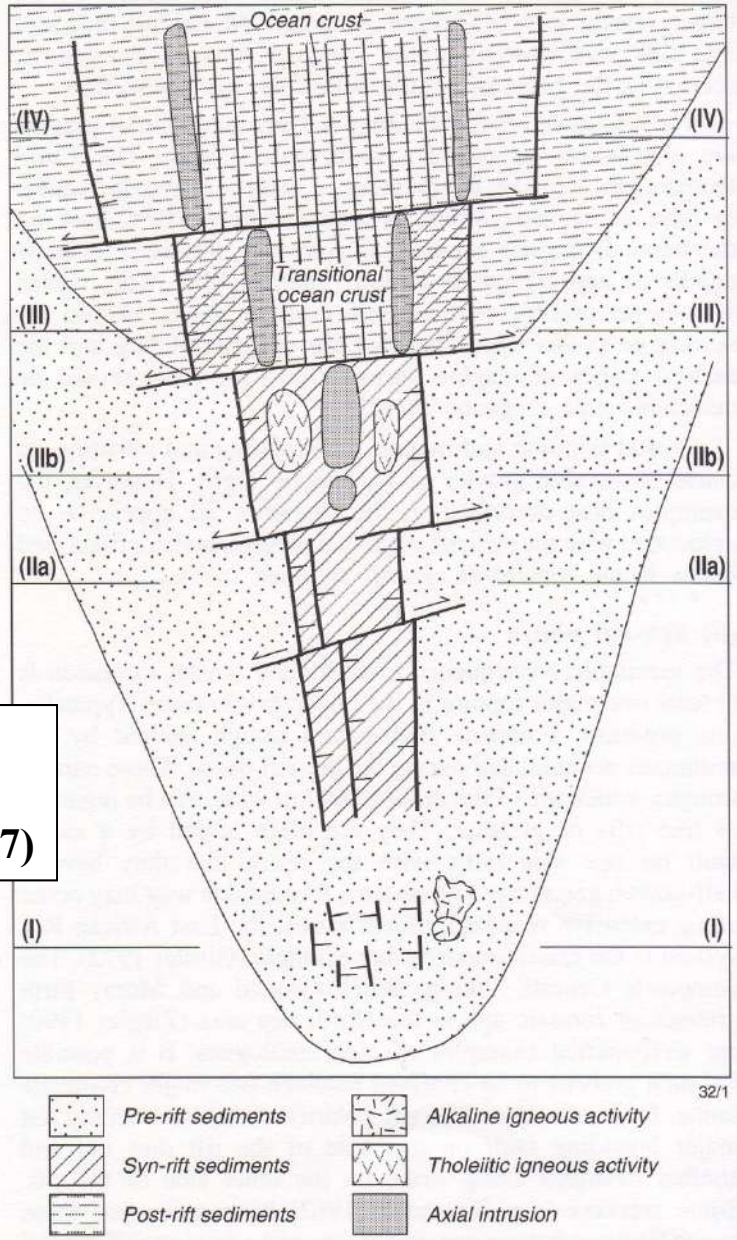


Figure 2. Plan view of the stages of crustal extension. Different degrees of extension are accommodated by transfer faults. This diagram assumes that that no significant strike-slip component occurs in the extension.

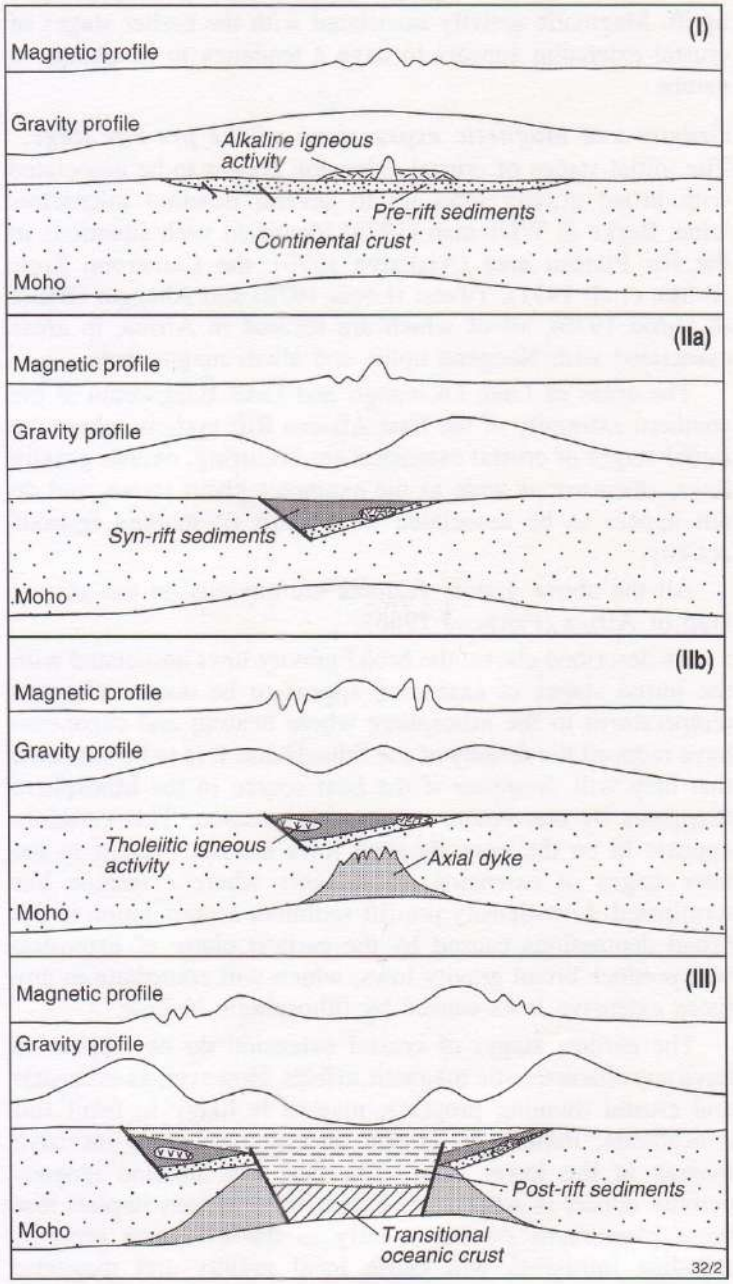
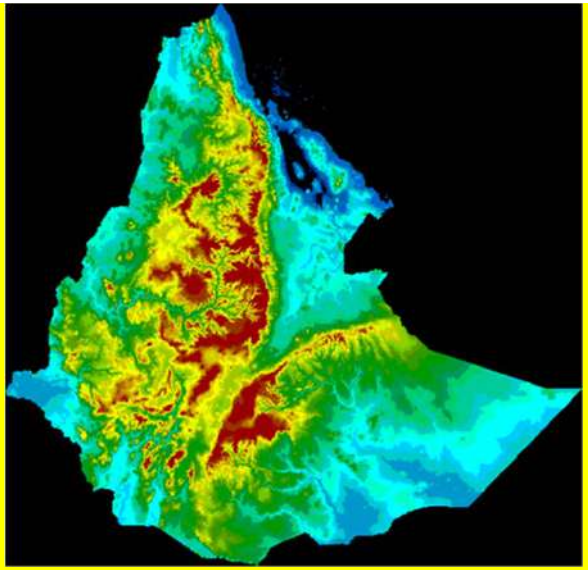


Figure 3. Magnetic and gravity expressions of the pre-rift and syn-rift stages. Sections correspond to sections shown in Figure 2.



Ethiopian Rift elevation

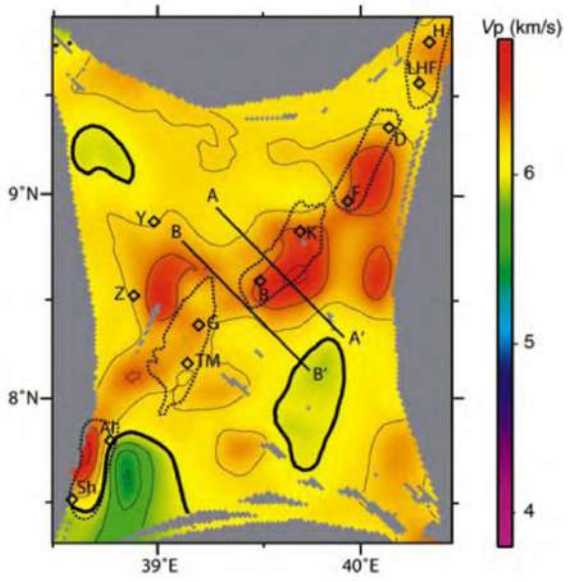
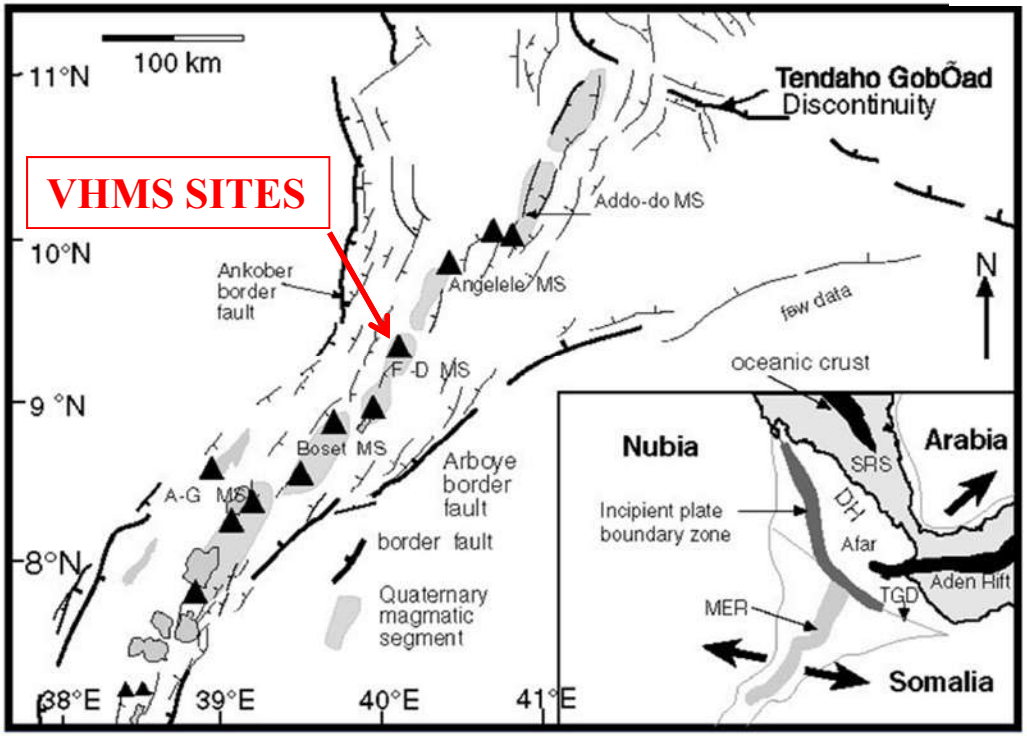


Figure 2. Horizontal slice 10 km depth below rift floor. High-velocity (V_p) bodies below rift axis are interpreted as solidified magmatic intrusions. Lettering, symbols, and area of figure are as in Figure 1; magmatic segments are shown by dotted lines.

Seismic tomography after Keranen et al. (2004)



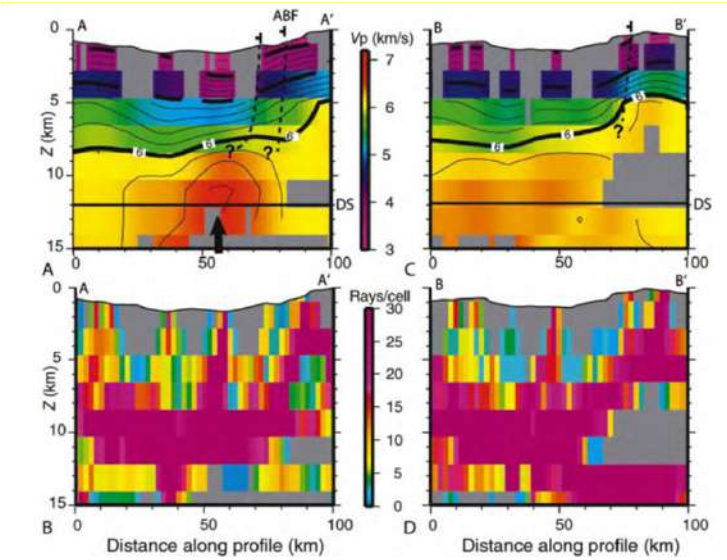
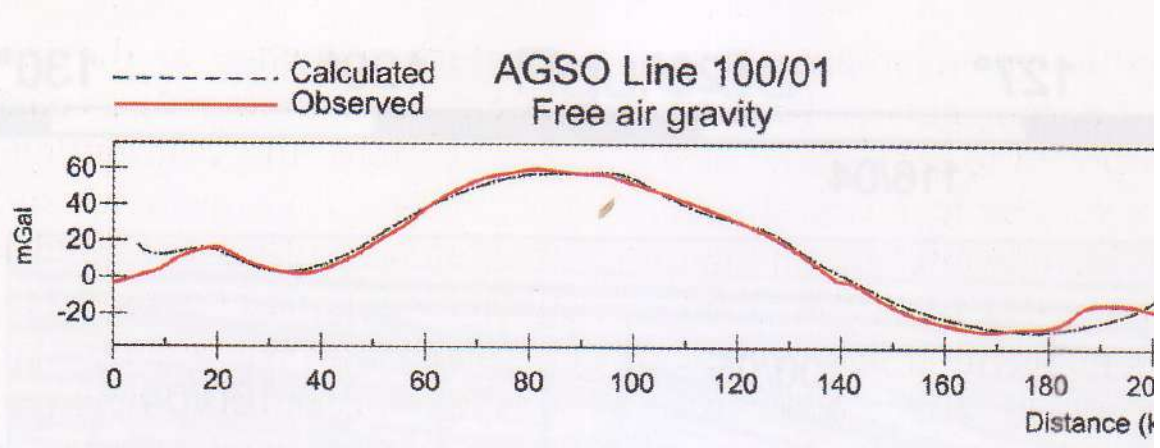
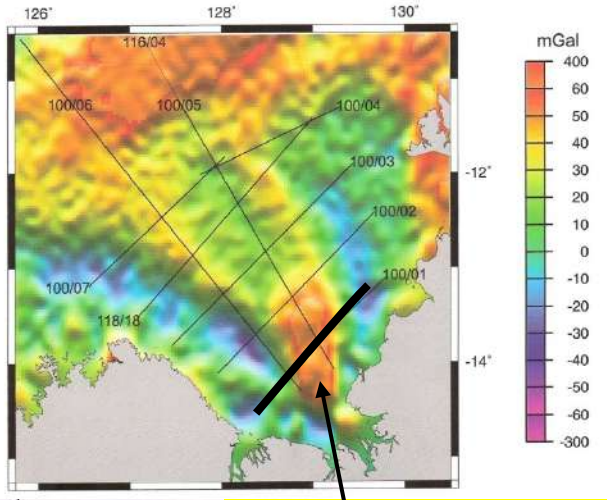
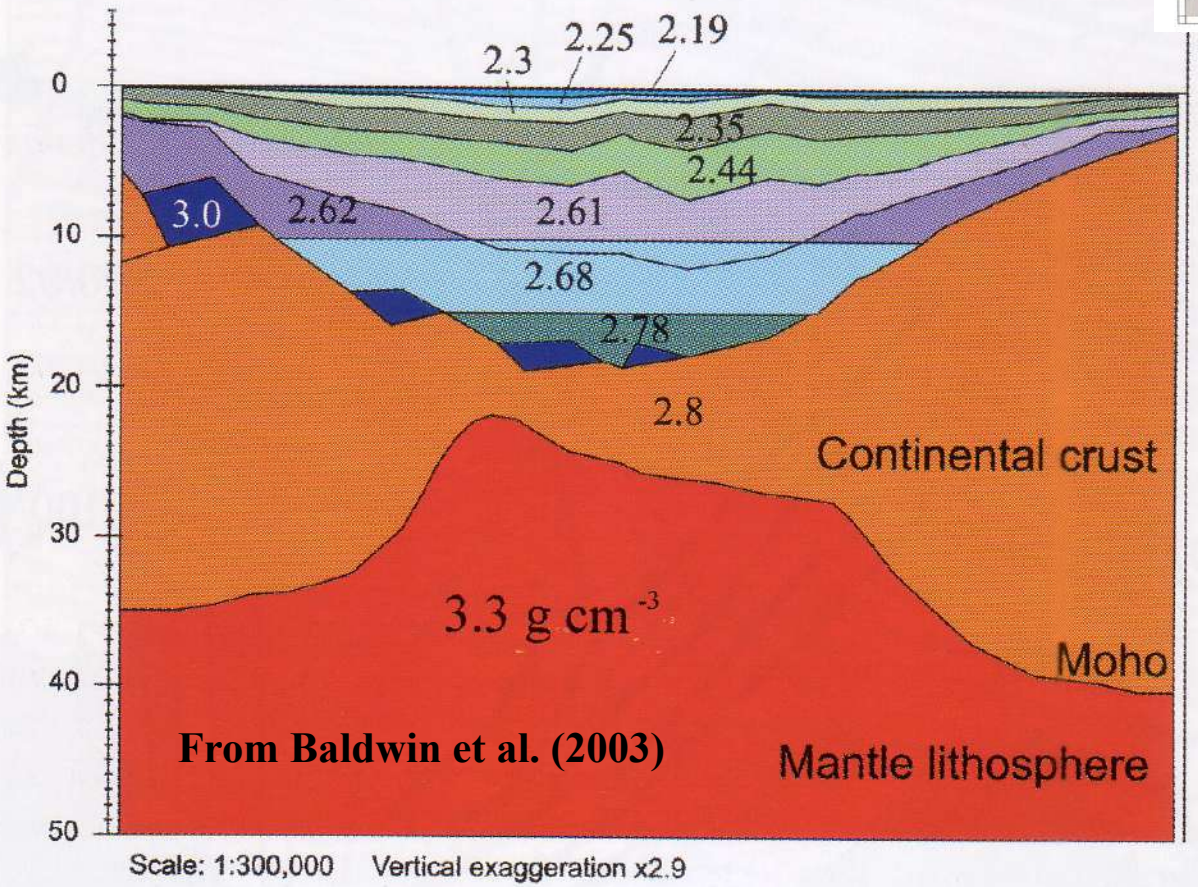


Figure 3. A: Rift-perpendicular cross-section A–A′ extending through Boseti magmatic segment between Boseti and Kone volcanoes (Fig. 1). High-velocity (*Vp*) body (vertical arrow) beneath rift valley is interpreted as solidified mafic magmatic intrusion into Precambrian basement. Faults (-| symbols) and proposed subsurface continuation of faults (dashed lines) are marked. Depth of slice (DS) in Figure 2 is marked by horizontal line. Areas with no ray coverage are shown in gray. Vertical exaggeration is 5:1. B: Ray coverage for slice A–A′. C: Rift-perpendicular cross-section B–B′ between magmatic segments (Fig. 1). D: Ray coverage for slice B–B′.







Barnett 2 oil Discovered by Gunn 1989

(From Baldwin (2003))

Bonaparte Rift section

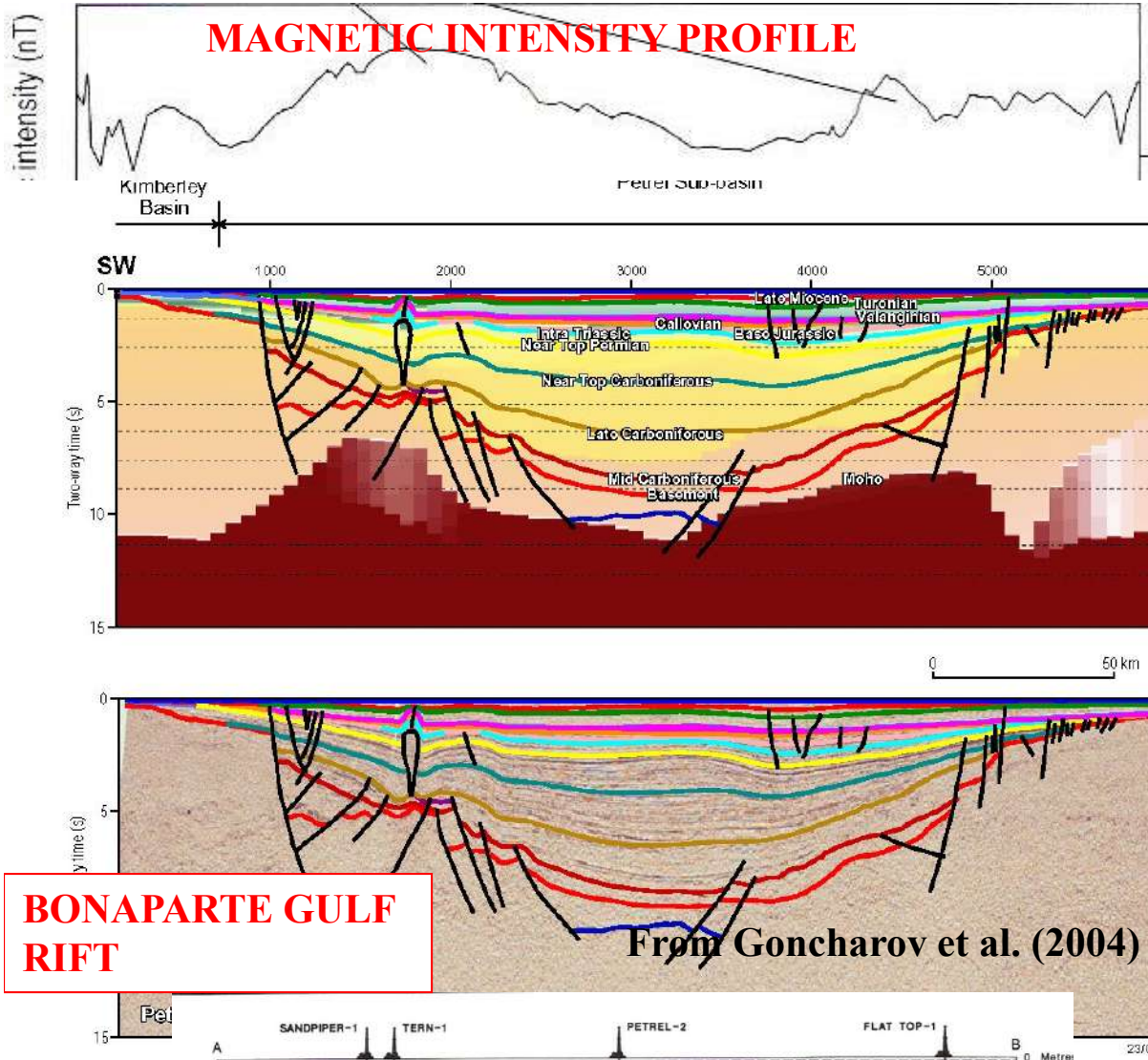
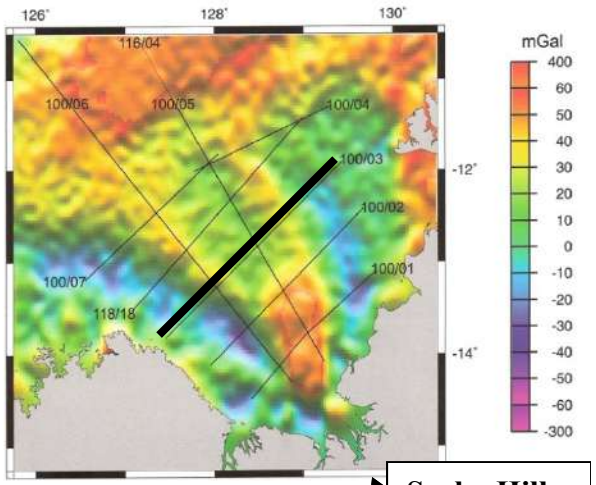
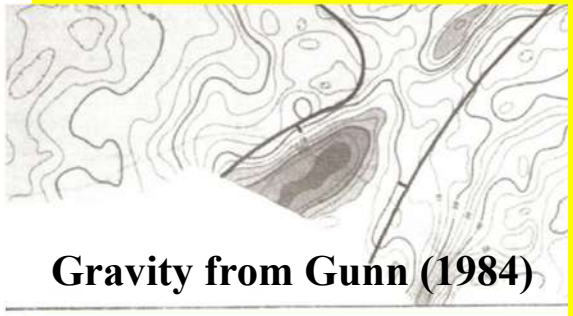


Figure 6. OBS l line 100/03.

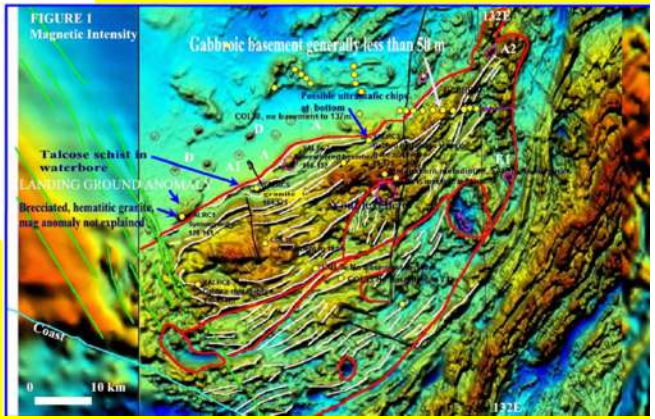


Gravity

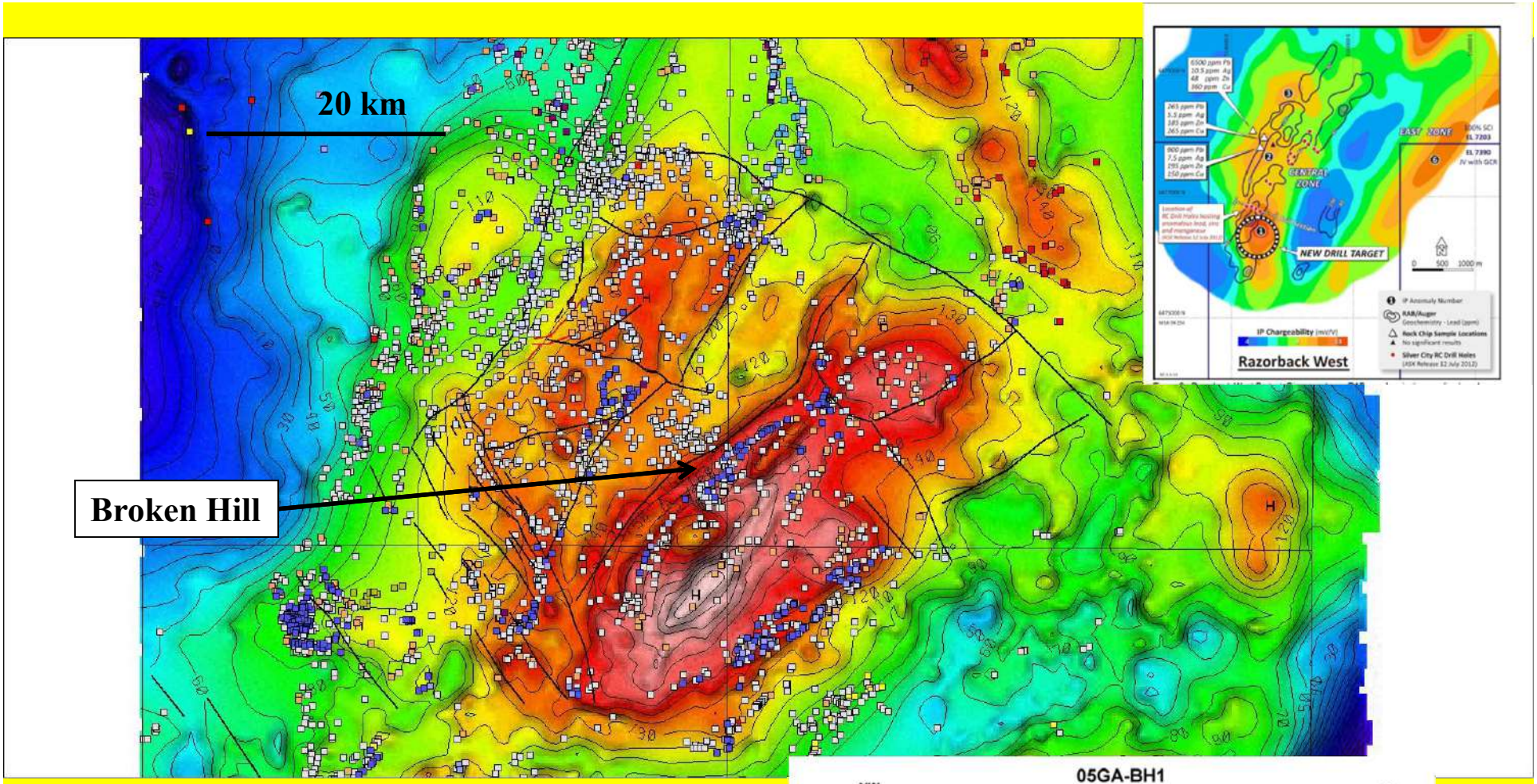
Sorby Hills Pb-Zn



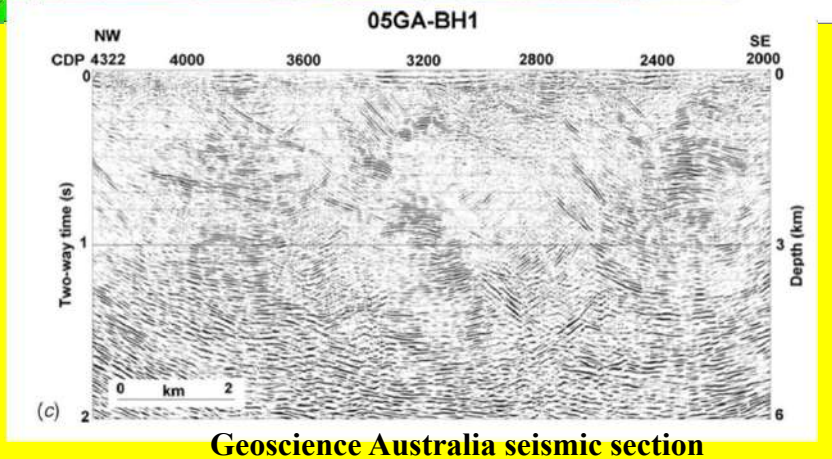
Gravity from Gunn (1984)



RTP magnetics

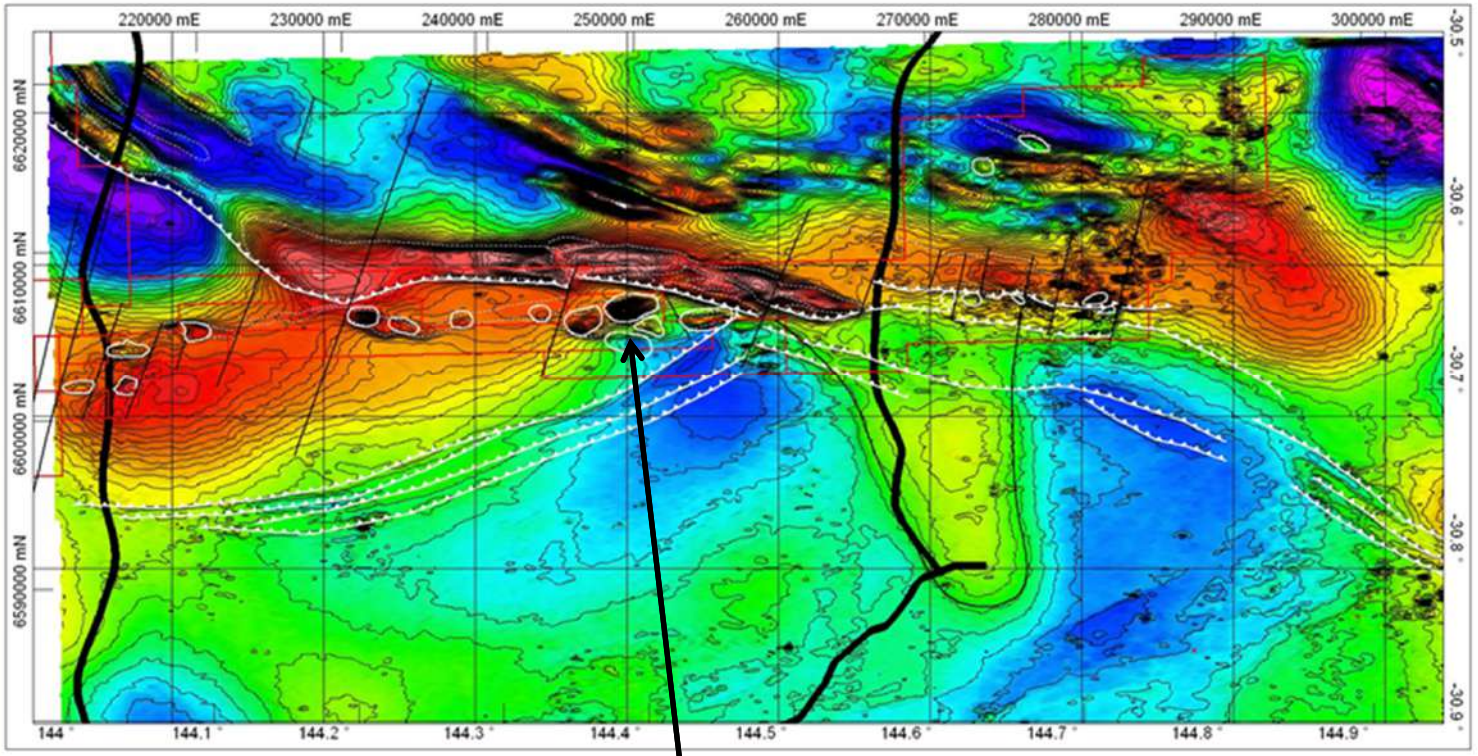


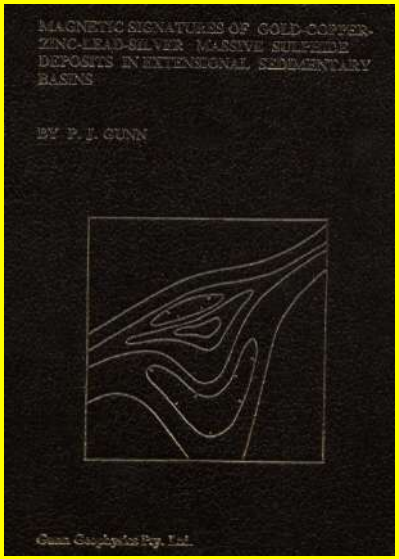
Broken Hill Bouguer gravity 10 gu contours.
Known mineral occurrences shown.
BH Ag-Pb-Zn type mineral occurrences in purple.



Geoscience Australia seismic section

RTP MAGNETICS





Cuttaburra Cu-Ag-pyrrhotite discovery
Under 75 metres of cover
New mineral province
50 km from nearest mineral drillhole
Never before held under an exploration licence.
Discovery based on rift model and Cobar analogues

THANK YOU