



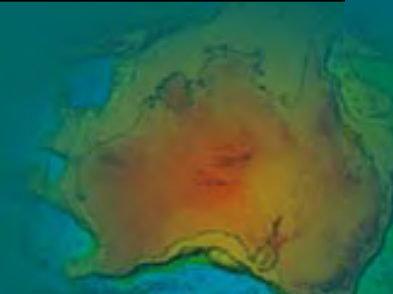
Australian Government
Geoscience Australia



Geophysical delineation and mineral potential of mafic-ultramafic intrusions in the Arunta Region

Tony Meixner, Dean Hoatson, Yanis Mieztis,
Subhash Jaireth & Jon Claoué-Long

Andrew Young Hills



Three major studies

Dean Hoatson, Jon Claoué-Long & Shen-su Sun

- Geological setting, event chronology & mineral potential

Tony Meixner & Dean Hoatson

- Geophysical interpretation – total subcropping extent, depth of cover, orientation & internal structure

Yanis Miezitis, Subhash Jaireth & Dean Hoatson

- Mineral potential modelling

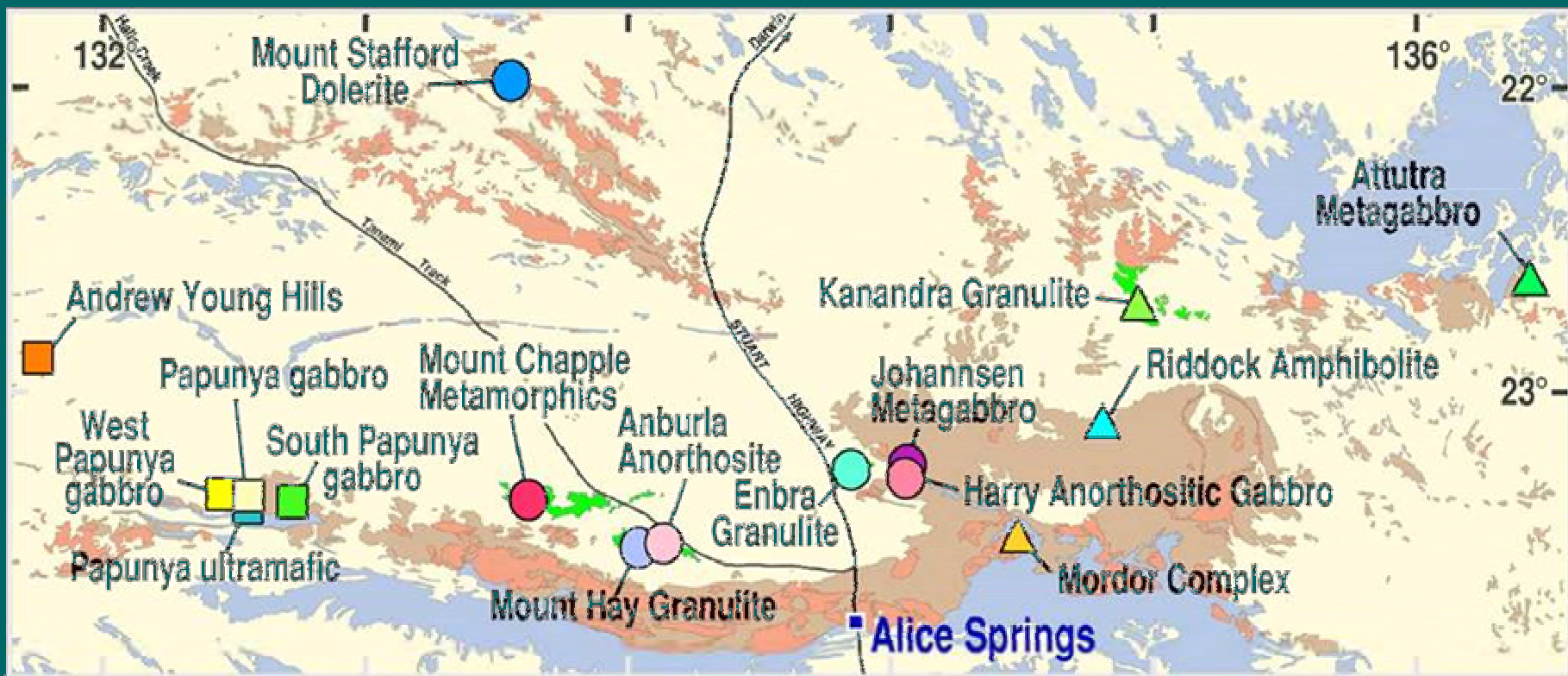
Acknowledgements:

Colleagues at Northern Territory Geological Survey

Various exploration companies in the Arunta Region



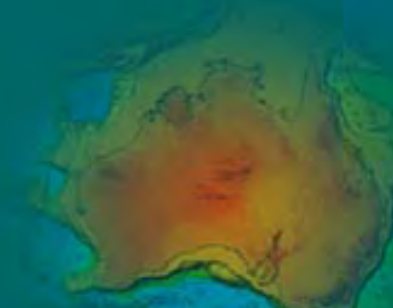
Distribution of major Arunta mafic-ultramafic intrusions



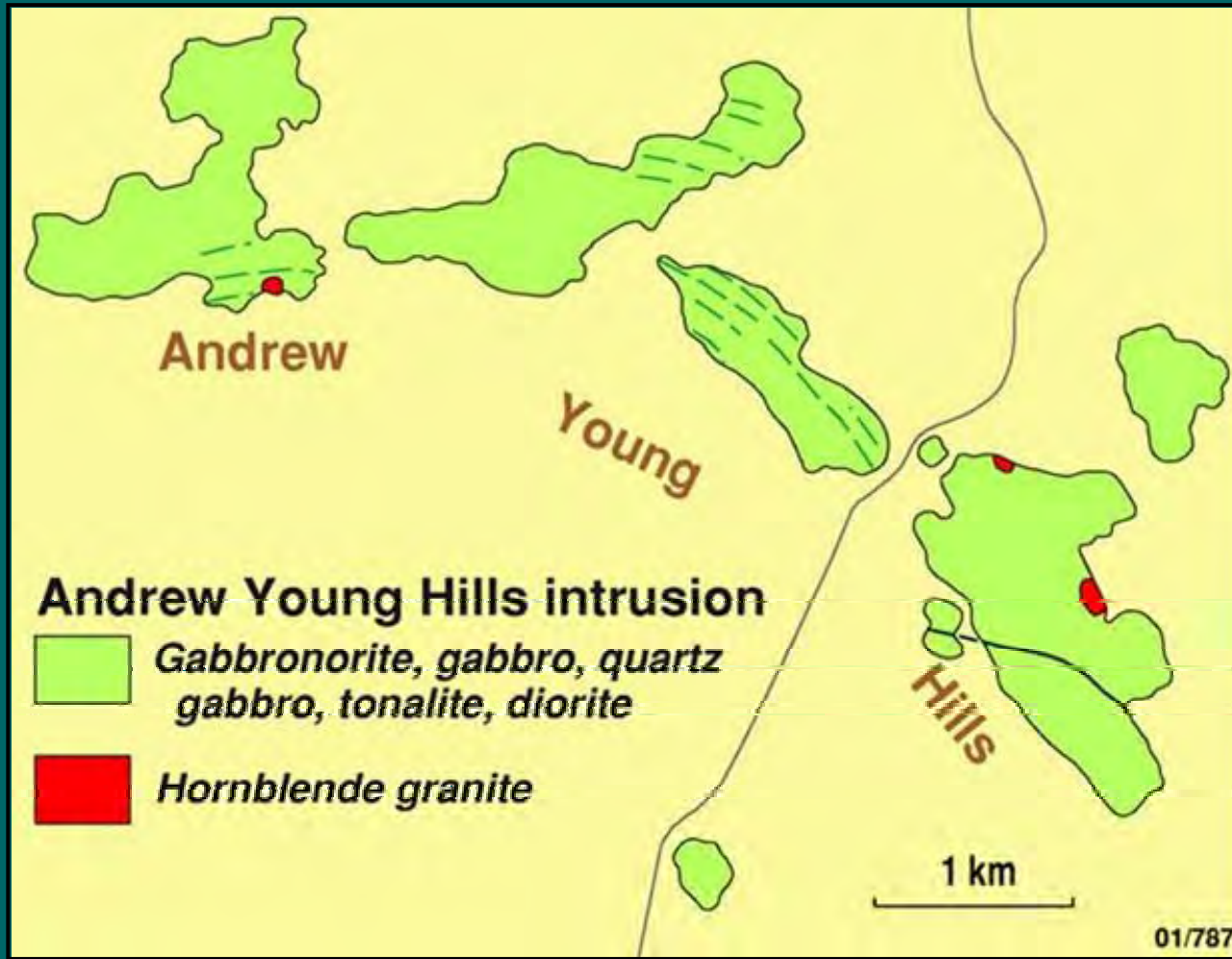
Cainozoic cover
 Amadeus, Ngalia and Georgina Basins

Arunta Province
 Granite
 Mafic-ultramafic intrusions investigated

100 km



Andrew Young Hills



High level -
fractionated
intrusion

Compositionally
layered

Undeformed

1635±9 Ma

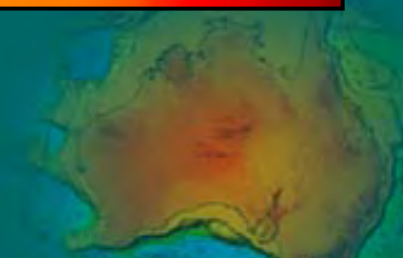
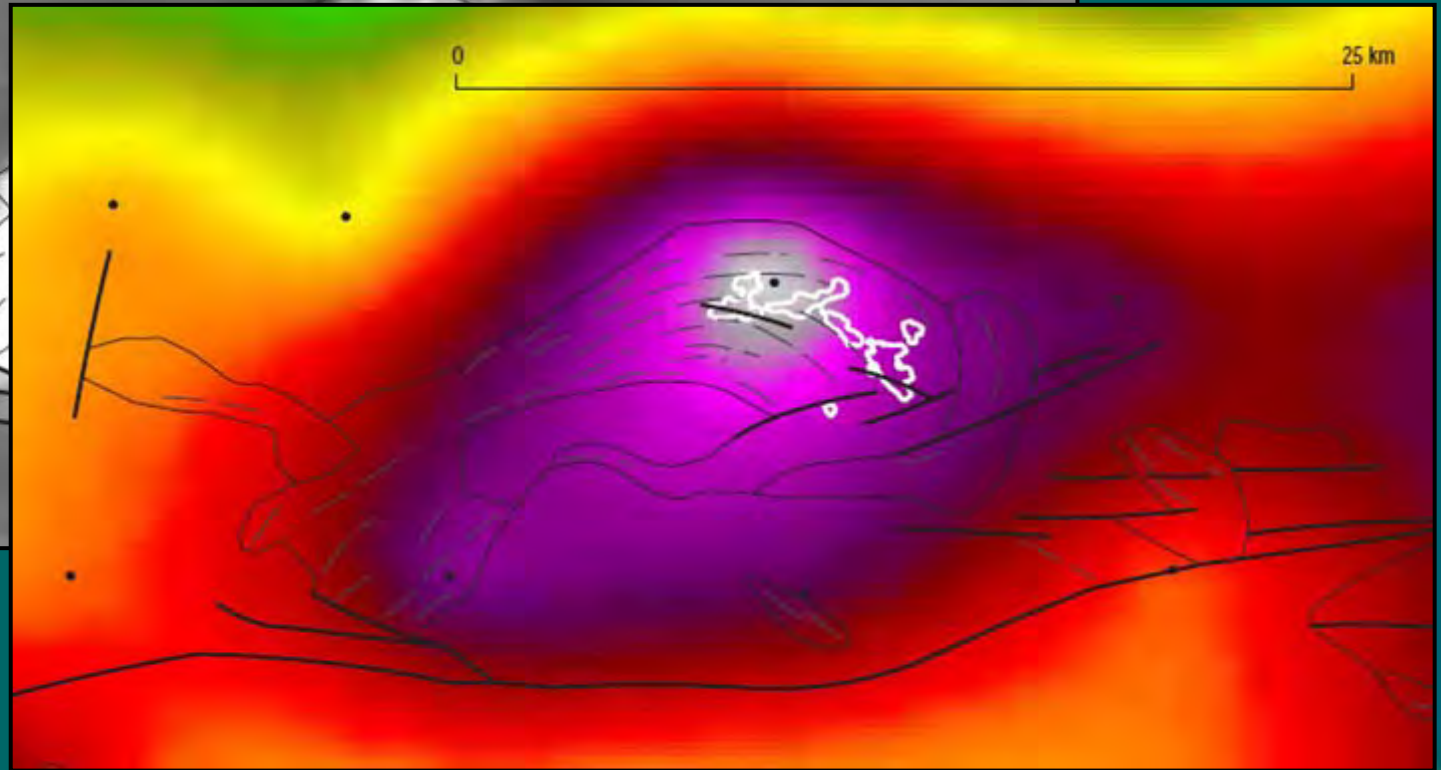
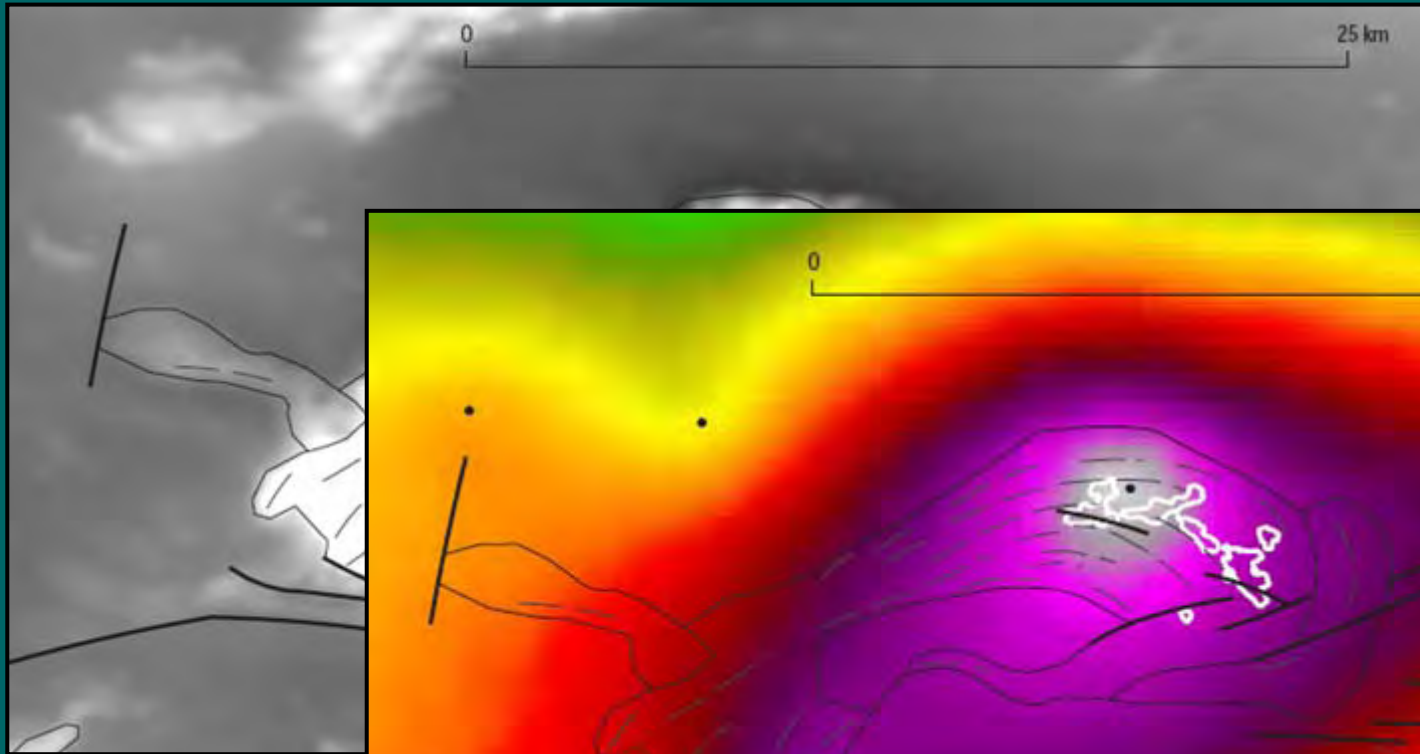
Crustal
contamination

Commingling of
mafic-felsic
magmas

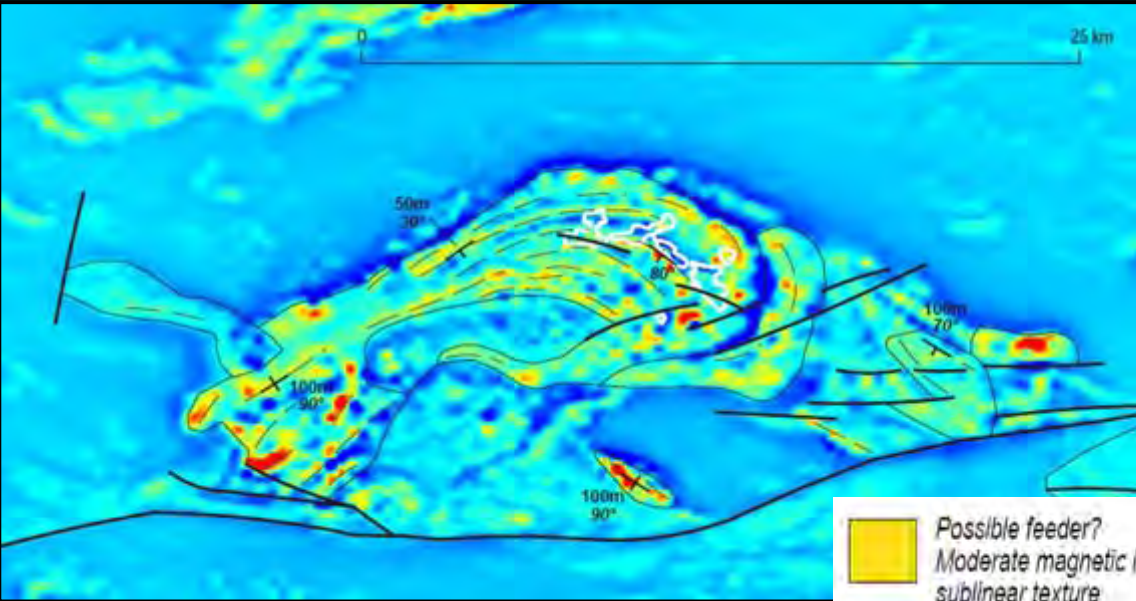
Early history of S
saturation







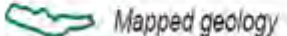
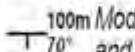


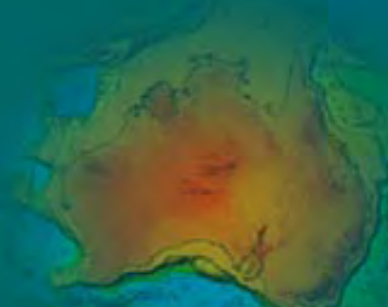
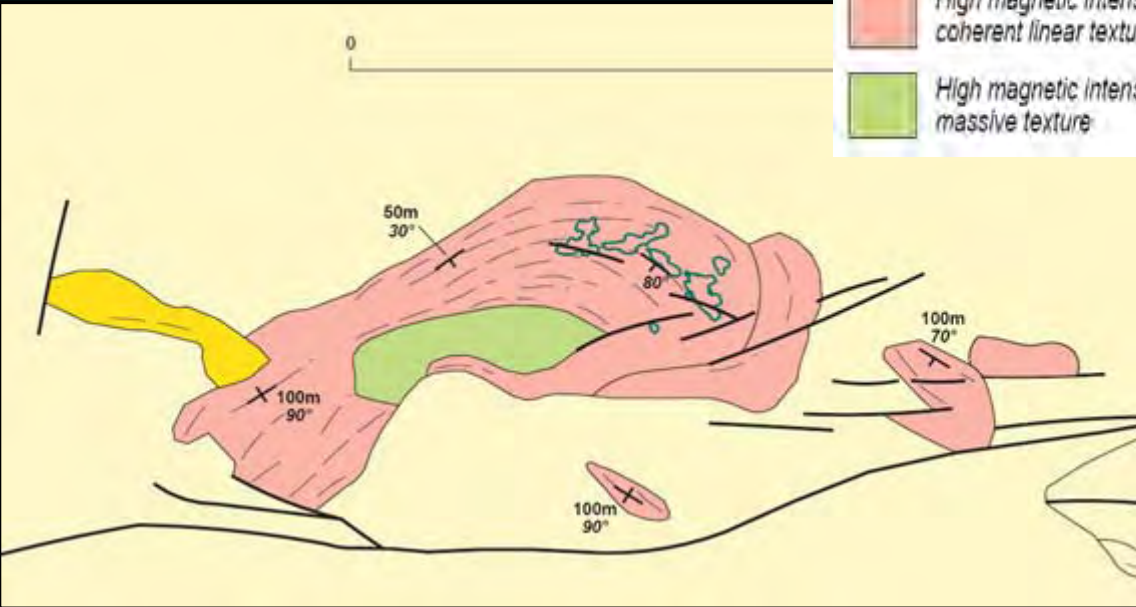
Andrew Young Hills



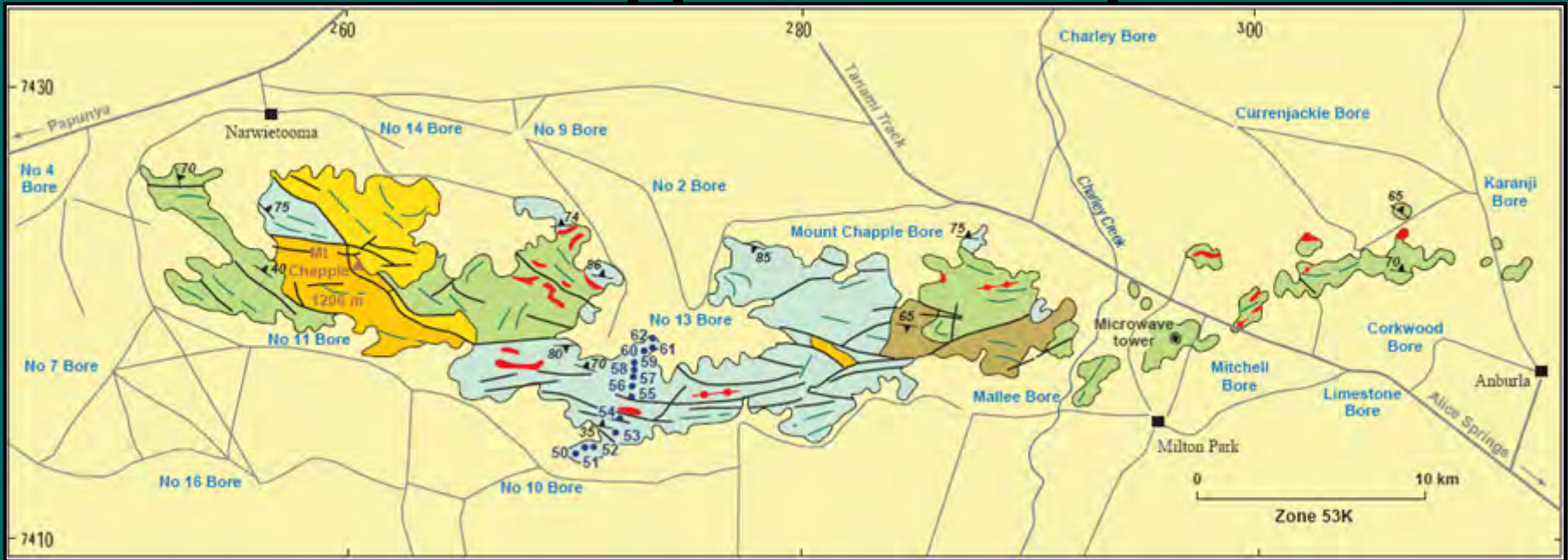
Andrew Young Hills



	Possible feeder? Moderate magnetic intensity sublinear texture		Fault
	High magnetic intensity coherent linear texture		Boundary confident
	High magnetic intensity massive texture		Magnetic trend
			Mapped geology
			100m Modelled depth below cover 70° and dip of magnetic unit



Mount Chappelle Metamorphics



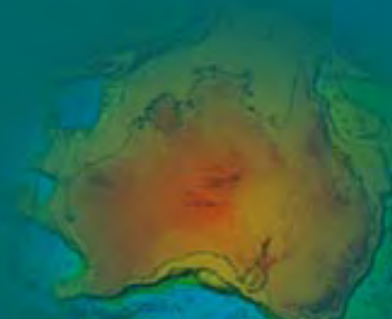
Large composite mafic-intermediate felsic igneous body

Central portion dominated by mafic gneiss of mafic-felsic magmas

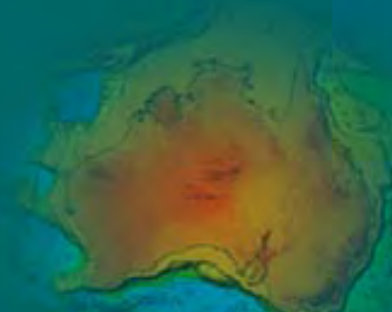
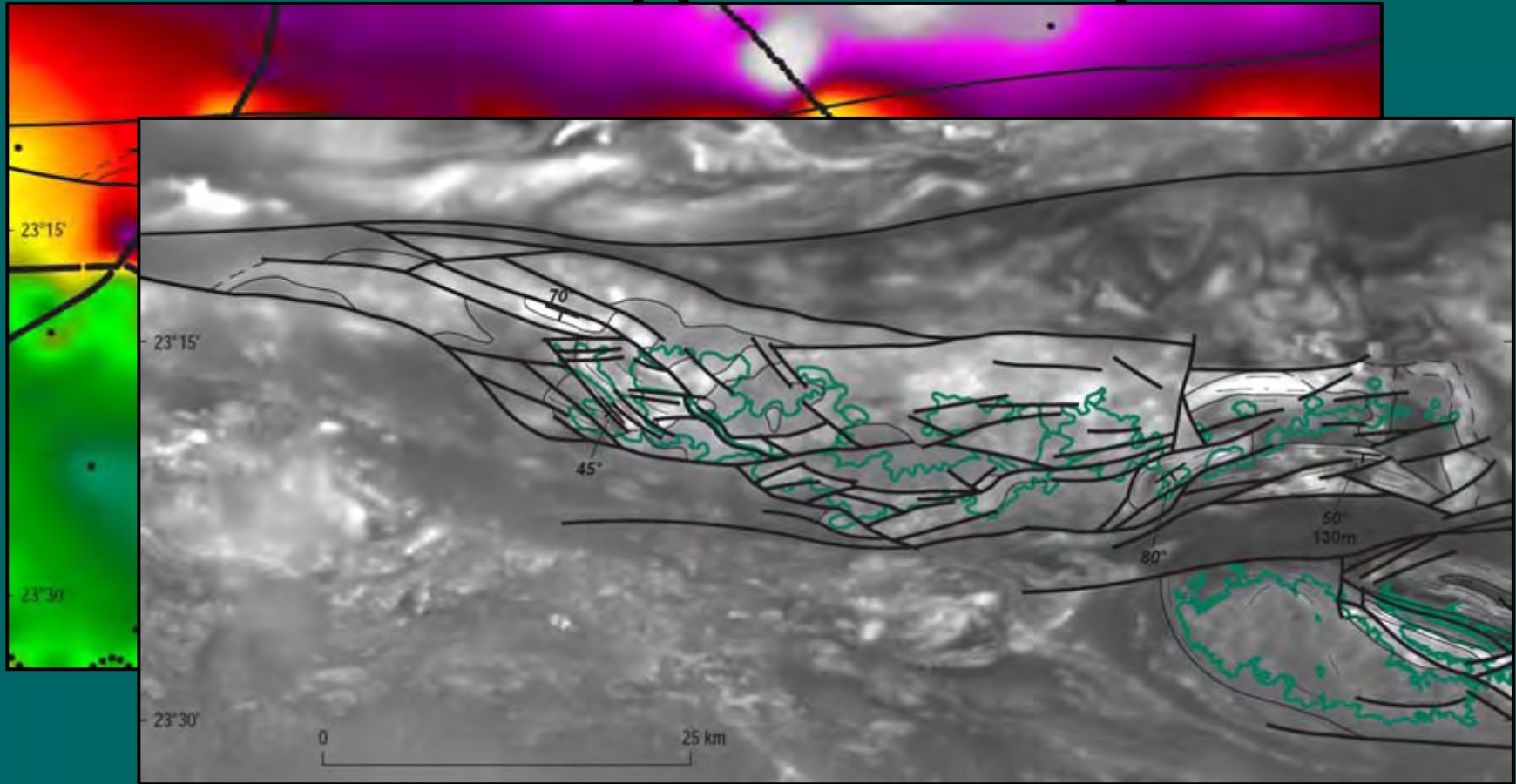
Felsic unit: $1771 \pm 10/-6$ Ma

Early history of S saturation

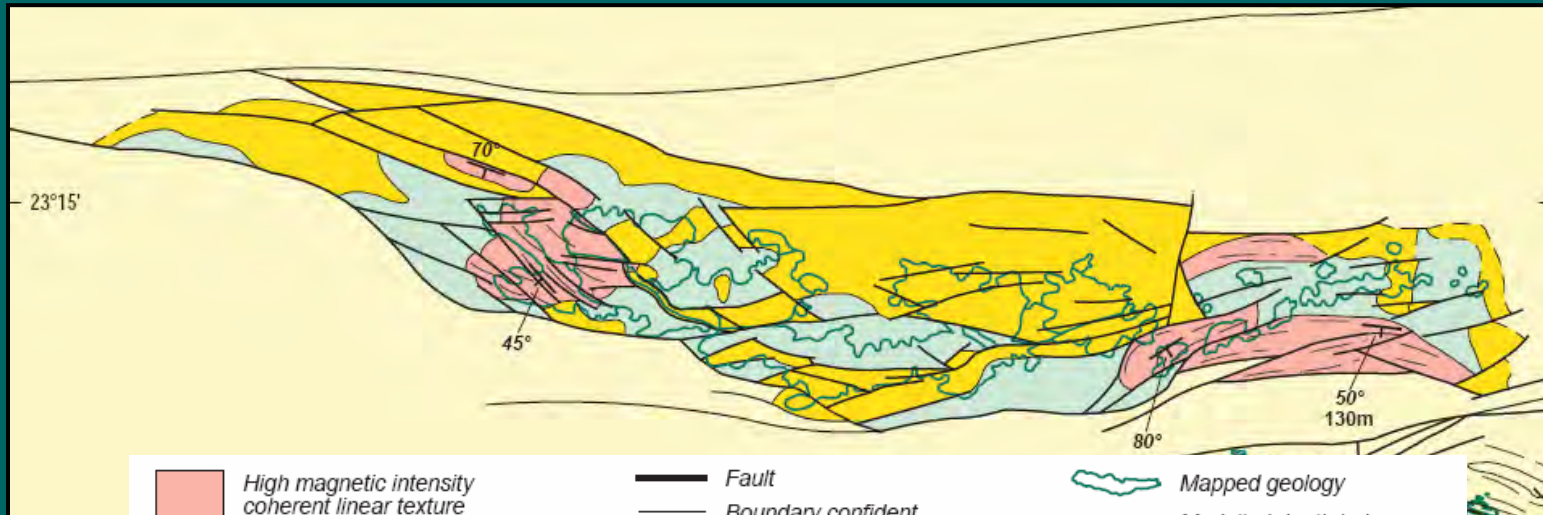
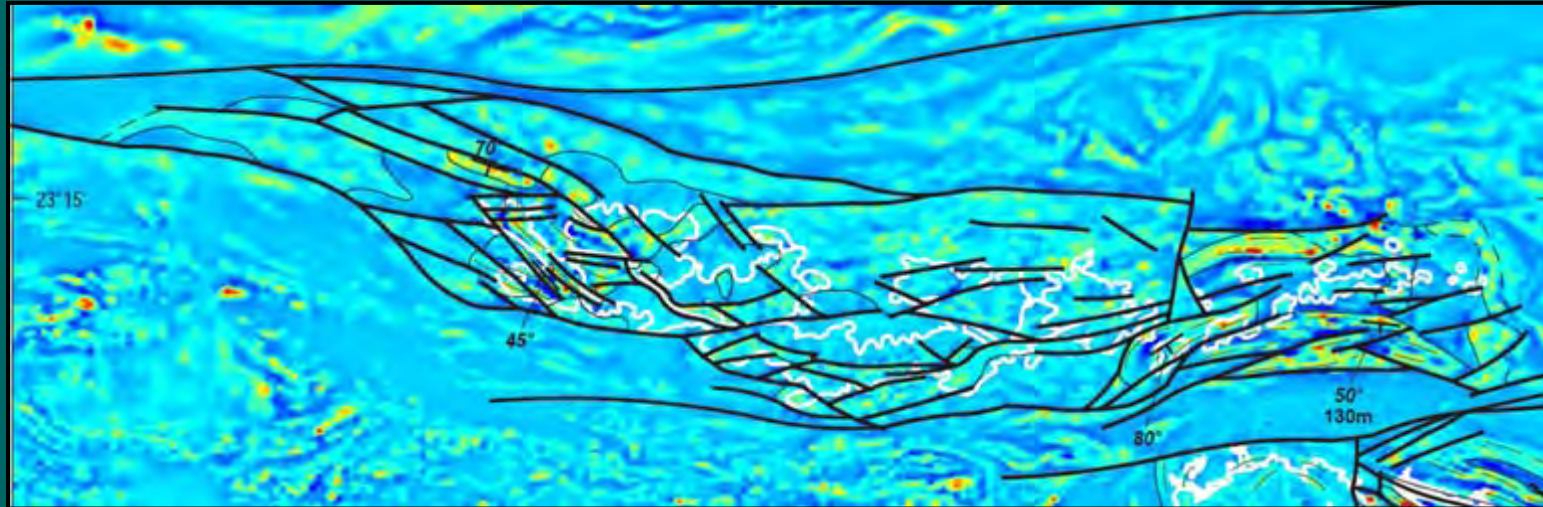
Mafic unit: 1774.0 ± 1.9 Ma













Mount Chapple Metamorphics



Mount Chapple Metamorphics



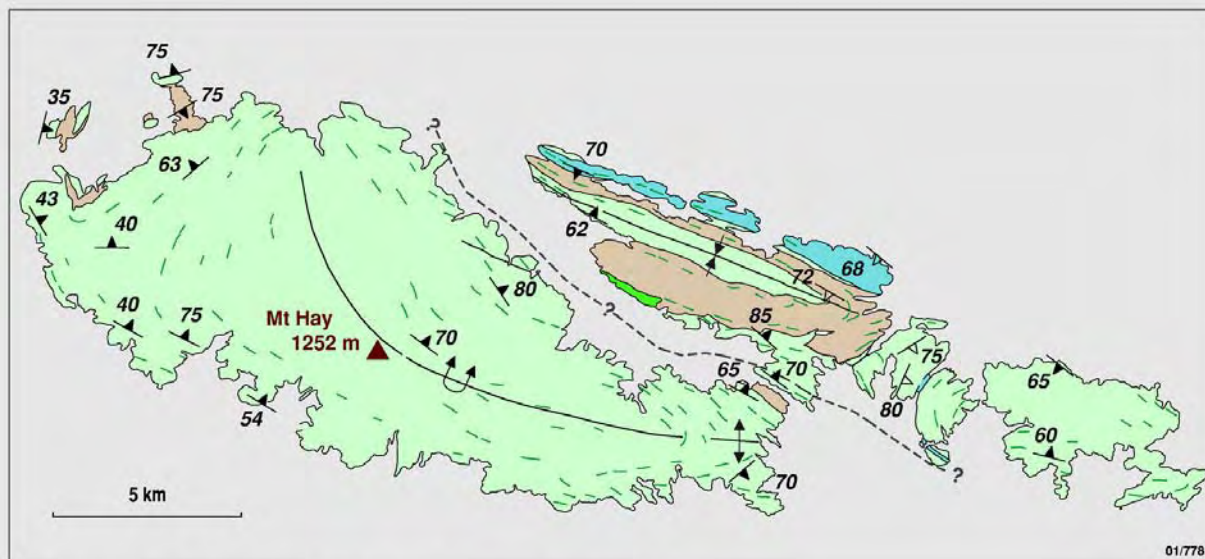
- | | | | | | |
|---|--|---|-------------------------|---|----------------------------------|
|  | High magnetic intensity
coherent linear texture |  | Fault |  | Mapped geology |
|  | Moderate magnetic intensity
massive texture |  | Boundary confident |  | 100m Modelled depth below |
|  | Low and flat magnetic intensity |  | Boundary less confident |  | 70° cover & dip of magnetic unit |
| | |  | Magnetic trend | | |

Mount Hay Granulite

Sub-horizontal
elongate balloon-like
body

Primary
crystallisation age:
1803±5 Ma

Deformation event:
1700±17 Ma



Mount Hay Granulite intrusion



Gabbro



Mafic granulite



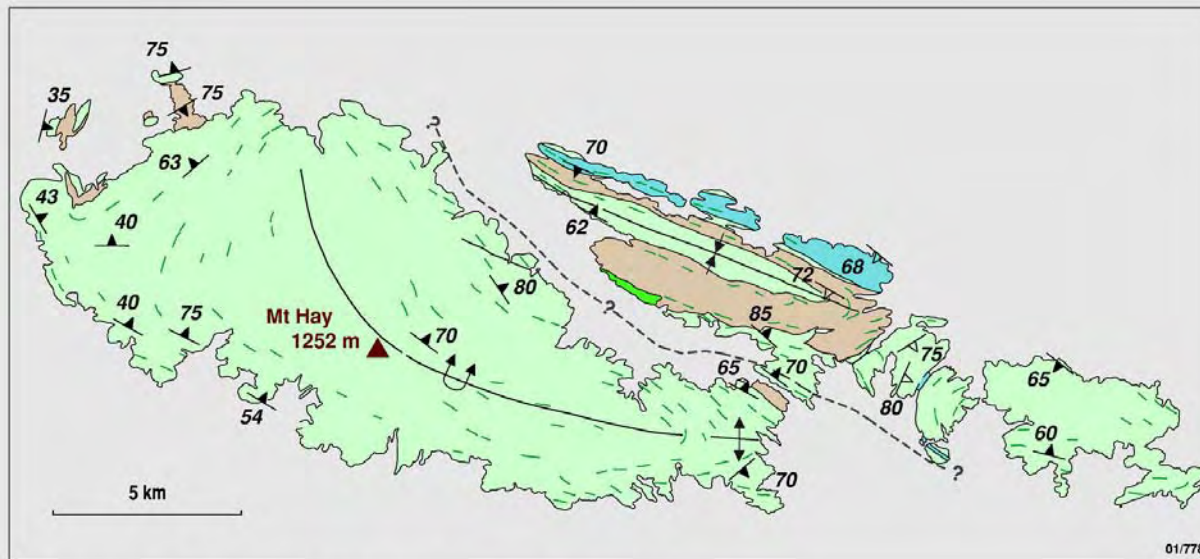
Mafic granulite, garnet gneiss

Anburla Anorthosite



Anorthosite

Mount Hay Granulite



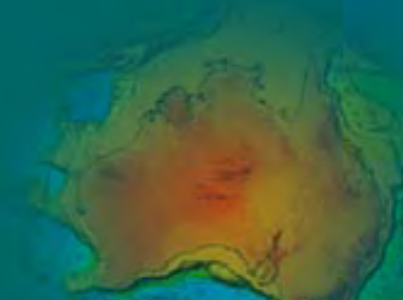
Mount Hay Granulite intrusion



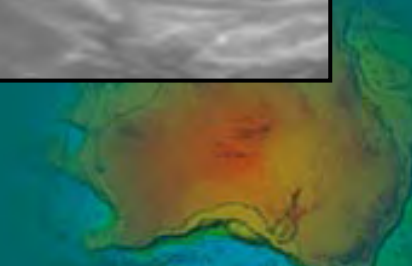
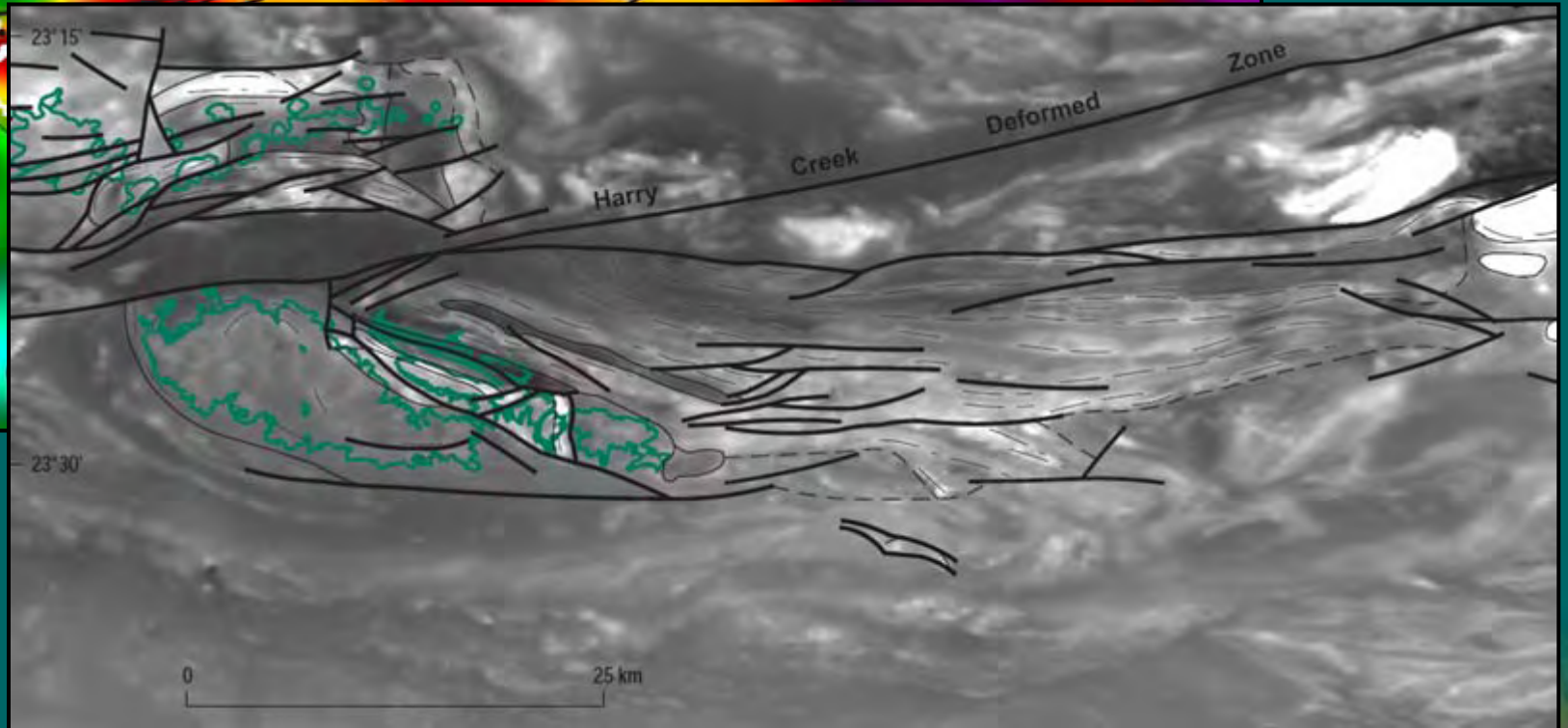
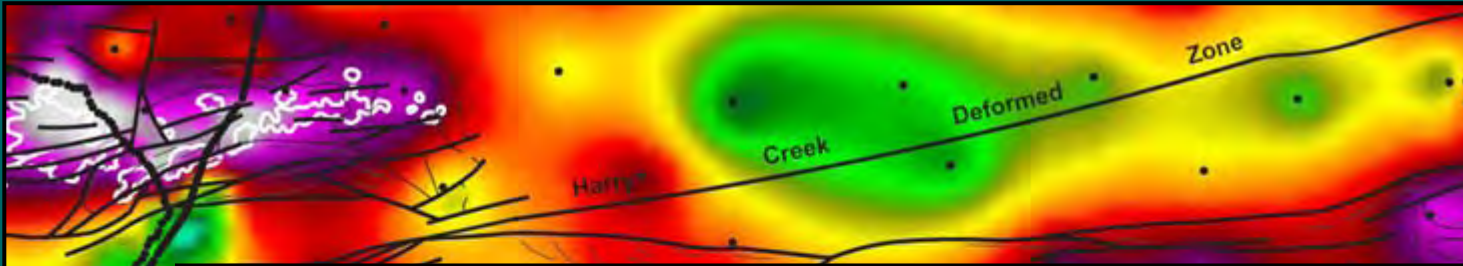
Crustal contamination

Commingling of mafic-felsic magmas

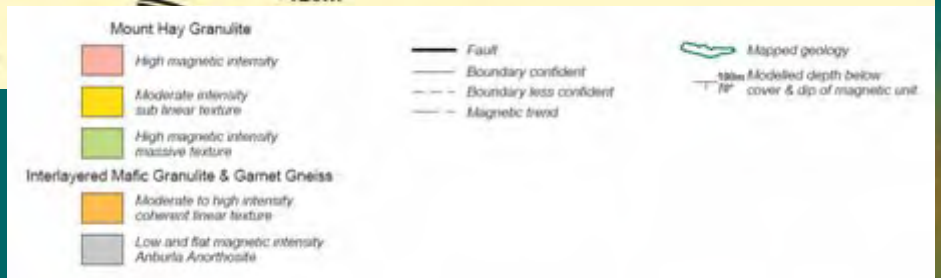
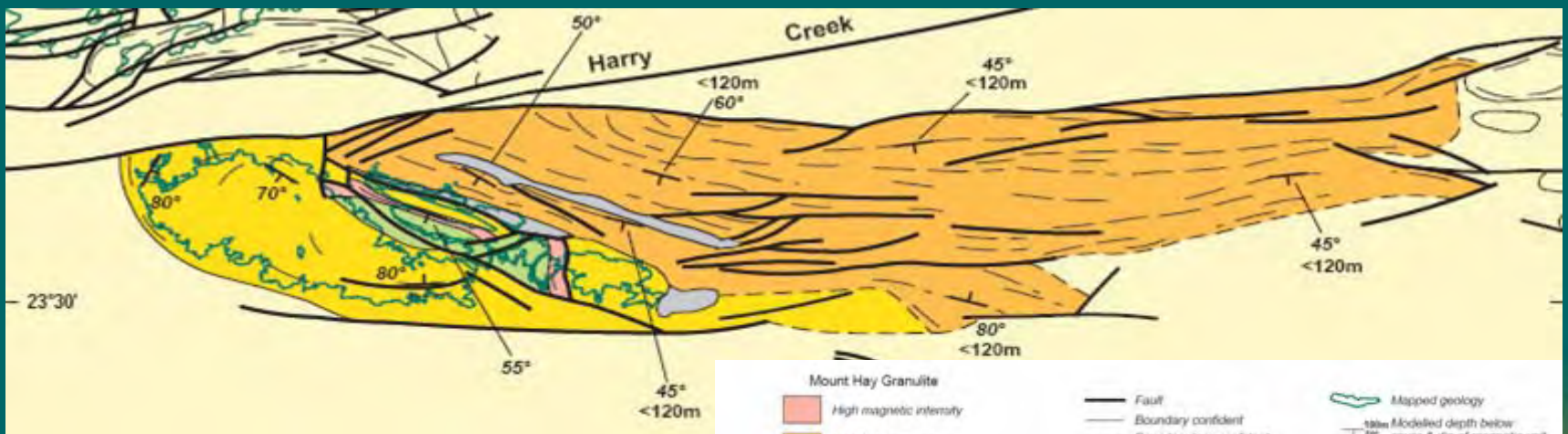
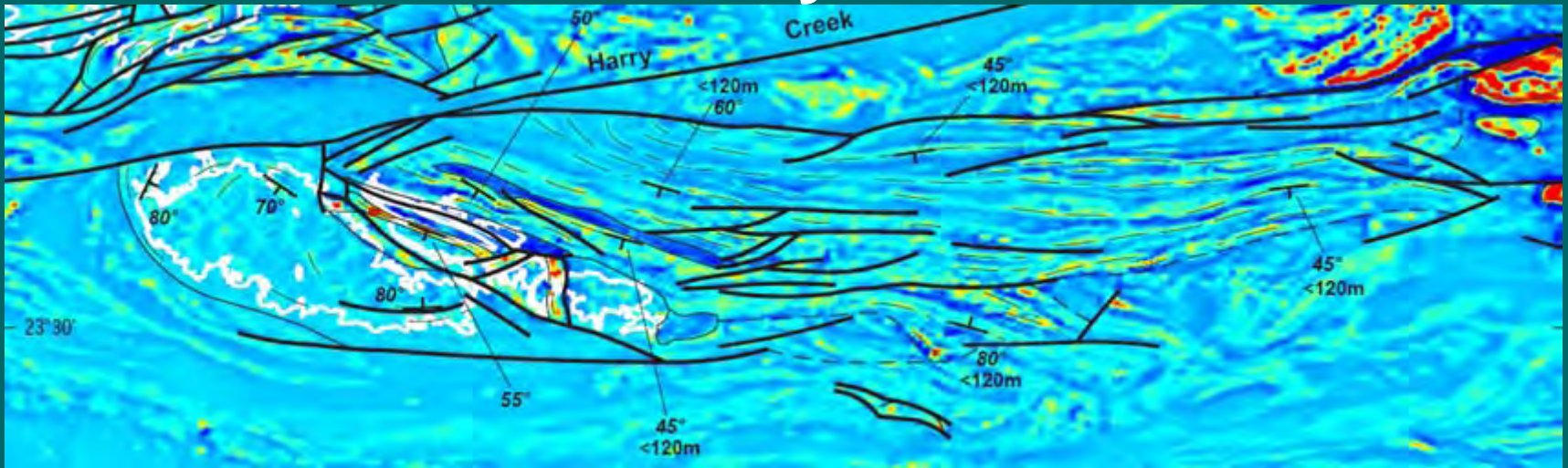
Early history of S saturation



Mount Hay Granulite



Mount Hay Granulite



Attutra Metagabbro



- Colluvium
- Coll over Attutra Metagabbro

Georgina Basin

Grant Bluff Formation

Qz arenite, greywacke

Elyuah Formation

Shale, sst, conglomerate

Attutra Metagabbro intrusion

Gabbro, pyroxenite, magnetite lenses

Bonya Schist

Metapelite, metapsammite, calc-silicate rock

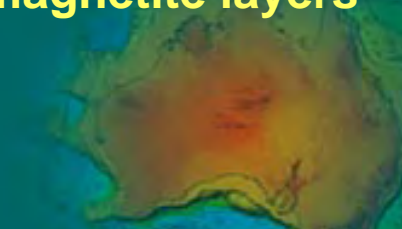
Relatively homogeneous weakly recrystallised metagabbro

Preservation of original igneous textures

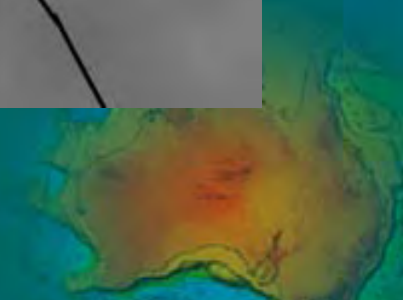
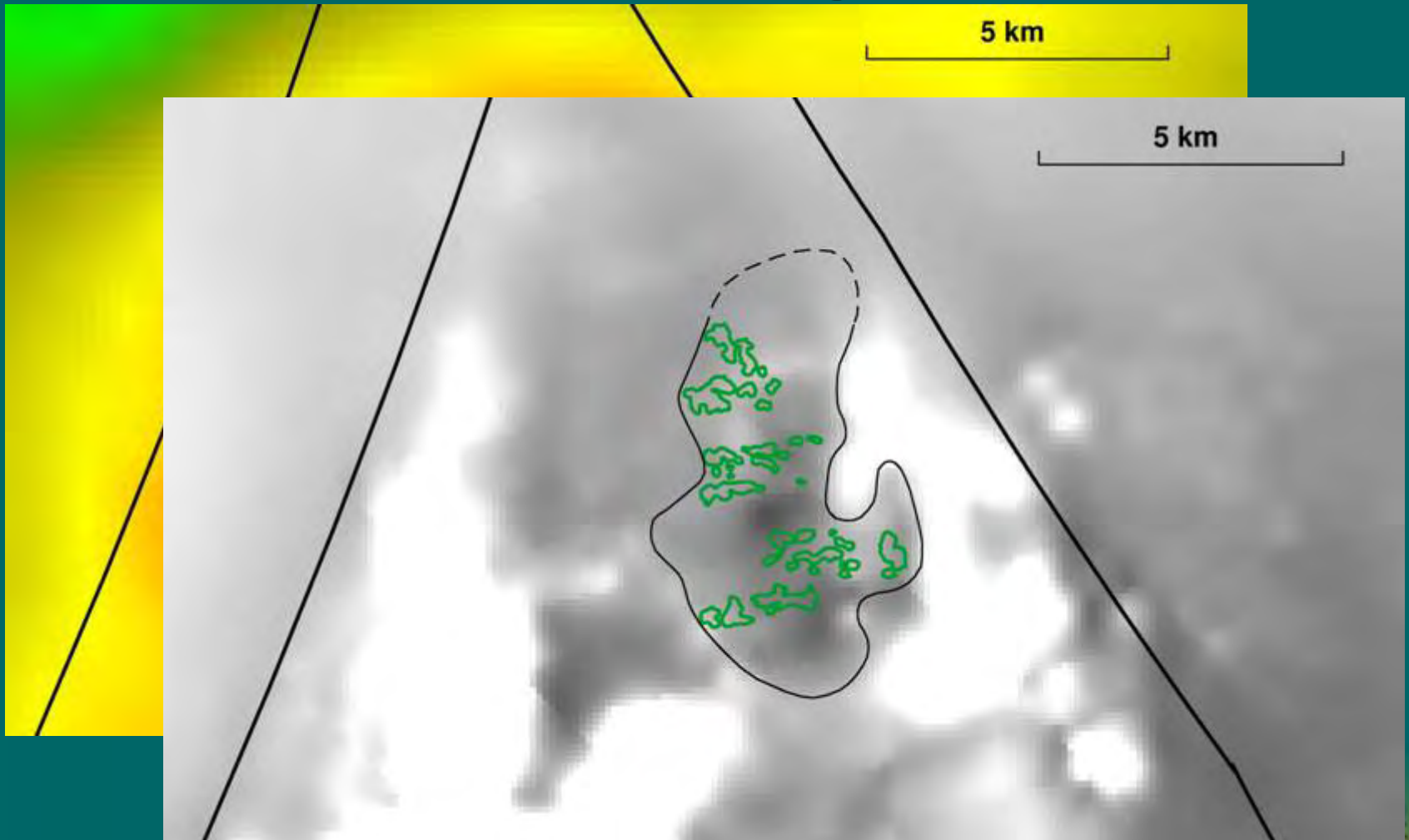
1786.4 ± 4.2 Ma

S undersaturated

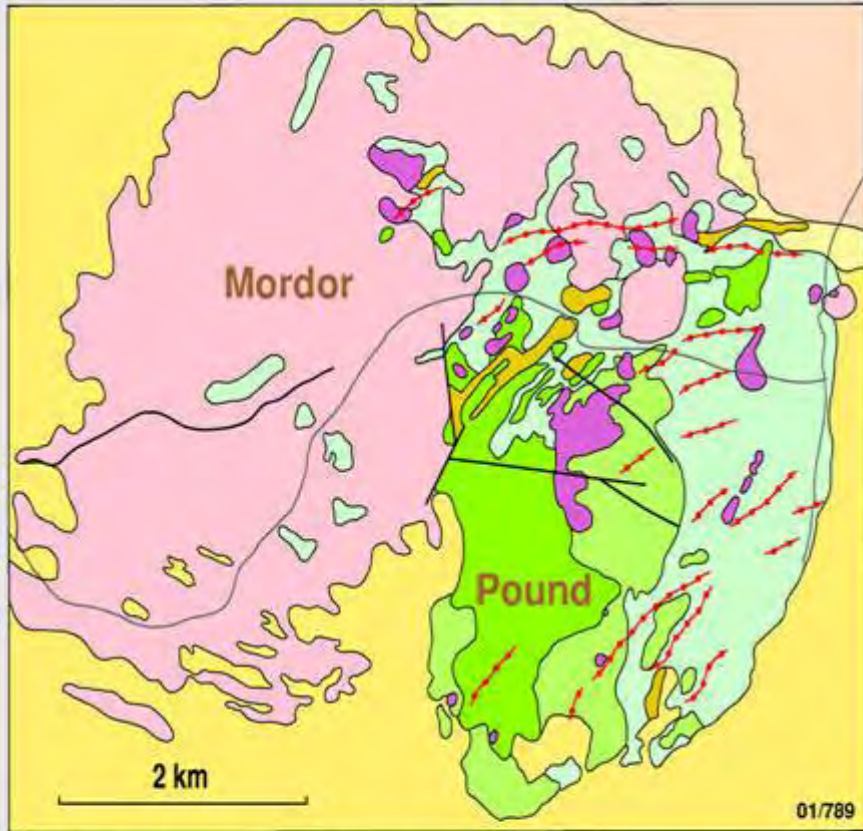
PGE-bearing magnetite layers



Attutra Metagabbro



Mordor Complex



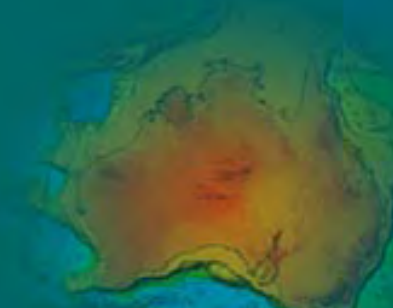
- Mordor Igneous Complex**
- Phlogopite pyroxenite, lherzolite, wehrlite*
 - Pyroxenite, shonkinite*
 - Monzonite*
 - Syenite*
 - Schist, gneiss, amphibolite*

Undeformed composite plug-like body

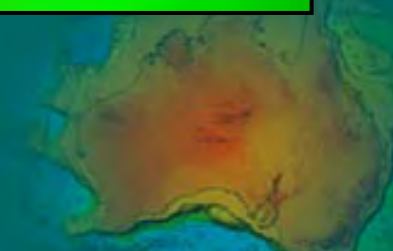
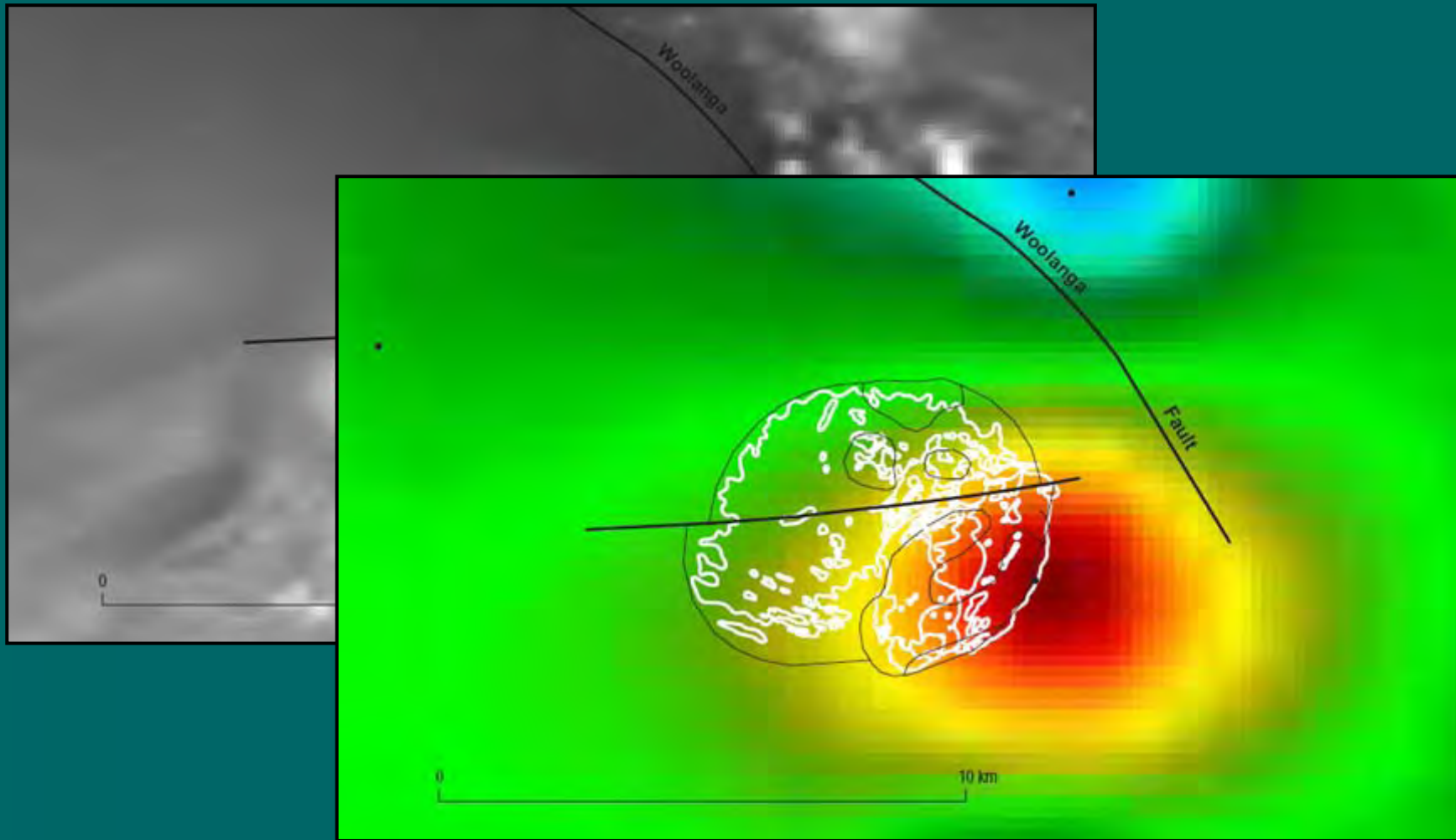
1133 ± 5 Ma

PGE-bearing sulphide mineralisation

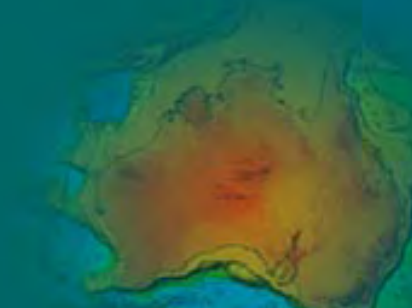
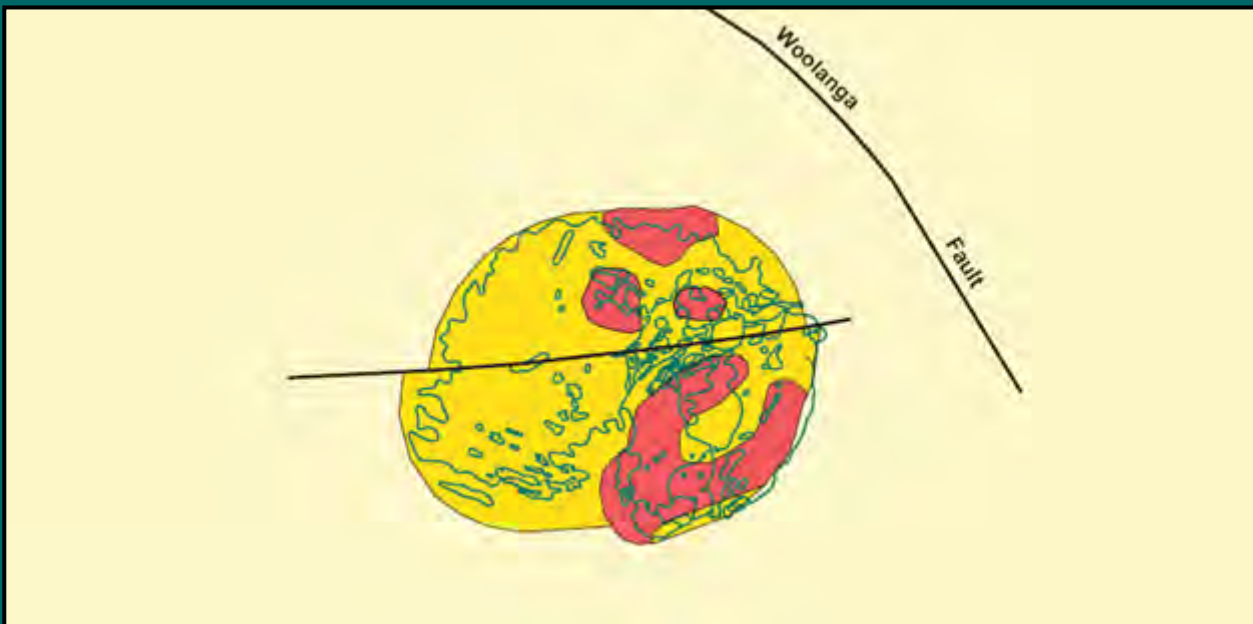
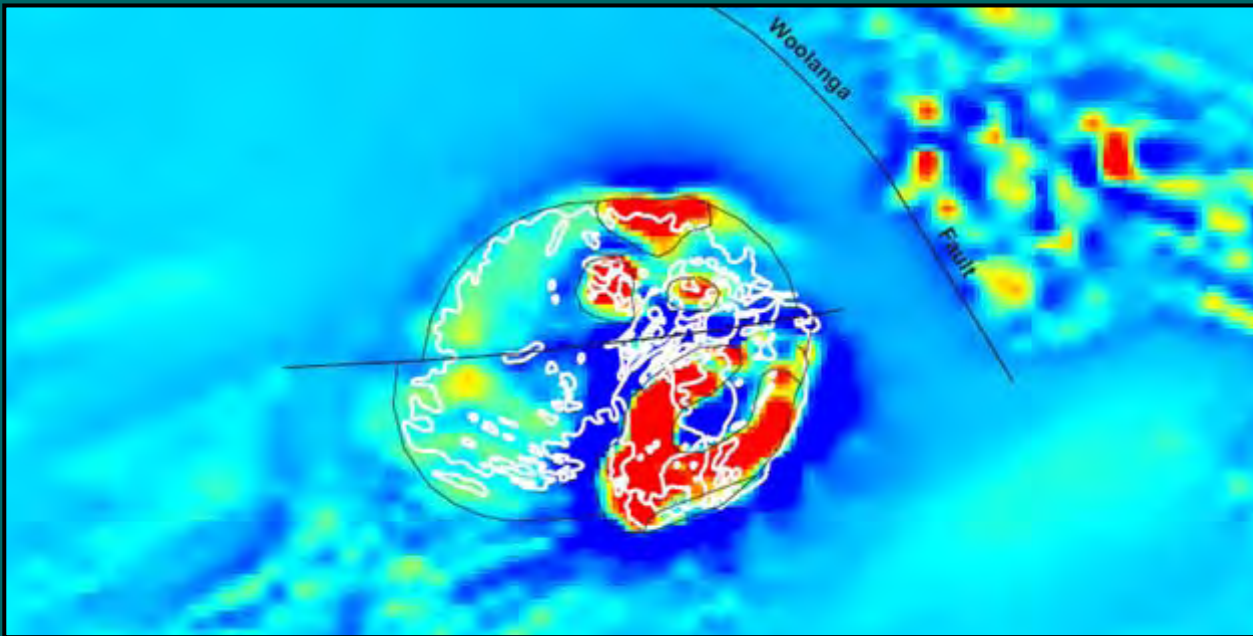
- Alluvium over MIC*
- Pegmatite*
- Heavitree Quartzite*
- Quartzite, sandstone*



Mordor Complex



Mordor Complex



Summary of geophysical signatures

- Intrusions coincident with high gravity anomalies
- Intrusions generally have medium to high magnetic anomalies
- Magnetic signatures are dependant on metamorphic grade and post emplacement deformation history

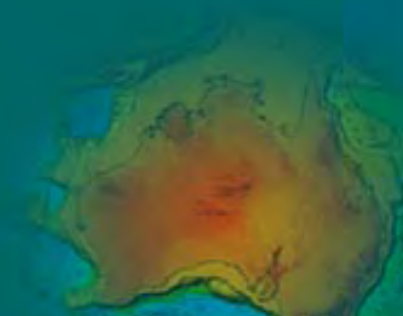
Low grade: readily differentiated from country rock
primary igneous features

Andrew Young Hills (macroscopic layering)

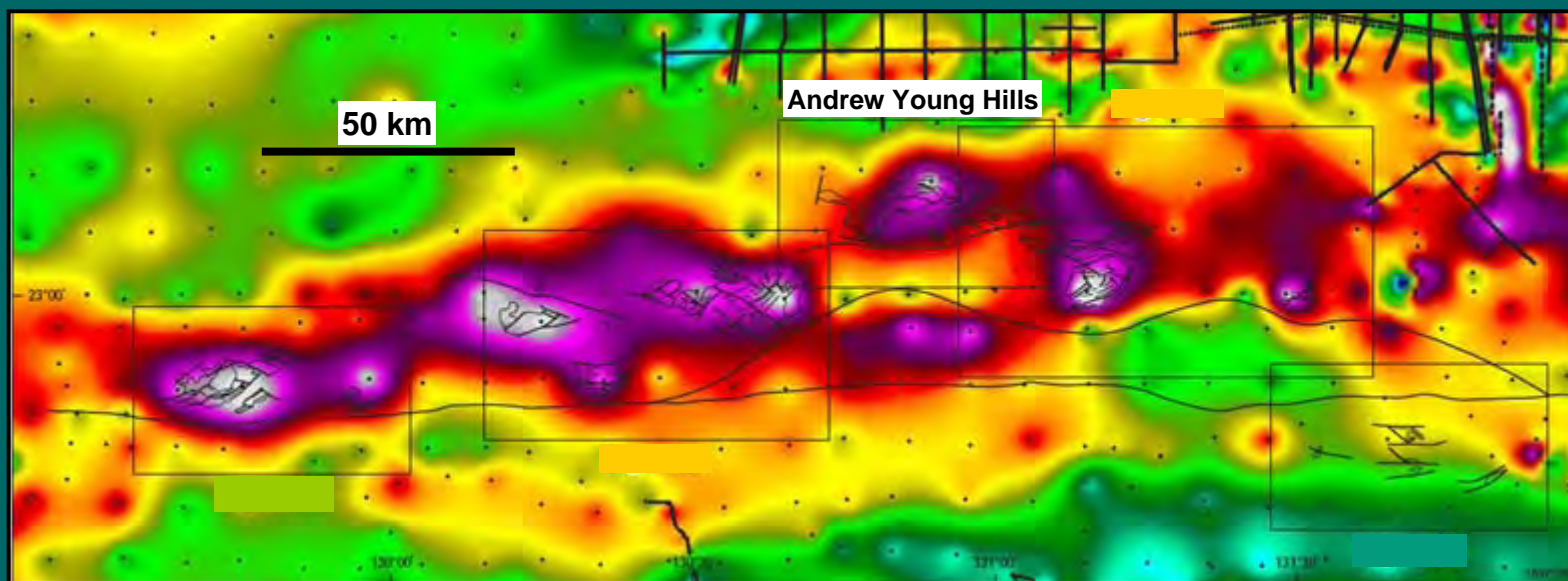
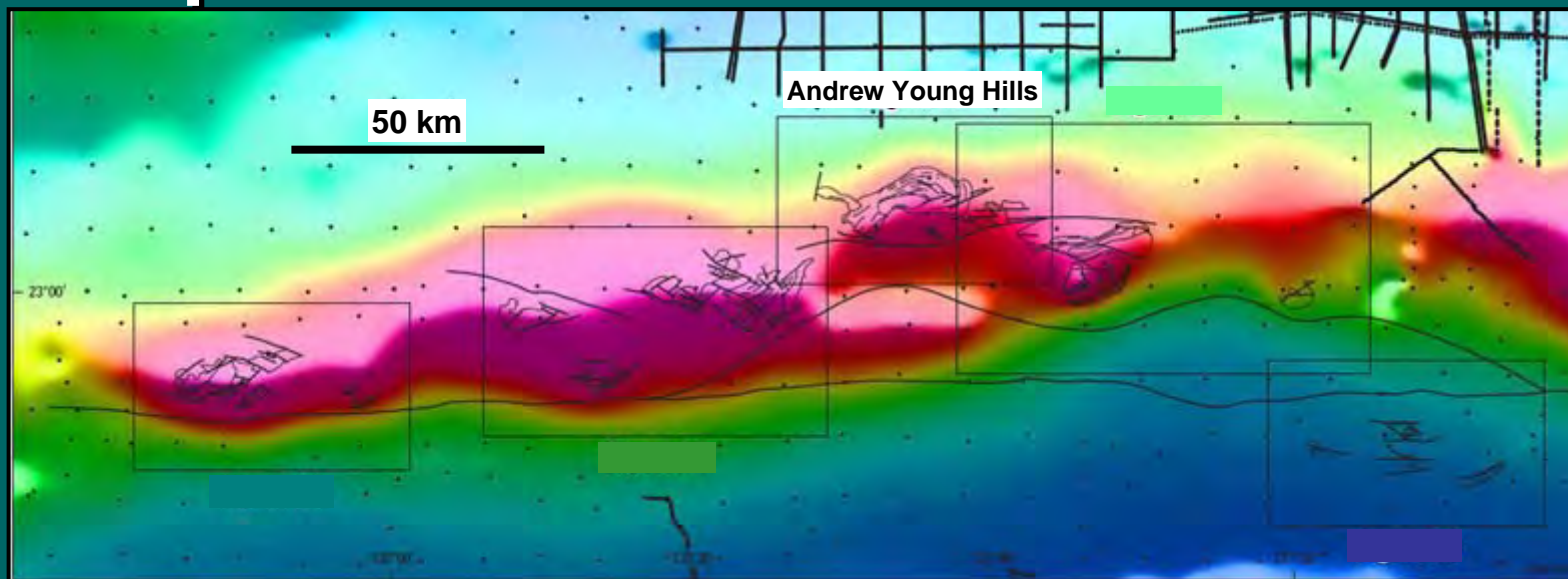
Mordor Complex (composition differences)

High grade: not so easy to differentiate from country rock
variable magnetic signatures are the result of deformation
processes

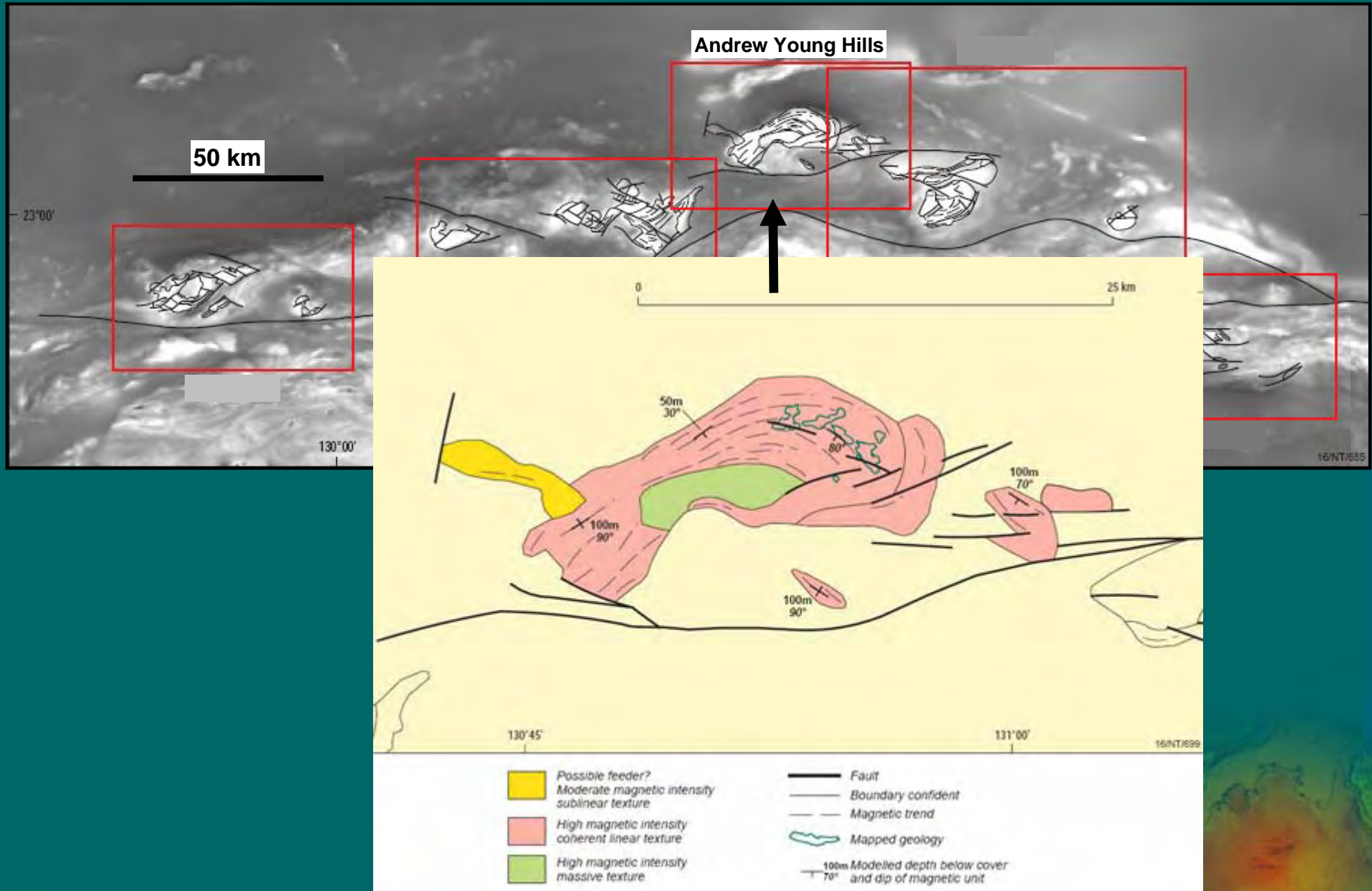
Exception: Mount Hay Granulite - high grade, exhibits
macroscopic layering



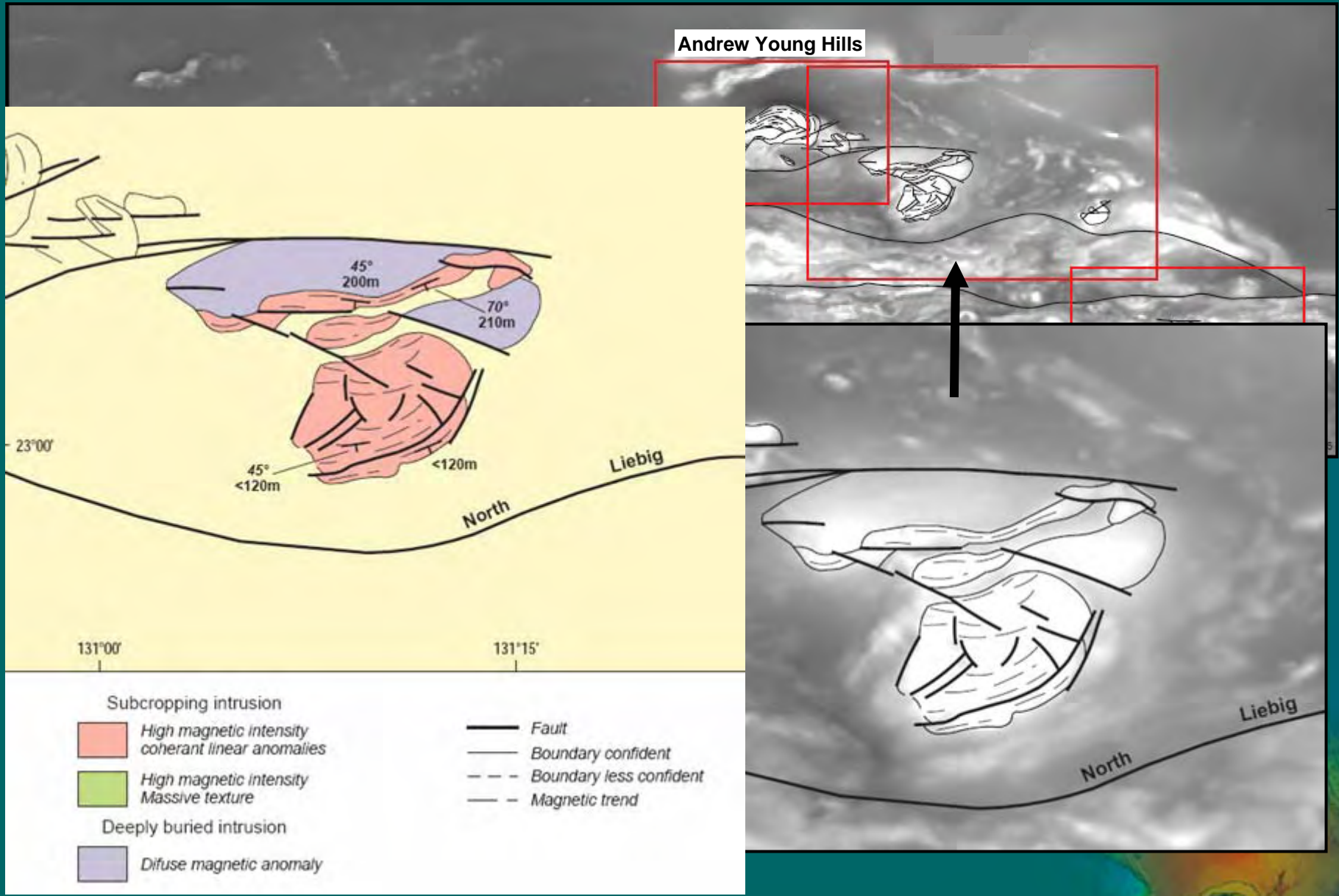
Interpreted mafic-ultramafic intrusions



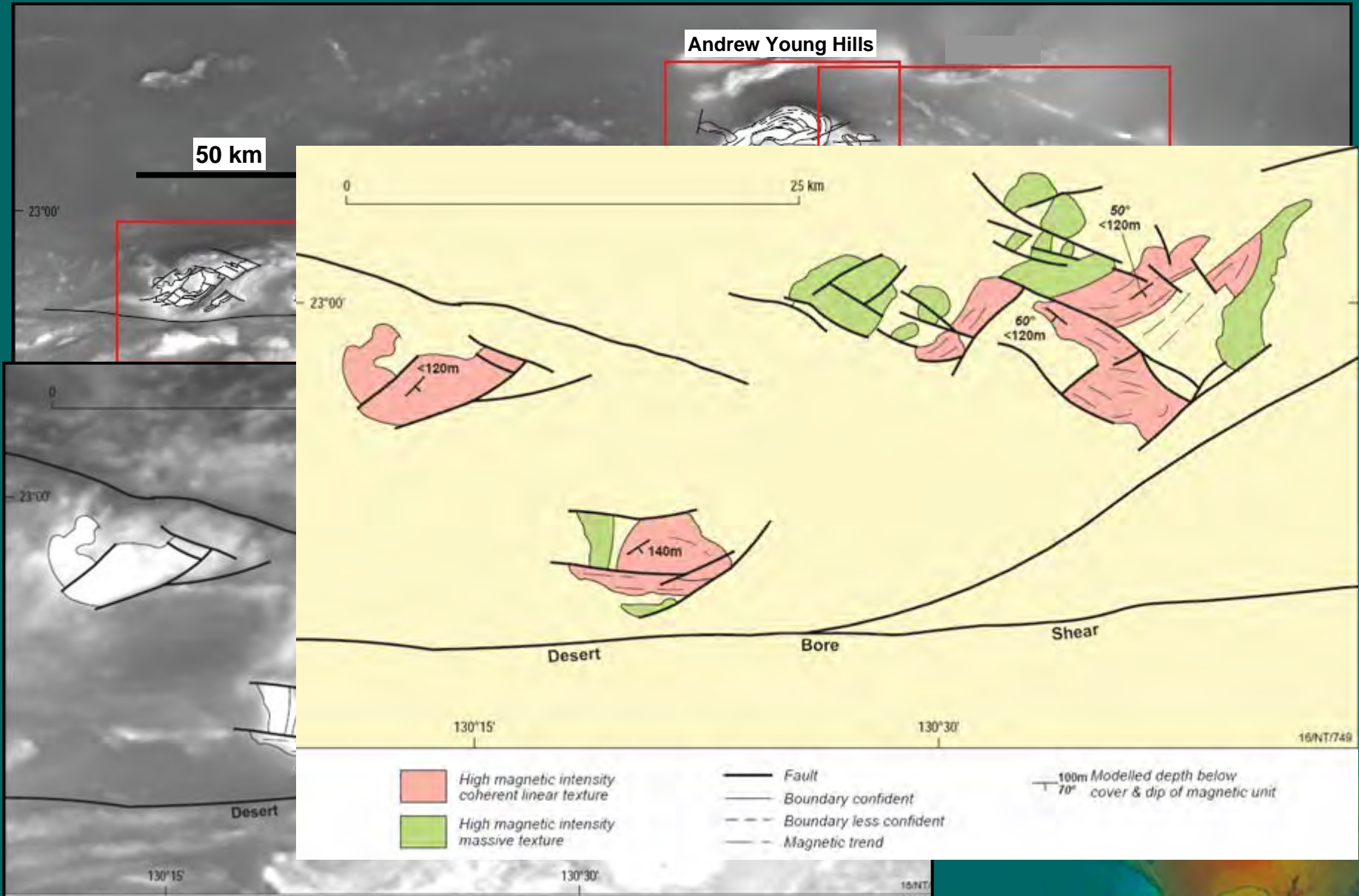
Interpreted mafic-ultramafic intrusions



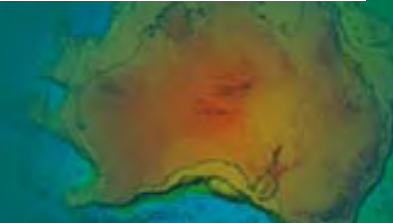
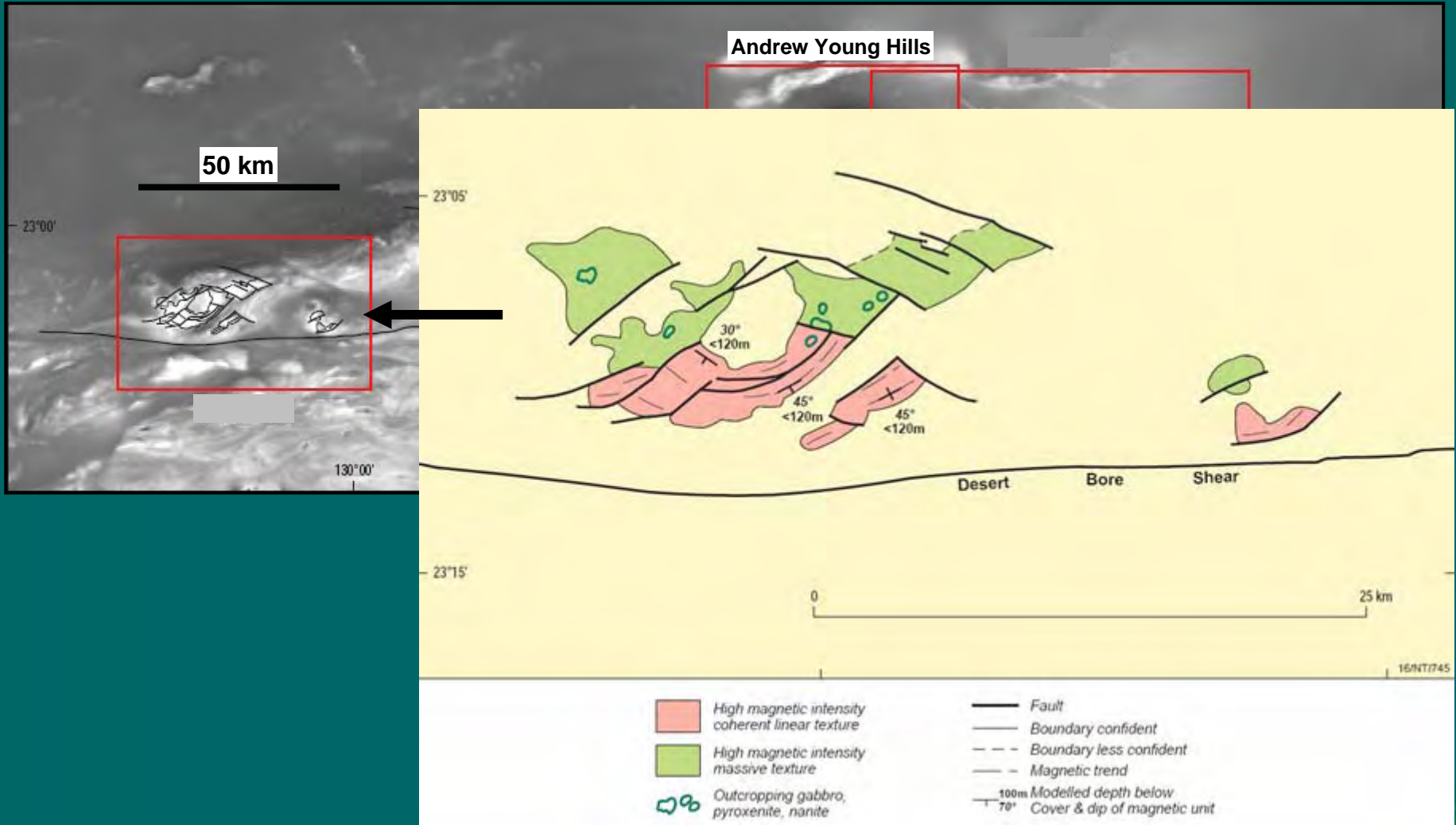
Interpreted mafic-ultramafic intrusions



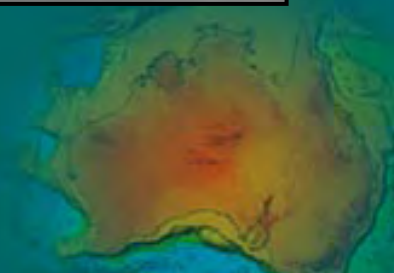
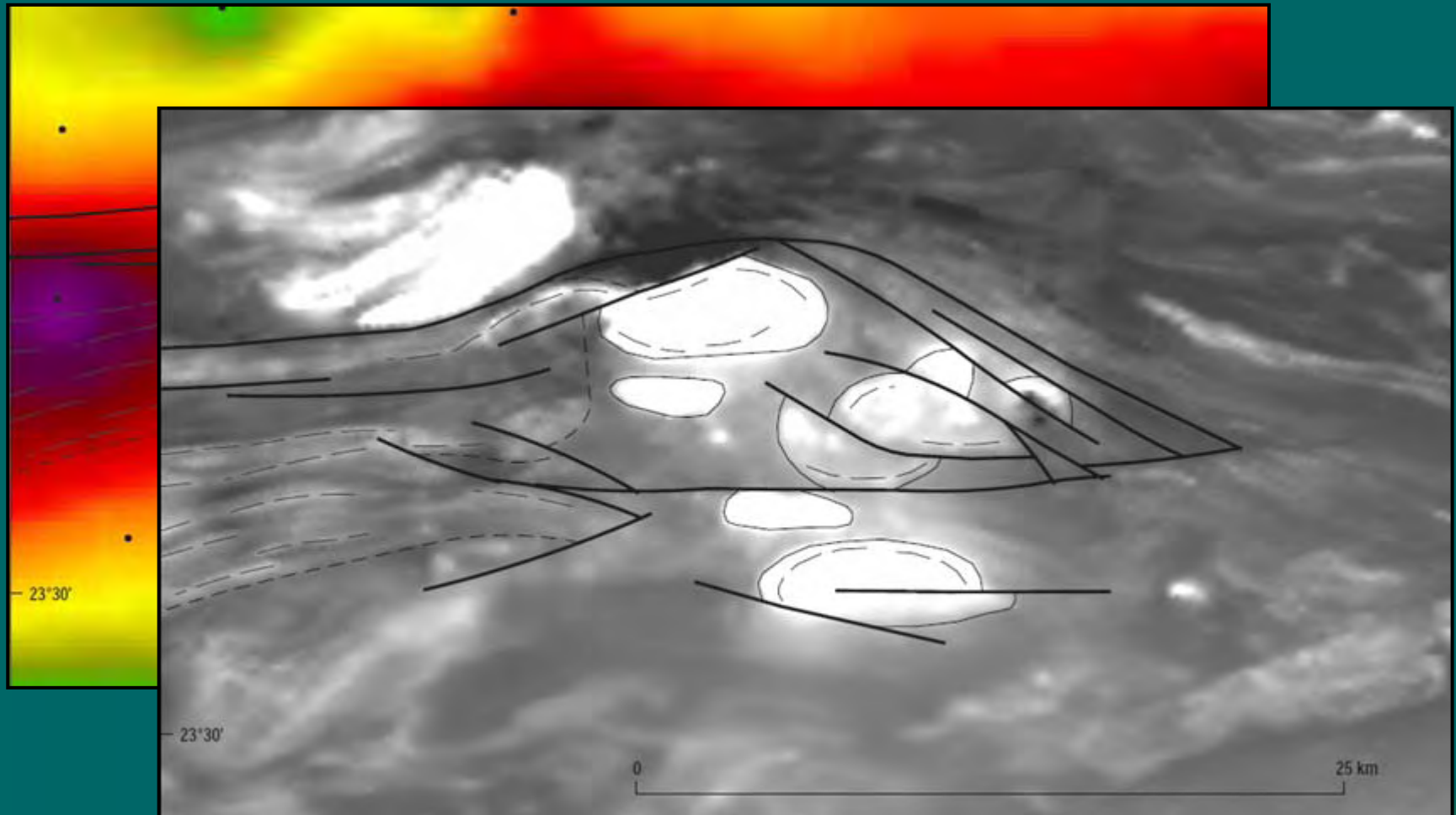
Interpreted mafic-ultramafic intrusions



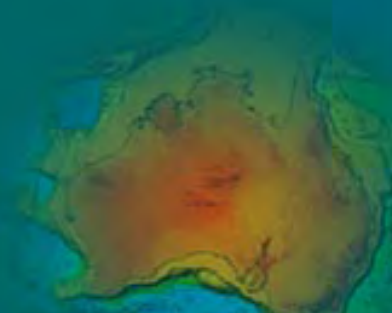
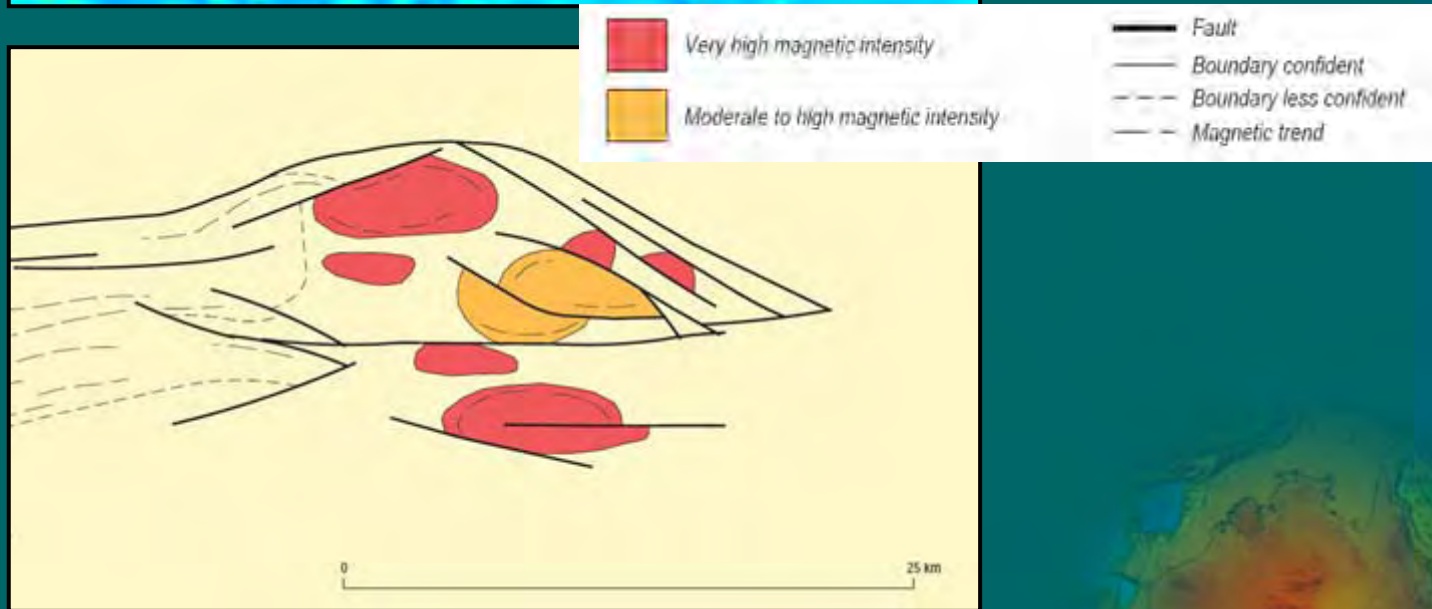
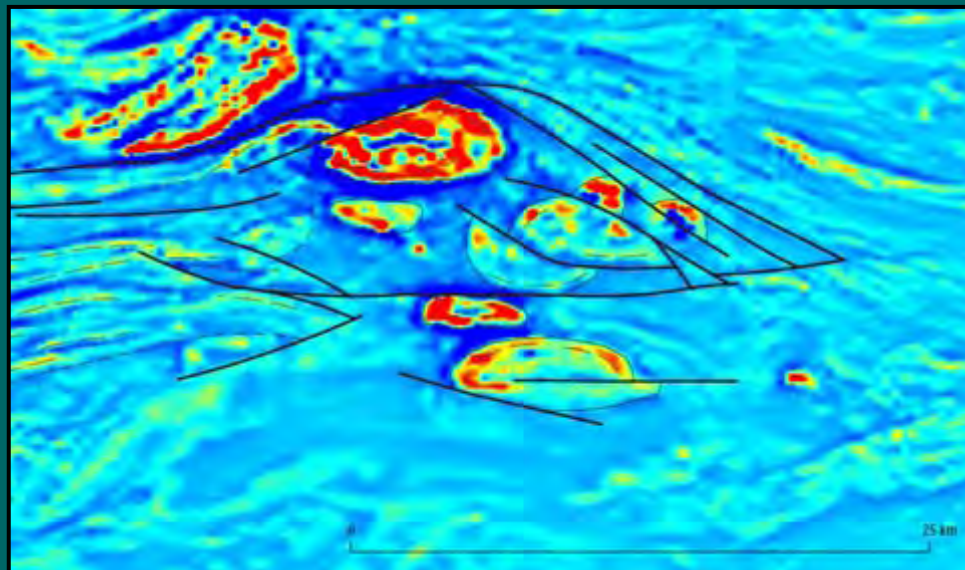
Interpreted mafic-ultramafic intrusions



Interpreted mafic-ultramafic intrusions



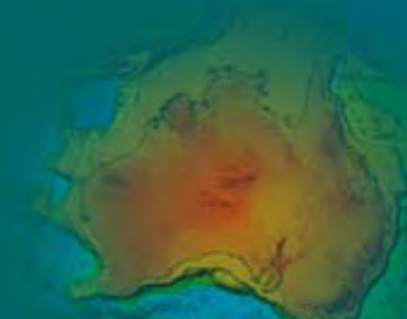
Interpreted mafic-ultramafic intrusions



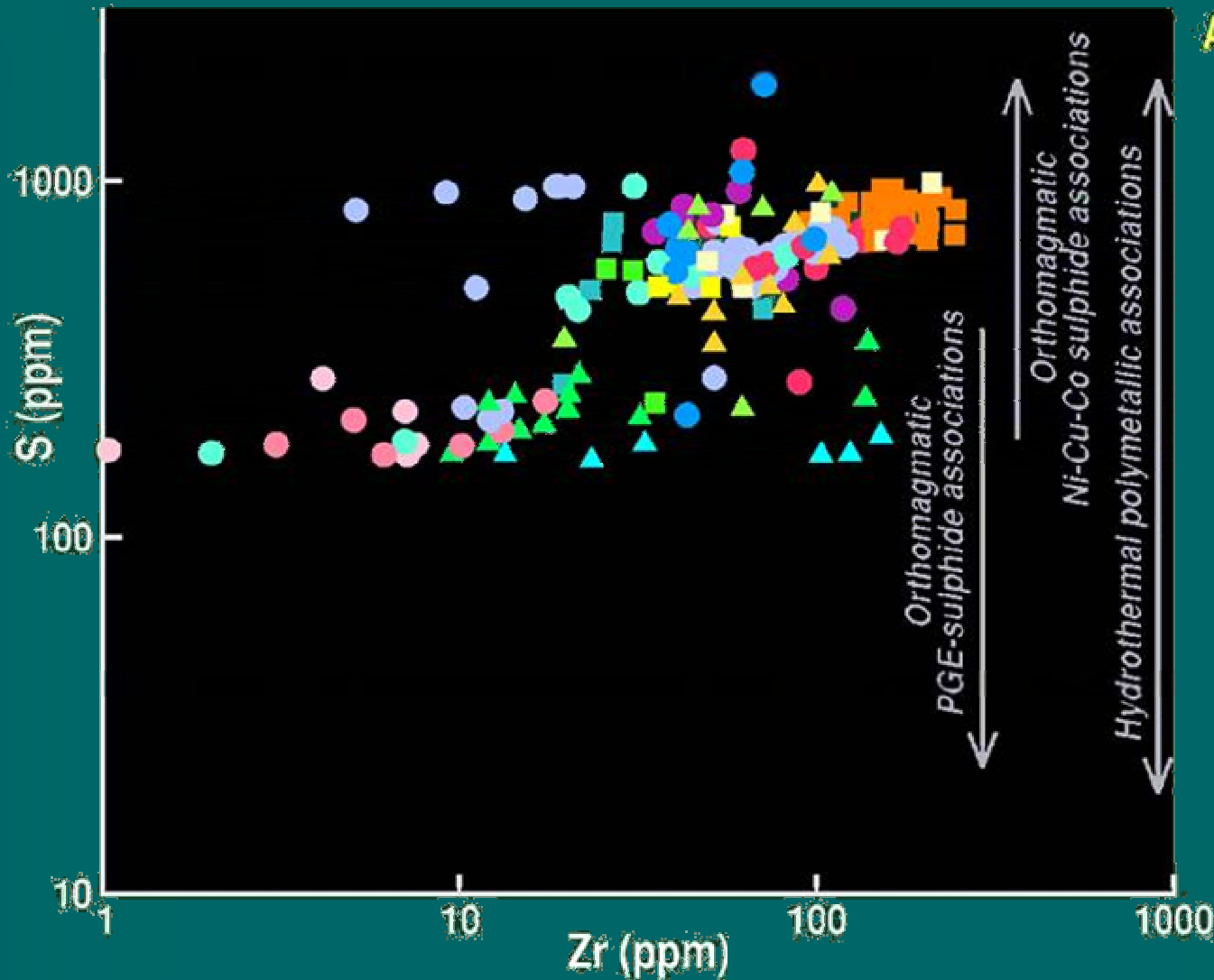
Relationships with crustal events

Crustal Events (~Ma)	Stafford 1805	Yambah 1780	Strangways 1740-1690	Liebig 1635	Teapot 1140
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Mordor Complex					1133±5
Andrew Young Hills				1633±3	
South Papunya gabbro				1635±5	
Papunya gabbro				1637±2	
Papunya ultramafic				1639±2	
Harry Anorthosite					
Gabbro		1787±3	1685±20		
Mt Chapple					
Metamorphics		1774±2		complex history	
Attutra Metagabbro		1786±4			
Johannsen					
Metagabbro	1805±3		1697±7		
Mt Hay Granulite	1803±5		1700±17		
Enbra Granulite	1811±3		1685±11		



S saturation



ARUNTA INTRUSIONS

WESTERN GROUP

- Andrew Young Hills
- Papunya gabbro
- Papunya ultramafic
- Sth Papunya gabbro
- W Papunya gabbro

CENTRAL GROUP

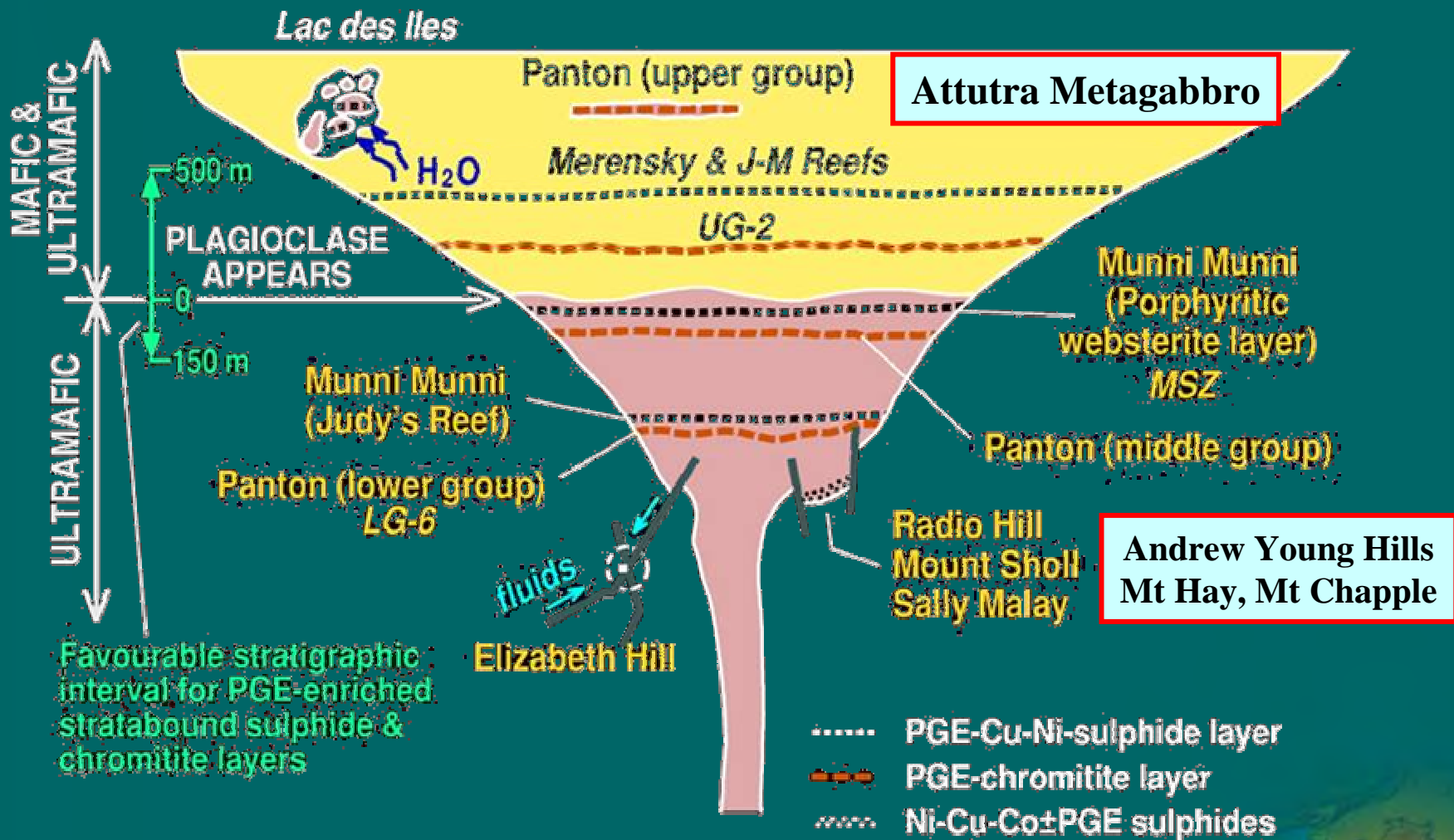
- Anburla Anorthosite
- Enbra Granulite
- Harry Anorth. Gabbro
- Johannsen Metagab.
- Mt Chapple Metam.
- Mt Hay Granulite
- Mt Stafford dolerite

EASTERN GROUP

- Attutra Metagabbro
- Kanandra Granulite
- Mordor Compl.
- Riddock Amphibolite



Potential settings for mineralisation in Arunta intrusions

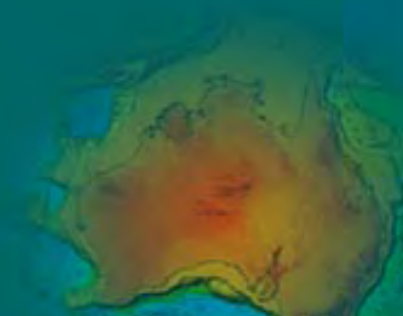


Mineral potential modelling

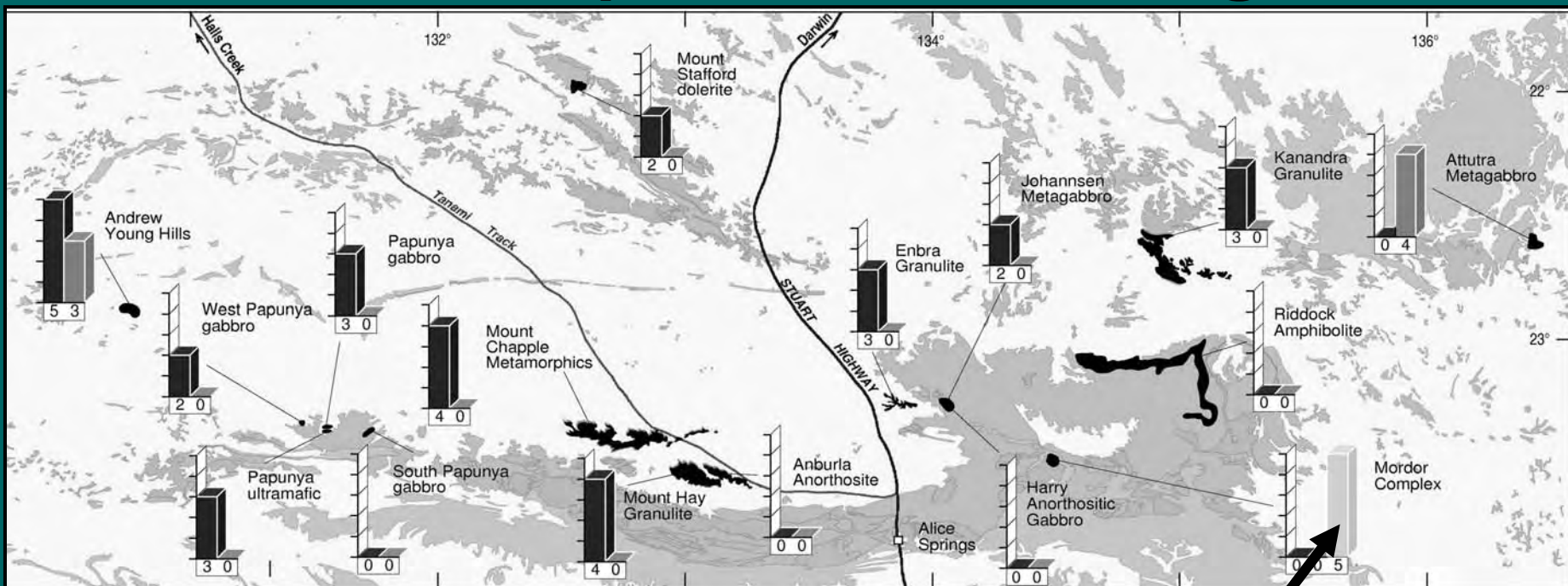
Knowledge driven qualitative method applied to rank the mafic-ultramafic intrusions with their probability to host Ni-Cu-Co±PGE mineralisation

Three types of orthomagmatic deposits:

1. Basal segregations of Ni-Cu-Co±PGE sulphides in mafic-ultramafic intrusions (Voisey's Bay type deposits)
2. Stratabound PGE-bearing sulphide layers in large layered mafic-ultramafic intrusions (Merensky Reef type deposits)
3. Stratabound PGE-bearing sulphide layers in alkaline-ultramafic intrusions (Alaskan type deposits)



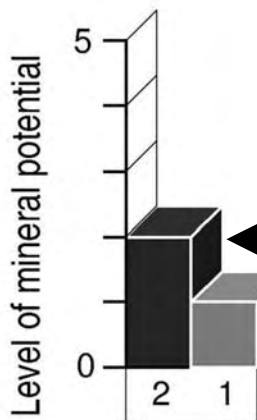
Mineral potential modelling



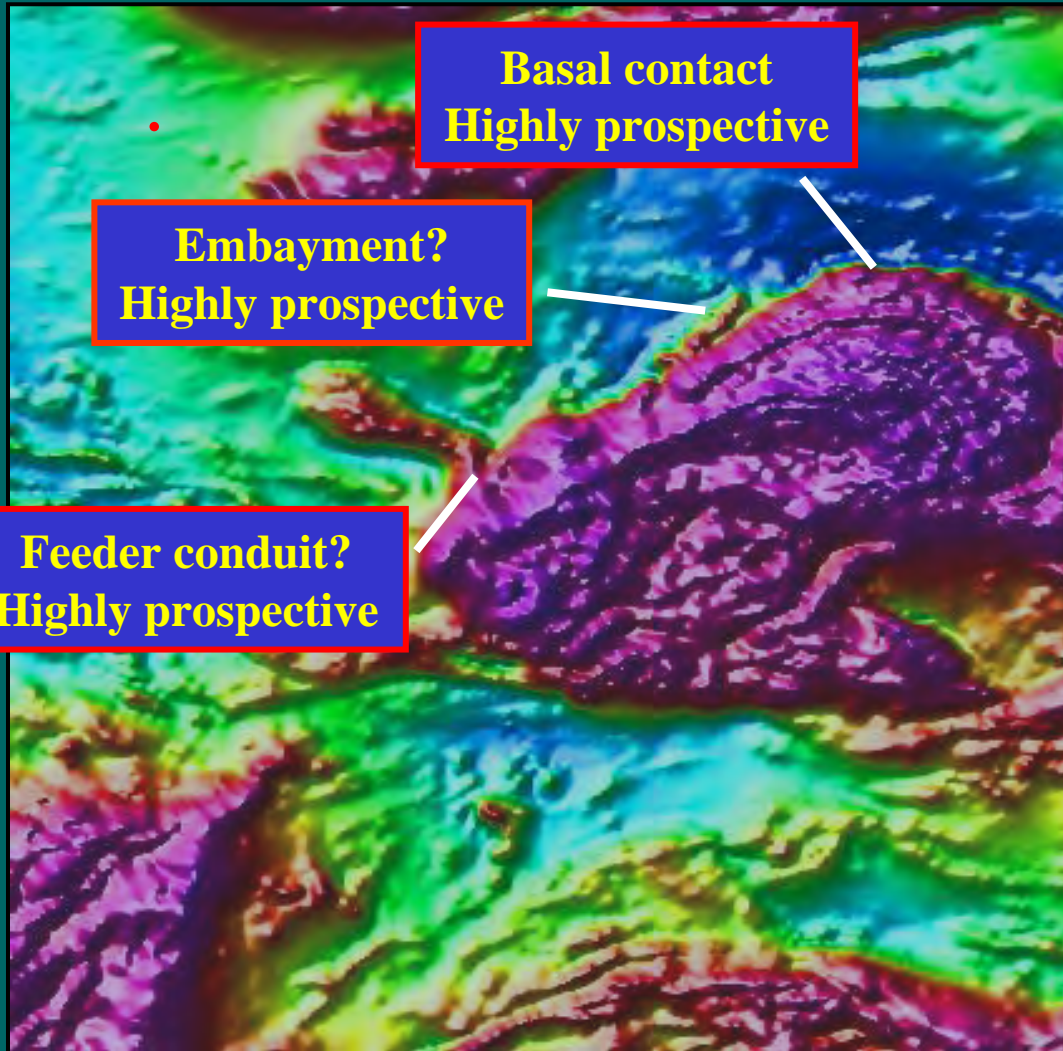
Stratabound PGE bearing sulphide layers in alkaline-ultramafic intrusions (Alaskan type)

Basal segregations of Ni-Cu-Co ± PGE sulphides (Voisey Bay type)

Stratabound PGE bearing sulphide layers in mafic-ultramafic intrusions (Merenski Reef type)



Favourable mineralised environments



Basal Ni-Cu-Co \pm PGE sulphides

- Ni bearing magmas
- Rapid S saturation by magma contamination with country rock
- Massive sulphides hosted by thin basal gabbroic rock
- Massive sulphides confined to
 - basal contact with feeder conduit
 - structural embayments
 - base of thickest sequences of cumulates

Geophysics (magnetics)

- Define intrusion geometry
- Determine younging direction
- Locate favourable mineralised environments

Geophysics (airborne and ground electromagnetics and induced polarisation)

- Delineate conductive sulphides

References

Journal papers

- Hoatson D. M., Sun S -s. & Claoué-Long J. C. 2005. Proterozoic mafic-ultramafic intrusions in the Arunta Region, central Australia. Part 1: geological setting and mineral potential. *Precambrian Research* 142, 93-133.
- Claoué-Long J. C. & Hoatson D. M. 2005. Proterozoic mafic-ultramafic intrusions in the Arunta Region, central Australia. Part 2: Event chronology and regional correlations. *Precambrian Research* 142, 134-158.

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- Hoatson D. M. & Stewart A. 2001. Field investigations of Proterozoic mafic-ultramafic intrusions in the Arunta Province, central Australia. *Geoscience Australia Record* 2001/395.
- Meixner A. J. & Hoatson D. M. 2004. Geophysical interpretation of Proterozoic mafic-ultramafic intrusions in the Arunta Region, central Australia. *Geoscience Australia Record* 2003/29.
- Mieзитis Y. & Jaireth S. & Hoatson D. M. 2006. Mineral potential modelling of Proterozoic mafic-ultramafic complexes in the Arunta Region, central Australia. *Geoscience Australia Record* 2006/14.

