3D Geological Model
and Geophysical Investigation
of the Yilgarn-Officer-Musgrave Region

James Goodwin, Tim Jones, Terry Brennan and Malcolm Nicoll
Aims

1. Compare the 11GA-YO1 seismic interpretation with gravity and magnetic data
   a) Interpretation of data grids
   b) Forward modelling
   c) 3D inversion

2. Produce a 3D geological model of the area surrounding 11GA-YO1
Isostatic Residual Gravity

- Musgrave Province
- Officer Basin
- Yamarna Terrane
- Canning Basin
- Amadeus Basin
Forward Modelling 11GA-YO1

*All density values displayed are g/cm$^3$*

- Observed
- Calculated

Gravity (mGal)

- Officer Basin 2.40
- Salt 2.35
- Bentley Supergroup 2.80
- Pitjantjatjarra Supersuite

- Upper Mantle 3.31
- Crust 2.83
- Tikelmungula 3.00
- Babool 2.76
- 2.73
- 2.73
- 2.75
- 2.92
- 2.75
- 2.75
- 2.75
- 2.75
- 2.75
- 2.65
- 2.90
- 2.90

- All density values displayed are g/cm$^3$
Surface Geology

**TMI RTP (nT)**

**Bentley Supergroup**

**Kunmarnara Group**
(Granulite facies, mafic granulite, gneiss, granite)

**Tjauwata Group**
(deformed sediments and bimodal volcanics)

**Giles Suite**
(Gabbro, mafic-ultramafic intrusion)

**Gravity**

**Mitika Fault**

**Woodroffe Thrust**

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Forward Modelling 11GA-YO1

- Officer Basin 2.40
- Salt 2.35
- Bentley Supergroup 2.80
- Pijantjarra Supersuite 2.65
- Tikelmungulda 3.00
- Upper Mantle 3.31

*All density values displayed are g/cm³
Bentley Supergroup
Kunmarnara (Granulite Facies, Mafic granulite, gneiss, granite)

Giles Suite
(Gabbro, mafic-ultramafic intrusion)

Upper Mount Palgrave Group
(rhyolite)

Winburn Granite

Mount Palgrave

Pussycat

Cassidy

Mission

Magnetic Intensity RTP
TMI RTP (nT)

Gravity
Forward Modelling 11GA-YO1

*All density values displayed are g/cm³

Gravity (mGal)

Officer Basin 2.40
Salt 2.35
Bentley Supergroup 2.80
Pitjantjatjarra Supersuite 2.65
Upper Mantle 3.31

Giles Suite gabbros/ultramafics

2.76
2.75
2.75
2.92
3.00
2.90
2.90
2.78
Surface Geology

Magnetic Intensity RTP

Gravity

Salt diapir

TMI RTP (nT)

Bouguer Gravity (mGal)

78.0
-113.8

Intensity

Saturation

Illumination
Forward Modelling 11GA-YO1

*All density values displayed are g/cm$^3$

**Observed Data**
- Gravity Calculated
- Magnetics Calculated

[Schematic diagram showing observed data including density values for various geological features such as Winburn Granite, Pitjantjatjarra Supersuite, and the Upper Mantle.]

**Density Values**:
- Winburn Granite: 2.64
- BIF: 2.76
- Pitjantjatjarra Supersuite: 2.5 - 2.9
- Upper Mantle: 3.32

**Notes**:
- All density values are in g/cm$^3$.
Forward Modelling 11GA-YO1

*All density values displayed are g/cm$^3$*

- **Observed Data**
- **Gravity Calculated**
- **Magnetics Calculated**

**Fractionated magma chamber 2.64-2.9**

**Pitjantjatjarra Supersuite 2.5 - 2.9**

**Upper Mantle 3.32**

<table>
<thead>
<tr>
<th>Density Value</th>
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<tbody>
<tr>
<td>2.73</td>
</tr>
<tr>
<td>2.73</td>
</tr>
<tr>
<td>2.75</td>
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<tr>
<td>2.75</td>
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<tr>
<td>2.80</td>
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<tr>
<td>2.86</td>
</tr>
</tbody>
</table>

**Notes:**
- Fractionated magma chamber 2.64-2.9
- Pitjantjatjarra Supersuite 2.5 - 2.9
- Upper Mantle 3.32
- All density values displayed are g/cm$^3$
Forward Modelling 11GA-YO1

*All density values displayed are g/cm$^3$*

- Observed Data
- Gravity Calculated
- Magnetics Calculated

- Upper Mantle 3.32
- 2.81
- 2.75
- 2.72
- 2.70
- 2.74
- 2.74
- 2.75
- 2.80
- 2.86

- Pitjantjatjarra Supersuite 2.5 - 2.8
- ? Giles gabbros/mafic intrusion

- 3.00
Large Magnetic Anomaly CDP 13000-16000

- 1000 nT anomaly
- Trends in a NW-SE direction (same as Yamarna Terrane)
- NE dip inferred from anomaly gradient
Large Magnetic Anomaly CDP 13000-16000

- 1000 nT anomaly
- Trends in a NW-SE direction (same as Yamarna Terrane)
- NE dip inferred from anomaly gradient

Sphere 0.2 SI
Tabular 0.5 SI
Shallowly Dipping Slab 1.0 SI
Shallowly Dipping Slab 1.0 SI
Irregular intrusive 0.2 SI
Building a 3D Geological Model

Input Data:

Surface and Solid Geology Maps

Gravity and Magnetic Data
  a) Data interpretation
  b) Worms
  c) Forward Modelling
  d) 3D Inversion

Seismic Interpretation (11GA-YO1 and industry traverses)

Drill Holes

Magnetotellurics (MT)

AusMoho
Building up the Model
Major Blocks - Undivided

AusMoho
Crustal faults
Musgrave Province
Proterozoic basement
Yilgarn Craton
Officer Basin
Canning Basin

Preliminary Model – Province Scale
3D Inversion

Gravity or Magnetic Data

3D Geological Model

Density or Susceptibility

Inverse Modelling

Non-unique

Constraints
Summary

Interpretation

• Gabbros and mafic-ultramafic intrusions of the Giles Suite correlate well with the largest gravity anomalies across the Musgrave Province

• Extent of salt within Officer Basin estimated from gravity and magnetic data

• Large NE dipping magnetic high between CDP 13000-16000 modelled as BIF/mafics within Yamarna Terrane

Preliminary 3D Geological Model

• Regional scale fault architecture defined
  • Woodroffe, Mitika and Winduldarra faults

• Officer Basin depth and extent well defined by seismic and drill hole data

• 3D inversion will be used to test and improve the 3D geological model
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   Richard Chopping
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Multi-scale Edge Detection (Worms)

(Upward Continuation Level)

Dipping Contact

40°
Gravity Worms

Gravity Worms

Continuation Height (m)

64786
46276
33054
23610
16864
12046
8604
6146
4390
3136
2240
1600

Officer-Musgrave contact
SW dipping

SW dipping

East dipping
Magnetic Worms

Continuation Height (m)

- 64786
- 46276
- 33054
- 23610
- 16864
- 12046
- 8604
- 6146
- 4390
- 3136
Seismic Interpretation and Drill Holes

Model Extent

- Officer_Basin_wells
- 10GA_YO1_487kms
- wa_land_seismic_gda94
- 10GA_YU1_v2_s-n_mga50
- 10GA_YU2_v2_e-w_mga50
Large Magnetic Anomaly