The Contribution of Magnetite to the Chargeability Response of the Centenary Orebody

July 2006
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Introduction

• The magnetic dolerite hosting the Centenary deposit is known to have a chargeability response, while the same magnetic dolerite not hosting mineralisation is not chargeable.

• The properties of magnetite which make it chargeable are not known.
Centenary Deposit

Darlot Pit

The Gap Prospect

Centenary Deposit
Petrophysics

• Measurements were taken of the mineralised dolerite and surrounding lithologies

• The mineralised (magnetic) dolerite is anomalously chargeable

• The non-mineralised magnetic dolerite is also significantly more chargeable than the non-magnetic dolerite

• No other physical property distinguishes mineralisation from background

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Chargeability (mV/V)</th>
<th>Resistivity (Ωm)</th>
<th>Density (g/cc)</th>
<th>Mag Susceptibility (SIx10^-3)</th>
<th>Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary Hardpan</td>
<td>5.1</td>
<td>34.0</td>
<td>1.94</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Pisolitic Laterite</td>
<td>14.5</td>
<td>22.0</td>
<td>2.73</td>
<td>13.80</td>
<td>1</td>
</tr>
<tr>
<td>Residual Clay/Saprolite</td>
<td>6.9</td>
<td>110.0</td>
<td>1.75</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Feitic Volcanic</td>
<td>2.3</td>
<td>5513.3</td>
<td>2.74</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Basalt</td>
<td>1.7</td>
<td>5006.7</td>
<td>2.91</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Dolerite</td>
<td>3.3</td>
<td>3985.0</td>
<td>2.91</td>
<td>1.36</td>
<td>5</td>
</tr>
<tr>
<td>Pyritic Dolerite</td>
<td>4.6</td>
<td>3660.0</td>
<td>3.08</td>
<td>0.60</td>
<td>1</td>
</tr>
<tr>
<td>Magnetic Dolerite</td>
<td>17.0</td>
<td>3886.8</td>
<td>2.94</td>
<td>68.62</td>
<td>13</td>
</tr>
<tr>
<td>Mineralised Dolerite</td>
<td>34.7</td>
<td>3129.5</td>
<td>2.99</td>
<td>64.71</td>
<td>27</td>
</tr>
<tr>
<td>Lamprophyre</td>
<td>3.6</td>
<td>3600.0</td>
<td>2.81</td>
<td>3.05</td>
<td>3</td>
</tr>
</tbody>
</table>
**Petrophysics**

- The magnetic dolerite hosting mineralisation is chargeable.
- The magnetic dolerite away from mineralisation is not chargeable. This could be solely due to disseminated sulphides.

<table>
<thead>
<tr>
<th>Location</th>
<th>Count</th>
<th>Density (g/cc)</th>
<th>IP (mV/V)</th>
<th>Mag Susc (SIx10^-3)</th>
<th>Resistivity</th>
<th>Percentage Magnetite</th>
<th>Percentage Pyrite</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCAL</td>
<td>24</td>
<td>2.98</td>
<td>71</td>
<td>69</td>
<td>3431</td>
<td>9.8</td>
<td>6.8</td>
</tr>
<tr>
<td>REGIONAL</td>
<td>11</td>
<td>2.93</td>
<td>36</td>
<td>72</td>
<td>3448</td>
<td>9.7</td>
<td>0.3</td>
</tr>
</tbody>
</table>

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- The magnetic dolerite away from mineralisation is not chargeable.
- This could be solely due to disseminated sulphides.
Aeromagnetics

- 20m terrain clearance and 25m line spacing
- Magnetic highs trace the magnetic portion of the Mt Pickering dolerite
- Surface projection of Centenary shown in white
- Stations 160m x 40m
- Orebody not visible in the data
- Gravity high coincides with outcropping magnetic dolerite
- Surface projection of Centenary shown in white
Down Hole IP and Resistivity

- Dipole spacing 20m
- Destruction of magnetite coincident with mineralisation
- Chargeability response offset from mineralisation (shallower)
Down Hole IP and Resistivity

- Dipole spacing 20m
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Induced Polarisation and Resistivity

Observed field data
Forward Model Induced Polarisation
Inverse Model IP And Resistivity

Smooth-model Resistivity (ohm-m)

Calculated Apparent Resistivity (ohm-m)

Observed Apparent Resistivity (ohm-m)

Smooth-model IP (mrad)

Calculated IP Response (mrad)

Observed IP Response (mrad)
Laboratory Measurements

• Thin sections were made of mineralised and unmineralised magnetic dolerite samples
• Grain size and percentage of both magnetite and pyrite was estimated
• These measurements were correlated with physical properties
Petrophysics
Petrophysics

![Graph showing the relationship between IP (mV/V) and Magnetic Susceptibility (SI x 10^-3) for different grain sizes of Magnetite.](Image)

- **IP (mV/V)**
- **Magnetic Susceptibility (SI x 10^-3)**

<table>
<thead>
<tr>
<th>Grain Size (mm)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Purple</td>
</tr>
<tr>
<td>1</td>
<td>Red</td>
</tr>
<tr>
<td>0.8</td>
<td>Yellow</td>
</tr>
<tr>
<td>0.5</td>
<td>Green</td>
</tr>
<tr>
<td>0.4</td>
<td>Green</td>
</tr>
<tr>
<td>0.3</td>
<td>Cyan</td>
</tr>
<tr>
<td>0.2</td>
<td>Blue</td>
</tr>
<tr>
<td>0.1</td>
<td>Black</td>
</tr>
</tbody>
</table>
Conclusions

• A straight forward correlation was not seen between quantity sulphides and chargeability in rock samples.

• It was only when quantity of magnetite was also considered that a relationship emerged.

• Downhole logging data show a chargeability response which was shallower than, and broader than, mineralisation.
Conclusions

• Forward and inverse modelling of surface data also suggested a contributory source to the anomaly which was shallower than mineralisation.

• Induced Polarisation should be employed as an exploration tool when looking for sulphide-associated mineralisation in host rocks containing magnetite.
• Barrick Gold of Australia Limited.
• Curtin University: Anton Kepic and Dom Howman.