Biased Heterodyne Method
A future technique for sulphide exploration
LABORATORY STUDY & KEMPFIELD FIELD TRIALS
Chargeable Mineralisation: an expensive prospect

- Limitations of geophysical methods
- Chargeable and conductive targets
- $100-$200 per metre for drill core
Resistivity
Clays
Shales
Graphite
Groundwater
Sulphides

Chargeability
Clays
Shales
Graphite
Fences!
Sulphides
Collaboration with

- CSIRO
- Fender Geophysics
- Tooronga Resources
- ARCTAN Services
- Quadrant Geophysics
The search for sulphides

- Clays, Shales and Sulphides are Chargeable and Conductive
R. White 1974
A Study of Non Linear Effects in Mineralised Rocks

- Semiconducting behavior of sulphide mineralogy
- Non-linear conduction – a way to discriminate shales and clays
- Heterodyne responses: $F_1 + F_2$ & $F_1 - F_2$
What are Heterodyne Signals?

Input Signals

F1
F2

Diode Mixer

Output Signals

F1-F2
F1
F2
F1+F2
F1+2F2
Heterodyne Signals – Mixing Terms

Electronically there is no difference between this ......

...... And billions of junctions on sulphide grain boundaries in an ore deposit.
Heterodyne Signals – Mixing Terms

Linear Conduction
Heterodyne Signals – Mixing Terms

Linear Conduction
Heterodyne Signals – Mixing Terms

Non-Linear Conduction
Heterodyne Signals – Mixing Terms

Non-Linear Conduction
Heterodyne Signals – Mixing Terms

Non-Linear Conduction

Amplitude (V) vs. Frequency (Hz) diagram showing various terms such as F1, F2, 2F1, 2F2, 3F1, 3F2, F2-F1, 2F1-F2, and F1+F2.
Technology – it has come a long way
Technology – it has come a long way

CSIRO-built 31-bit analogue to digital converter
Laboratory Testing

AT CSIRO’S LINDFIELD SITE
Sample MBDD024
Kempfield Field Study

CSIRO AND FENDER GEOPHYSICS IN COLLABORATION WITH ARCTAN SERVICES, TOORONGA RESOURCES AND QUADRANT GEOPHYSICS
Argent Minerals: Kempfield

Kempfield
60km south of Bathurst
Known target
Extensively surveyed sulphide mineralisation
Kempfield: An Ideal Target
Poly-metallic massive sulphide VMS style deposit
Well defined – hundreds of drill holes
Surveyed with most other geophysical methods
Argent owns property and exploration licence
Accommodation (farmhouse) on site
Secluded – In a blind valley
Close to Sydney – 3 ½ hours
Noise Floor – No Generators

Frequency (Hz)

Amplitude (V)
The First Response
The Generator Terms

Frequency (Hz)

Amplitude (V)
Measuring the Profile

Frequency (Hz) vs. Amplitude (V) graph showing peaks at various frequencies and corresponding amplitudes.
Primary Profile: 80Hz

![Graph showing primary profile at 80Hz with series 1, 2, 3, and 4.

- Series 1
- Series 2
- Series 3
- Series 4]
Secondary Profile: 130Hz
KEMPFIELD MINERALISATION
The Next Stage: Improving the method

DC Bias

Generator Noise

Multi-Line Arrays
Example profile – Line 8050 electrode pair 8: 31-bit ADC
Data issues: Level Shifts

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<th>Value</th>
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Example profile – Line 8050 electrode pair 8: 31-bit ADC
The Next Steps: Improving the method

DC Bias

Purpose-Built Transmitters

Additional Areas
Laboratory Testing Continued

ARGENT MINERALS KEMPFIELD SAMPLES
Control Sample: Fired Clay with Aggregate
Control Sample: **LUMP OF BRICK**
Control Sample: Fired Clay with Aggregate
Kempfield Sample 229828
Kempfield Sample 1123697
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<th>Code</th>
<th>Description</th>
<th>Mixing Terms</th>
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<td>disseminated sulphides</td>
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<td>diffuse fine flecks</td>
<td>low possible</td>
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<td>229828</td>
<td>dark fine grained matrix</td>
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<tr>
<td>1223696</td>
<td>visible sulphide grains</td>
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<td>1223697</td>
<td>no visible sulphides</td>
<td>no</td>
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<tr>
<td>Brick</td>
<td>fired clay and aggregate</td>
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<td>Sample</td>
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