HYPERSPECTRAL CORE IMAGING
AT THE LA COLOSA PROSPECT, COLOMBIA

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CORE IMAGING – HISTORY AT AGA

• Proof of concept exercise in 2003 using De Beers AMS airborne scanner

• Decision made to develop imaging system as opposed to profiler

• Delivery of Hyperspectral Core Imager (HCI) in 2005, designed and built by SpecTerra Systems

• Used extensively on Witwatersrand reef intersections, as well as other deposits

• Shortcomings are core handling, acquisition speed, transportability

• Cannot be used as a production instrument, so other options evaluated

• Specim SisuRock prototype tested in 2007, indicated that this is a feasible instrument
HYPERSPECTRAL CORE IMAGER

**Hyperspectral Core Imager (HCI) Specifications**

<table>
<thead>
<tr>
<th>Scanning System</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength Range</td>
<td>~500nm to ~2500nm</td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>~5nm</td>
</tr>
<tr>
<td>Spatial Resolution</td>
<td>0.5mm x 0.5mm</td>
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<table>
<thead>
<tr>
<th>RGB Camera System</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame capture system</td>
<td>~24 frames/meter</td>
</tr>
<tr>
<td>Spatial Resolution</td>
<td>&lt;100 microns</td>
</tr>
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<table>
<thead>
<tr>
<th>Rates and Volumes</th>
<th>Specifications</th>
</tr>
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<tbody>
<tr>
<td>Scanning Speed</td>
<td>~4m/hour (high res.)</td>
</tr>
<tr>
<td>Spectral Data</td>
<td>~340Mb/meter (raw)</td>
</tr>
<tr>
<td>Camera Data</td>
<td>~130Mb/meter (raw)</td>
</tr>
</tbody>
</table>
WITWATERSRAND RESULTS

- Fe-carbonate ± white mica ± chlorite
- Chlorite + white mica
- White mica + chlorite
- White mica ± chlorite
- White mica (illitic)
- White mica + sulphide?
- White mica + quartz/feldspar
- White mica
- White mica + pyrophyllite
LA COLOSA PROSPECT

• Discovered in 2007 (stream sediment geochemistry)

• First hole >200 metres @ 1.4g/t

• 56 diamond holes drilled 2007-2008, inferred resource of 12.9 Moz @1g/t

• Porphyry deposit, hosted by polyphase dioritic intrusives intruded into Palaeozoic metasediments (schists) with localised hornfelsing

• Mineralisation hosted in intrusives, country rocks

• Well developed alteration (potassic, sodic-potassic)

• Prefeasibility study initiated, after hiatus (permitting) now in progress
IMAGING OF COLOSA CORE

- Suitable site for production test of a hyperspectral imaging system
- Main application is geometallurgical
- Specim prototype rented, delivered to site in January 2009 (~130kg total weight)
- Local geologists trained for data capture
- All 56 boreholes (17000 metres) imaged in two week period, including data QA/QC
- System was SWIR camera only, no VNIR data captured
- No RGB system fitted
SISUROCK AT WORK
DATA PROCESSING

- Large volume of raw data (~1 Terabyte)
- Bad bands identified and omitted
- Data processed using in-house software
- Data volume too large for endmember/classification approaches
- Spectral features extracted (absorption depths, wavelengths, intensities)
- Data were inspected to identify minerals present – biotite, amphibole (hornblende/actinolite), chlorite, epidote, kaolinite, sericite, illite, Al-smectite, goethite, dolomite, jarosite, nontronite identified
- Decision tree approach used to code pixels by minerals present using spectral feature information
- Spectral features output as averages over 0.5 metre intervals
- Mineral count percentages calculated and output for 0.5 metre intervals
QA/QC AND PROCESSING ISSUES

- Initially, weight of core created problems, solution provided overnight
- Different size boxes (3, 4 and 5 rows)
- \(~1\text{mm spatial resolution achieved}\)
- Incomplete/no white measurement
- Masking of core boxes non-trivial (slight changes in spectral response, not all boxes straight)
- Dust at base of box manually removed
SPECTRAL FEATURES

D2200

D2250

D2260
DECISION TREE APPROACH
DECISION TREE MINERAL MAPPING

[Image of a decision tree with mineral mapping and a graph showing reflectance vs. wavelength for Chlorite, Biotite, and Amphibole]
MINERAL PROPORTION PLOTS

MINERAL PROPORTION PLOTS

COL055

Mineral Percentages

Phyllosilicate-Tectosilicate Percentages

Core Image Pixel Number

0

Amphibole
Biotite
Biotite-Clinozoisite
Chlorite
Epizome
Hornblende
Hydrated White Mica
Intermediate Hydrated White Mica
Intermediate Anhydrous White Mica
Anhydrous White Mica
Kasolite
Jarosite
Calcite
Limonite
Phyllosilicates
Tectosilicates
Other
VALIDATION OF RESULTS

- Submitted 50 samples for QXRD (Rietveld) at two laboratories, two metre assay pulps

- QXRD results difficult to correlate with spectral data:
  - Overestimation of proportions using decision trees (yes/no answer)
  - Non-linear mixing effects (AlOH phyllosilicates “bright”)
  - Quartz/feldspar uncertainty
  - Uncertainties in QXRD proportions (chlorite/kaolinite overlap, smectite and illite difficult to identify and thus quantify)

- Re-submit samples to more laboratories to test QXRD

- Test spectral feature results for correlations (cf. AMIRA P843A)
CONCLUSIONS

- Valuable dataset, objective and consistent across entire project area

- Identification of mineralogical zones within deposit (potentially different behaviours)

- Identification of low temperature alteration zone with enhanced grades

- Quantification needs to be addressed and solved for geometallurgical application

- Further processing development required (robust mask, reliable spectral matching to allow classification approach to large datasets)

- Total cost ~$10 per metre, aim to reduce this to $5 per metre in future

- Drilling cost north of $350 per metre (helicopter support etc.), so very minor cost component