HYPERSPECTRAL CORE IMAGING AT THE LA COLOSA PROSPECT, COLOMBIA

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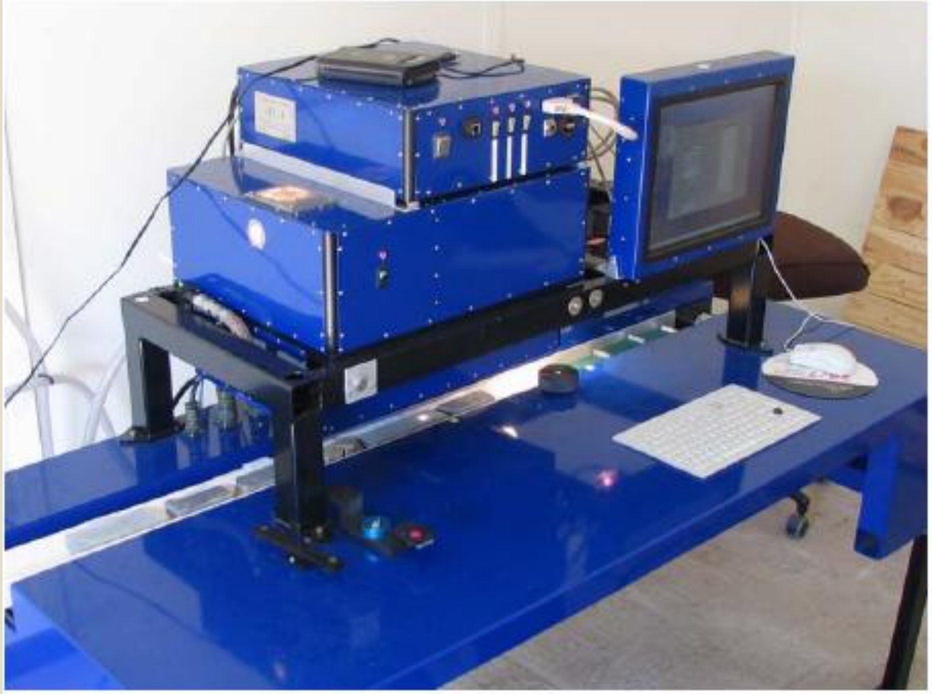
CORE IMAGING – HISTORY AT AGA

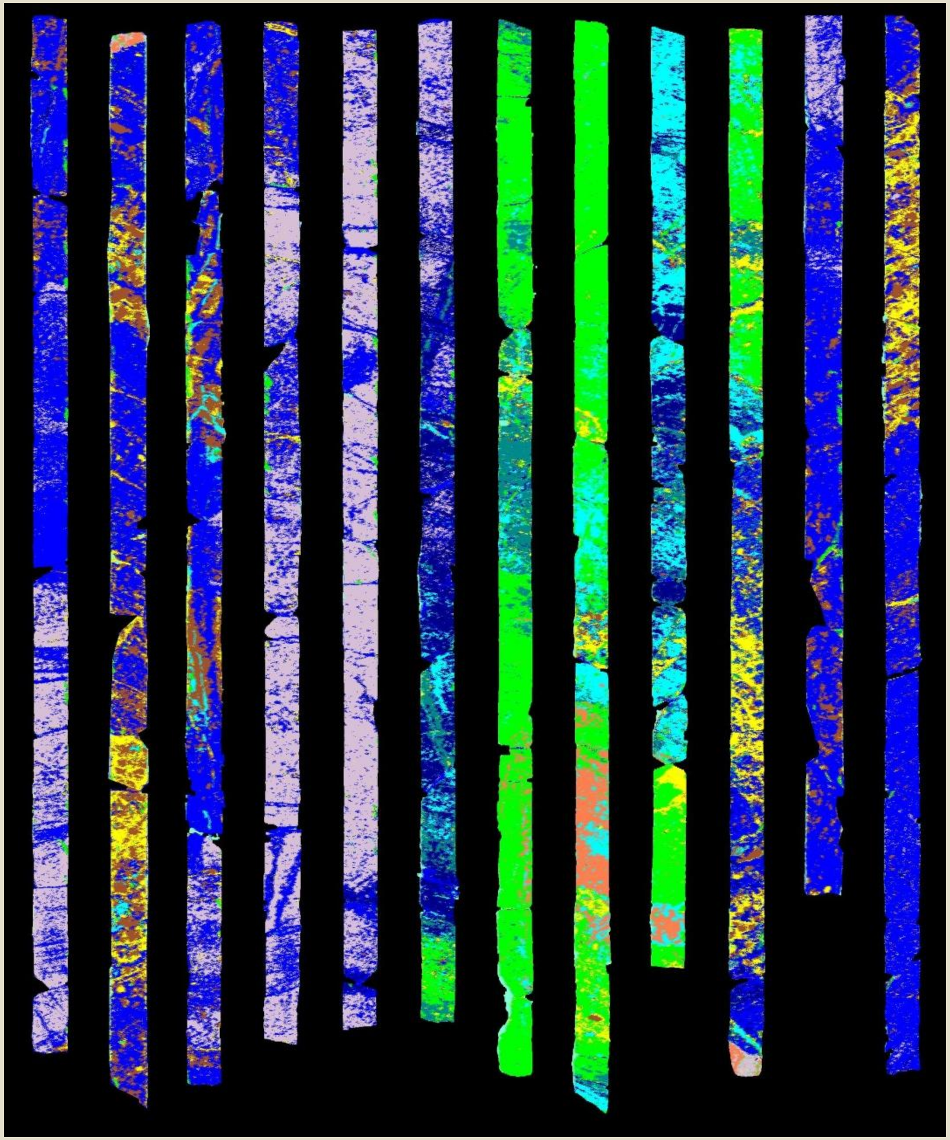
- Proof of concept exercise in 2003 using De Beers AMS airborne scanner
- Decision made to develop imaging system as opposed to profiler
- Delivery of Hyperspectral Core Imager (HCI) in 2005, designed and built by SpecTerra Systems
- Used extensively on Witwatersrand reef intersections, as well as other 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



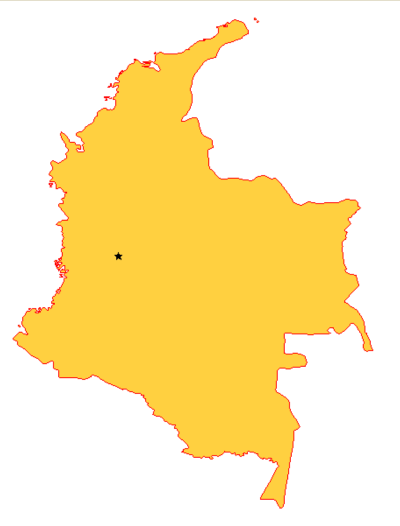
Hyperspectral Core Imager (HCI) Specifications	
Scanning System	
Wavelength Range	~500nm to ~2500nm
Spectral Resolution	~5nm
Spatial Resolution	0.5mm x 0.5mm
RGB Camera System	
Frame capture system	~24 frames/meter
Spatial Resolution	<100 microns
Rates and Volumes	
Scanning Speed	~4m/hour (high res.)
Spectral Data	~340Mb/meter (raw)
Camera Data	~130Mb/meter (raw)

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

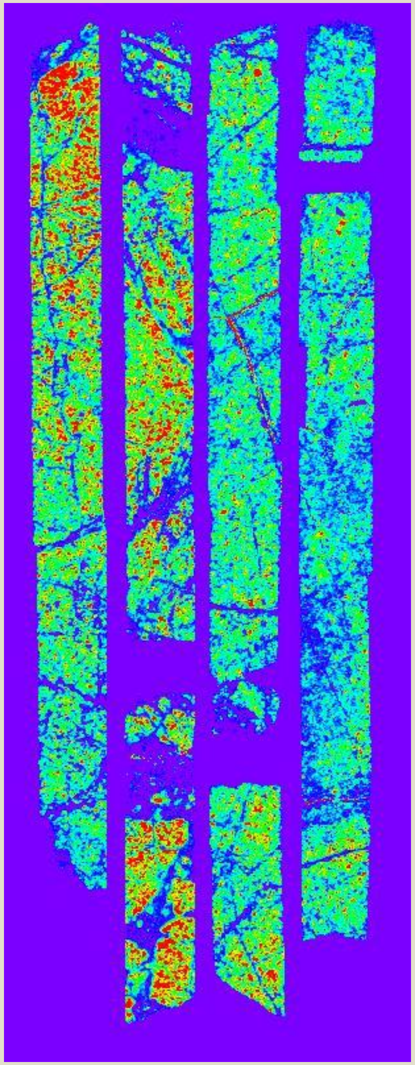
DATA PROCESSING

- 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)
- ~ 1mm 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



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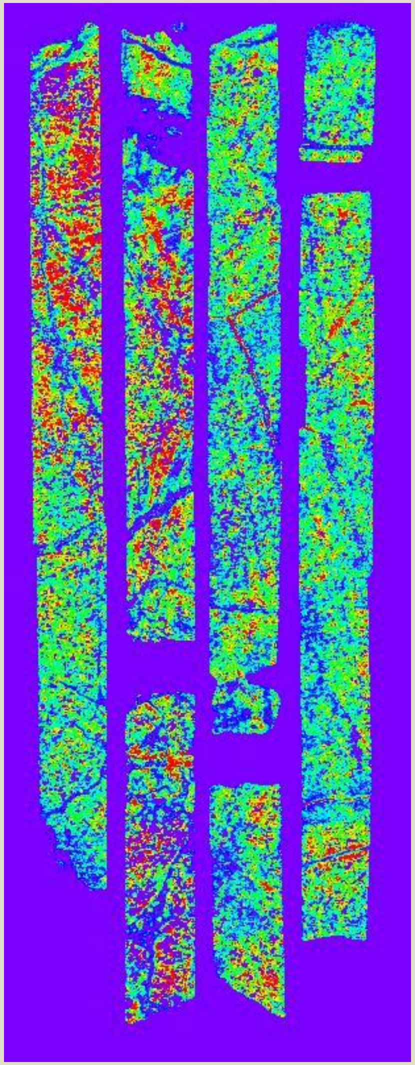

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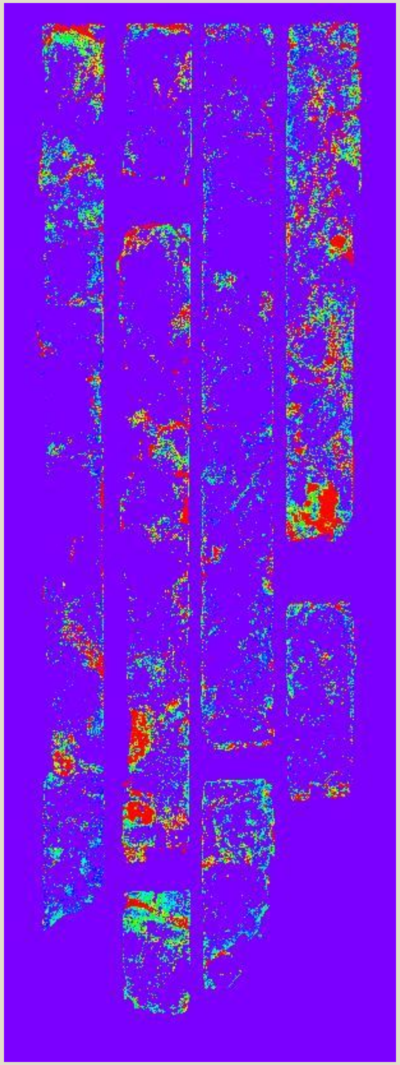

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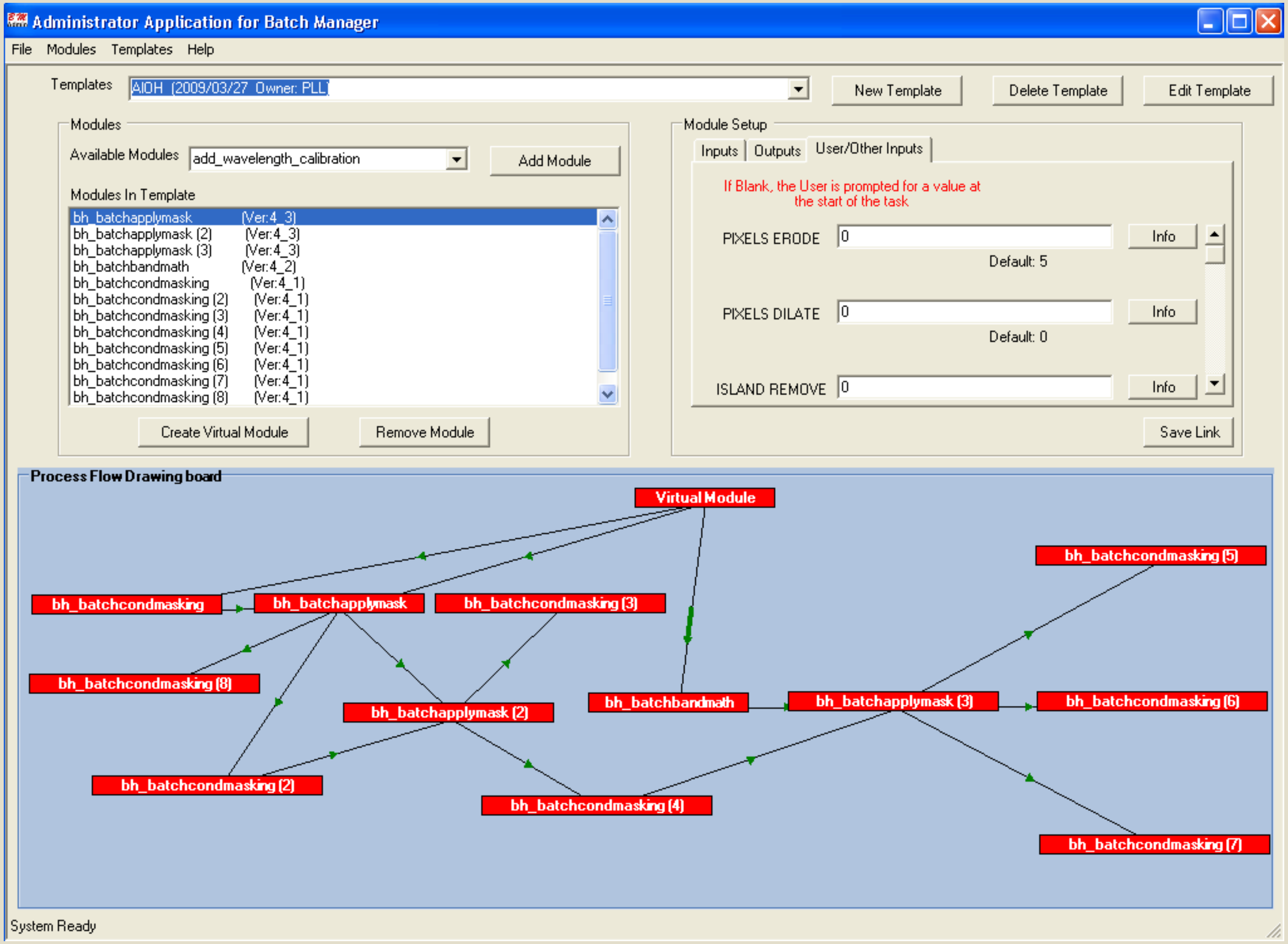
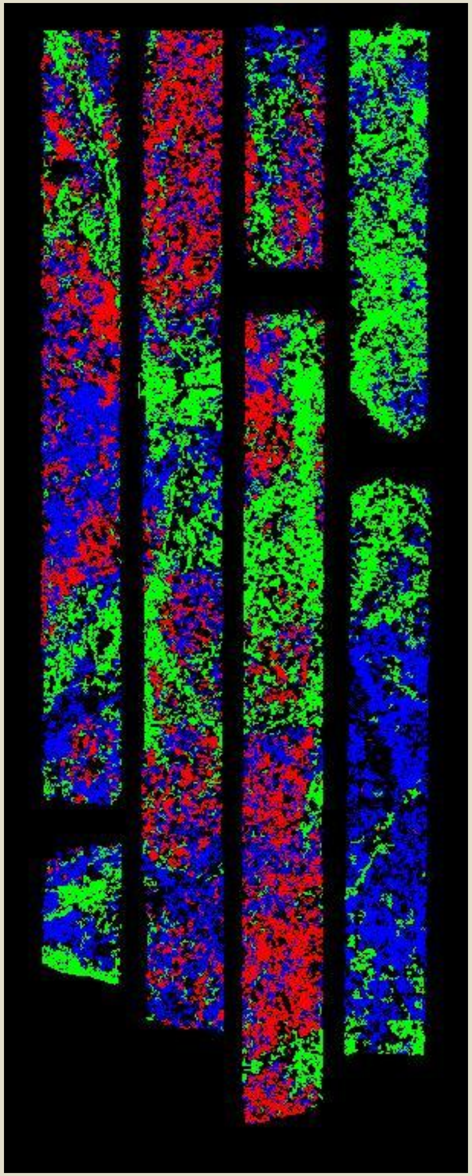
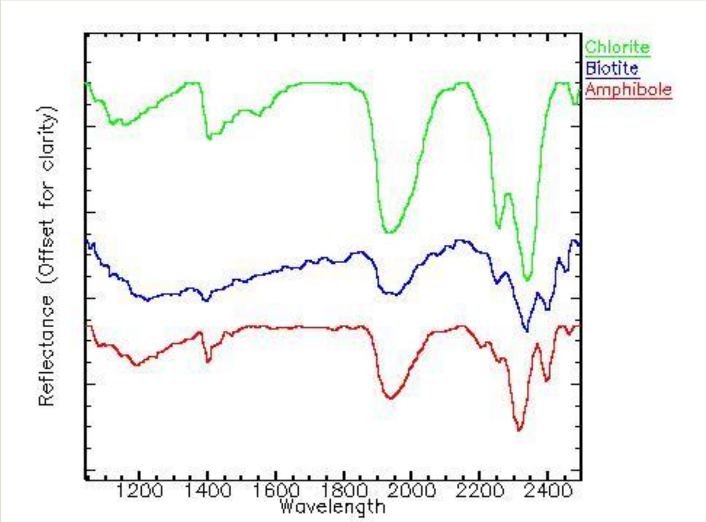
DECISION TREE APPROACH

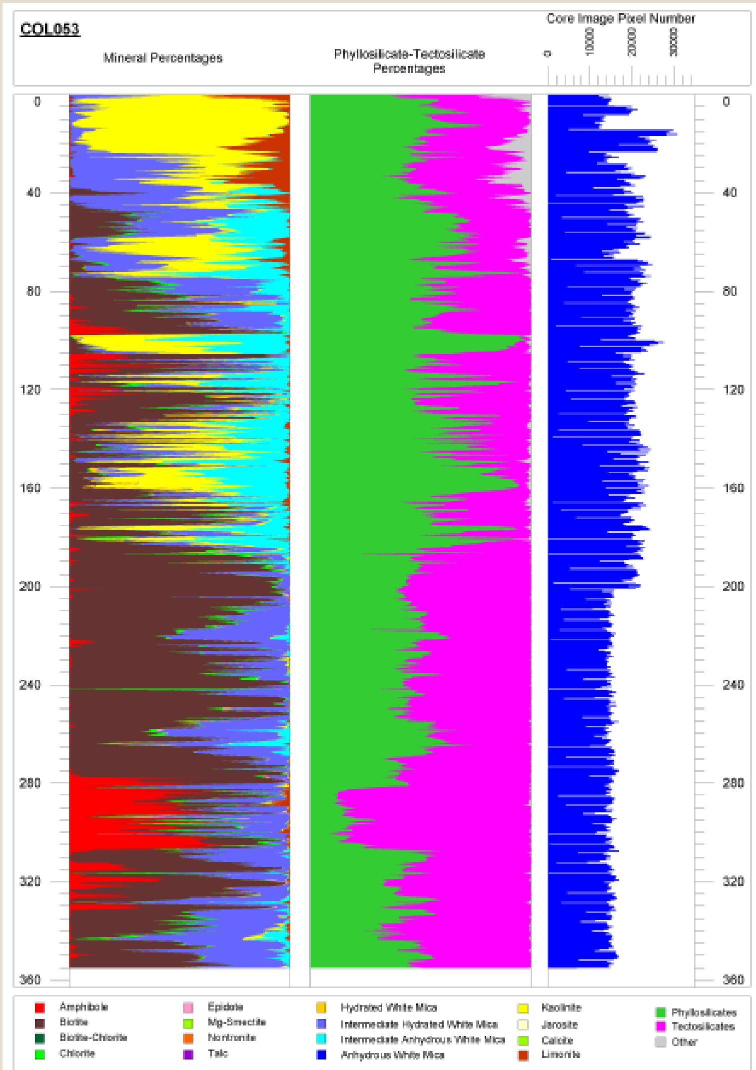


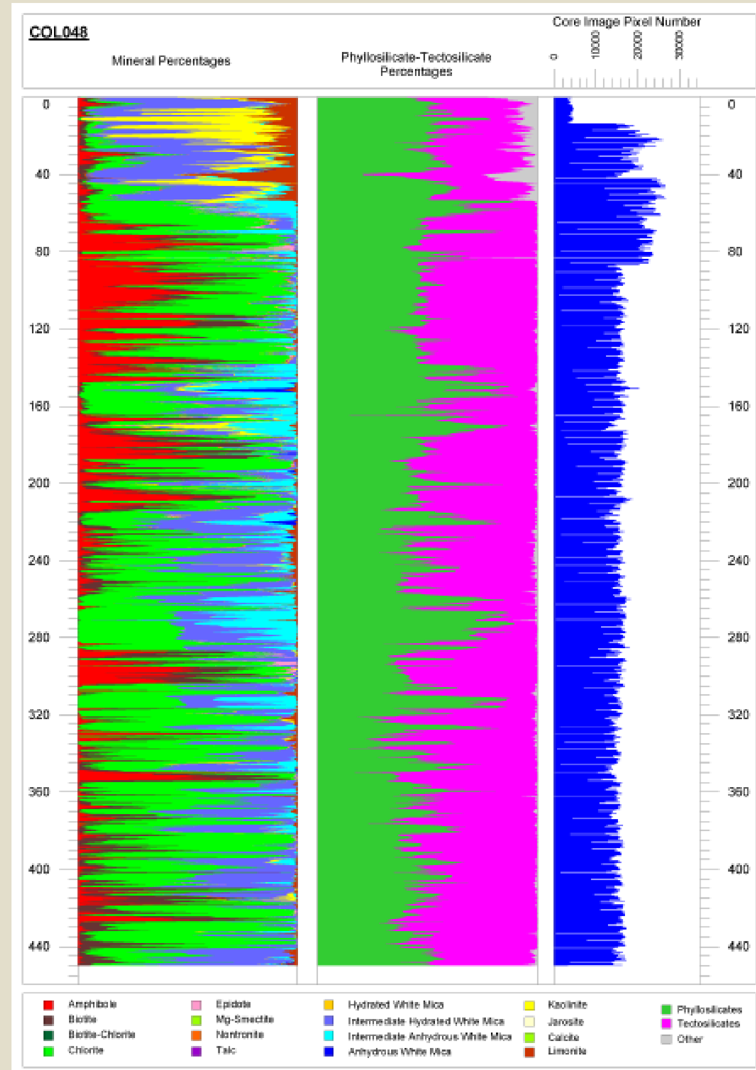
DECISION TREE MINERAL MAPPING





MINERAL PROPORTION PLOTS





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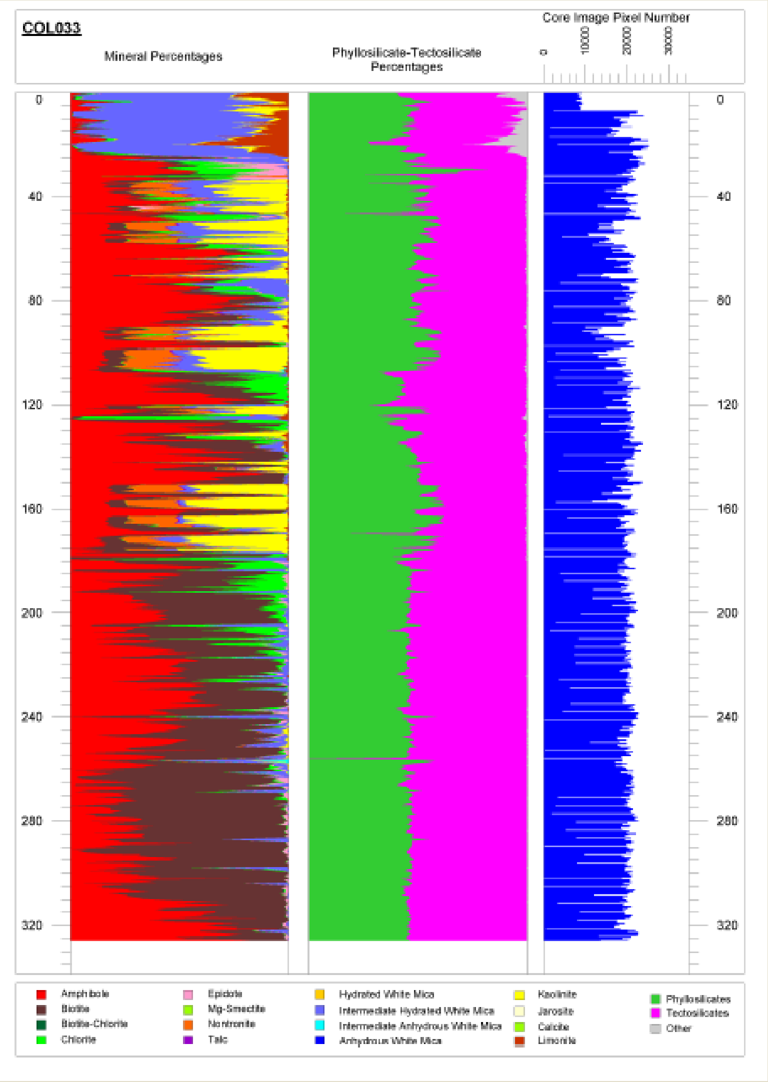

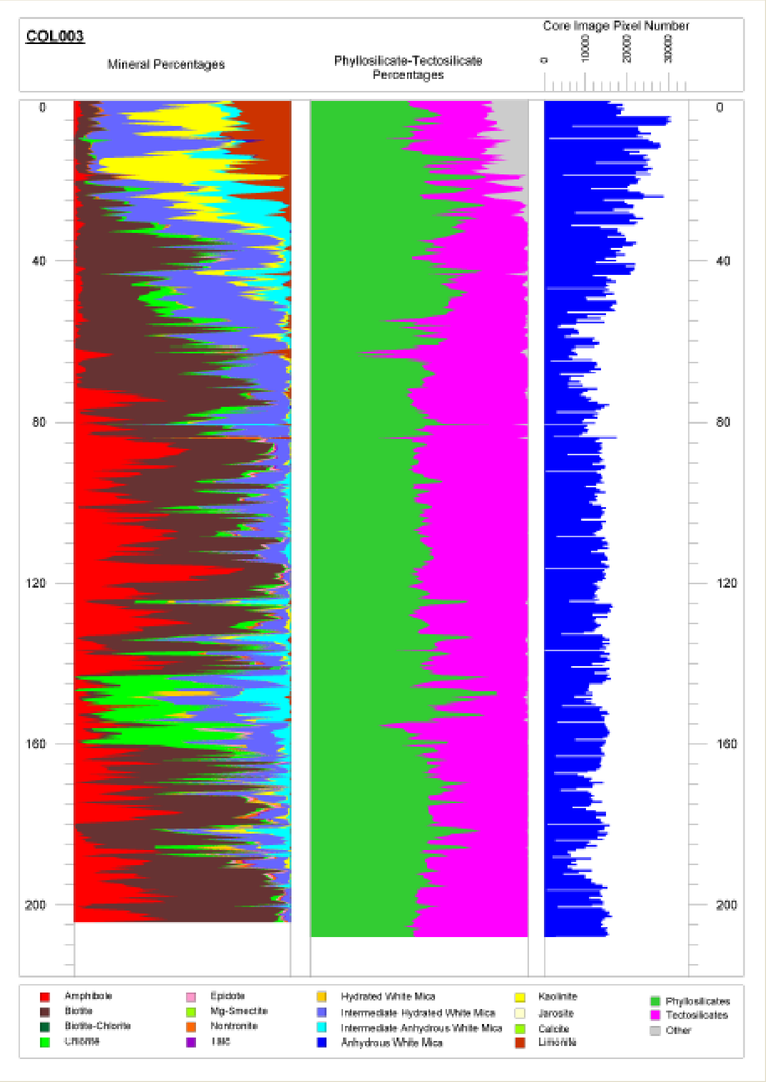

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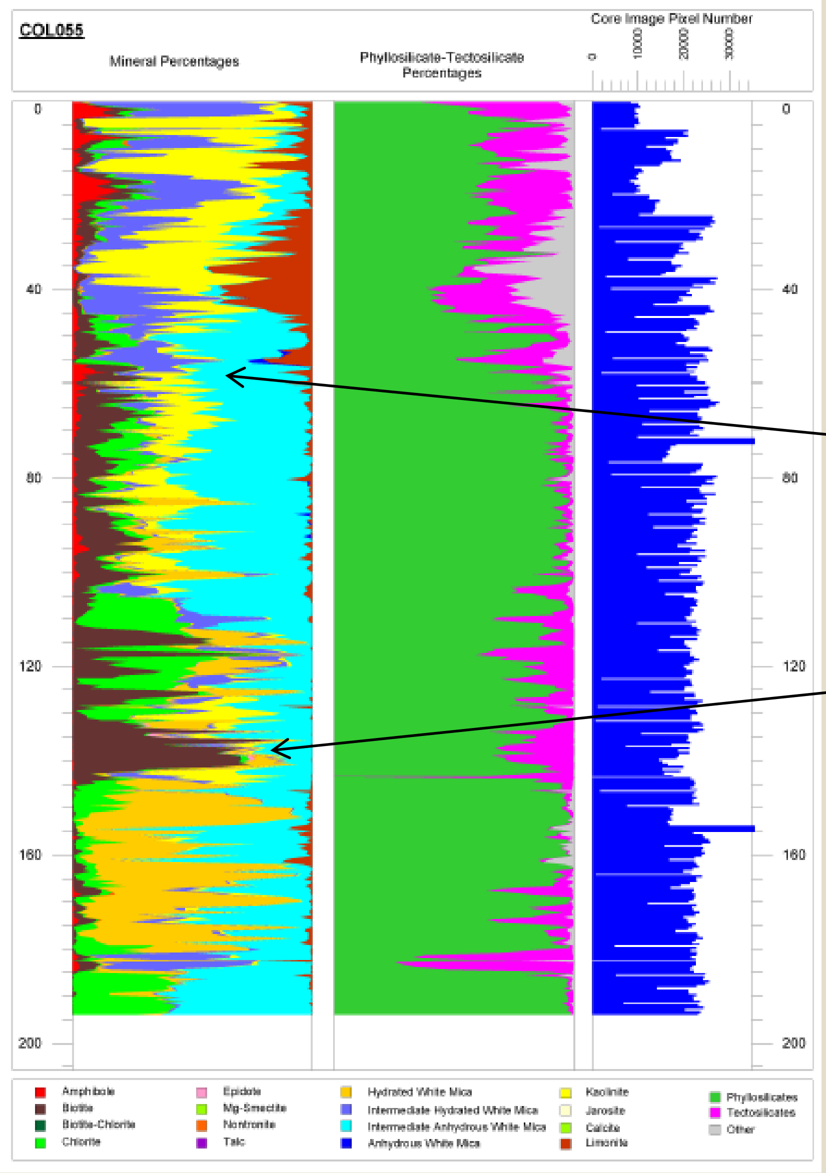
MINERAL PROPORTION PLOTS



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