Regional Diamond Exploration Under Cover

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150 years of modern diamond exploration has turned up

- 7000 kimberlites
- 1000 diamondiferous
- 60 economic
- 10 Tier-1 ($20b reserve)
Measure potential fields:
EM conductivity
Mag susceptibility
Gravity density

Geochemical samples

Thermal does both and can penetrate moderate vegetation and transported material
Japanese Aster satellite launched late 1999 images 5 bands thermal @ 90m

Japanese Aster satellite

First images collected in 2000
Still operating

ASTER Spectral Bands

- VNIR: 0.4-1.4 microns
- SWIR: 1.4-3.0 microns
- TIR: 8-11.5 microns
Size issues: 90m spatial does not give many pixels
5 spectral bands does not give many minerals

Kimberlites from mantle along with chromite, diopside, garnet, ilmenite olivine

Very distinct LWIR spectra

Components of spectral mixtures
Spectral unmixing

Find endmembers in scene or external?

then unscramble the egg

Reference Spectra

Linear Unmixing

Intensity of Emission vs Wavelength
Aster late autumn image taken 18 years ago
known kimberlite locations indicated by o
Processing flowchart

Atmospheric correction

Temperature/emissivity separation

Find 16 endmembers to produce a spatially sparse representation

Project 5D LWIR into a 16D space
LWIR classes coloured 1=blue through to 16=red
Class abundances
Sorted on their similarity to monticellite, a calcic-olivine
Top classes

Emissivities penetrate vegetation and windblown sand
Top classes are spatially coherent
Can do the same thing with SWIR
Class 16 (Saponite) maps the kimberlites
Saponite SWIR reflectance spectrum focus on the 2.3 micron Mg feature, the reason De Beers pioneered hyperspectral kimberlite exploration.
A scatter of saponite in the desert worth drilling?

- Are known kimberlites

Orapa diamond province

MgChlorite SWIR abundance
Do a bit of Kriging
The next step: a Botswana group shoot

- Fourier transform infrared (FTIR) spectrometer → higher achievable SNR
- Michelson interferometer
- MCT focal plane array detector → adjustable acquisition area
- 2 internal calibration blackbodies → fast calibration
- Operability from -10°C to + 45°C
- Acceptable weight (30 kg)
- Facilitates vertical measurements at ground level
- 45° tilted gold coated mirror that is located in the instrument’s field of view
- 0.25x telescope
  - FOV at a sensor-target distance of 1.5 m is 672 x 538 mm
  - Resulting pixel size is 2.1 mm
- Airborne mode at 1500 m
  - FOV: 672 / 168 m
  - Pixel size: 2.1 / 0.53 m
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Hyper-Cam-LW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral Range</td>
<td>μm</td>
<td>7.7 – 12</td>
</tr>
<tr>
<td>Spectral Resolution</td>
<td>cm⁻¹</td>
<td>0.25 to 150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(user adjustable)</td>
</tr>
<tr>
<td>Image Format</td>
<td>-</td>
<td>320 x 256 pixels</td>
</tr>
<tr>
<td>Field of View</td>
<td>Degrees</td>
<td>6.4 x 5.1 (nominal)</td>
</tr>
<tr>
<td></td>
<td>Degrees</td>
<td>25.6 x 20.4 (0.25X telescope)</td>
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<tr>
<td>Typical NESR</td>
<td>nW/cm²sr cm⁻¹</td>
<td>&lt; 20</td>
</tr>
<tr>
<td>Radiometric Accuracy</td>
<td>K</td>
<td>&lt;1</td>
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</table>
• Stabilization platform: dampens the airplane vibrations and compensates the airplane yaw
• Image Motion Compensator (IMC) mirror: compensates the airplane pitch, roll and forward motion
• GPS/INS unit: enables ortho-rectification and geo-referencing
Spectral abundances
Conclusions

Mantle minerals associated with kimberlites can be rapidly and inexpensively mapped using ASTER LWIR imagery.

The next step is airborne LWIR @2.5m spatial, 132 bands [7.6 11.4]

Remote geochemistry is a cost effective addition to the toolbox of the modern diamond explorationist.

Good exploration targets in the southwest of the OKF Zebediela kimberlite swarm worth investigating as both Marsfontein & Klipspringer are LWIR anomalies.