# 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

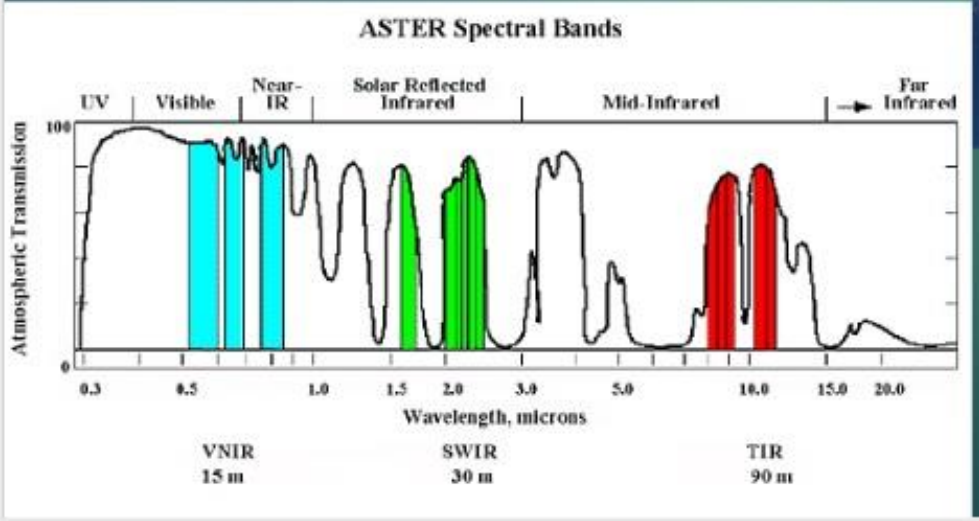
Geochemical samples

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



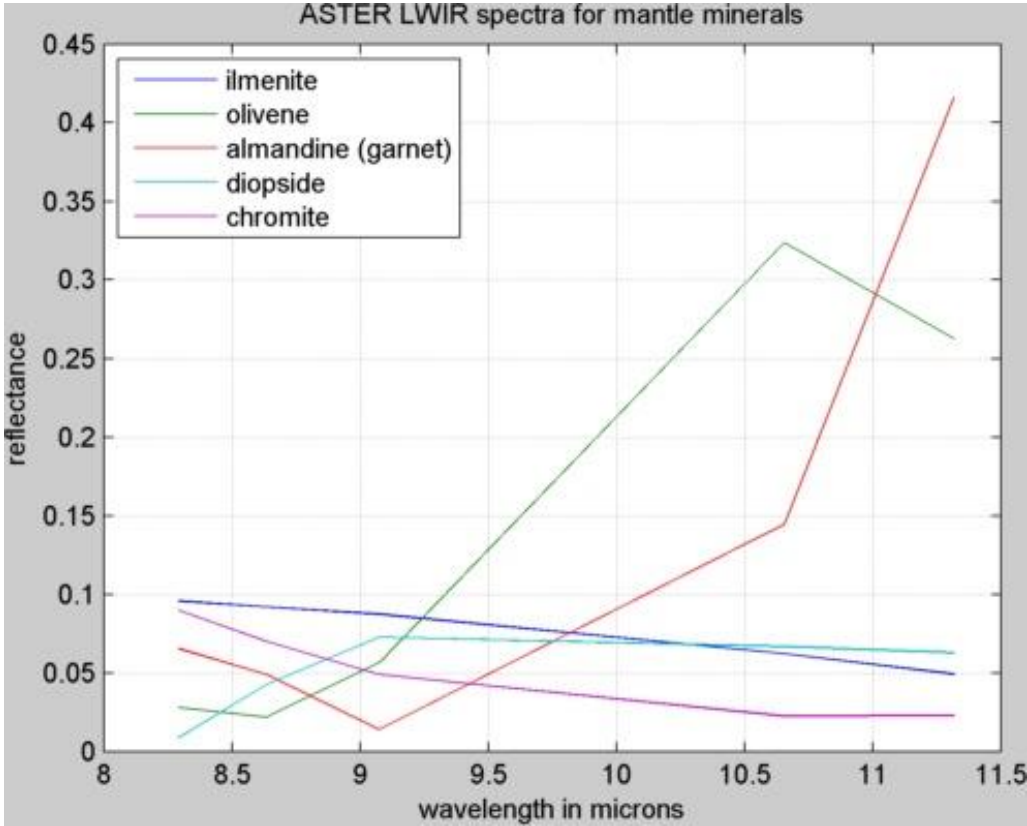

VNIR: 0.4-1.4 microns
SWIR: 1.4-3.0 microns
TIR: 8-11.5 microns

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

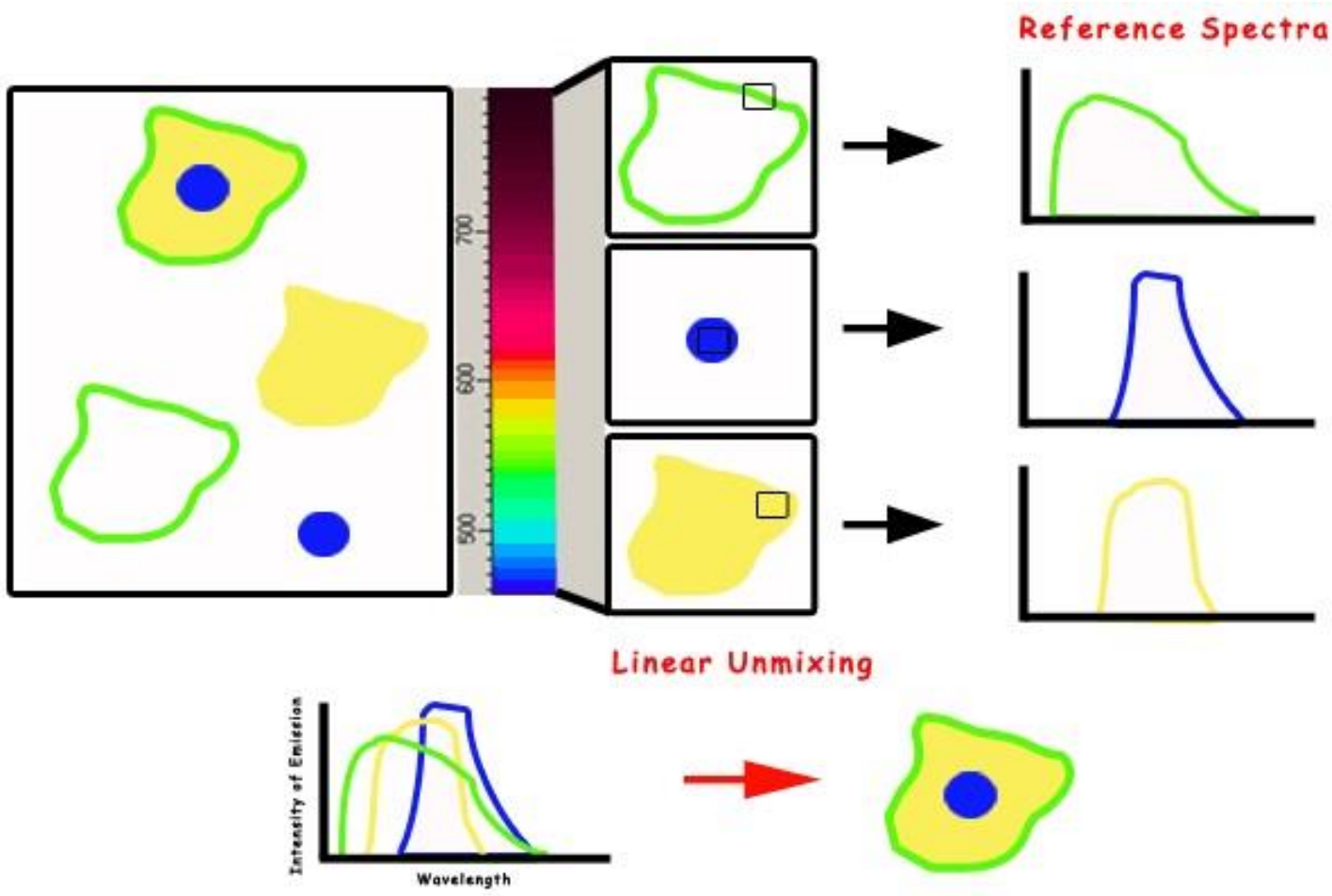
Components of spectral mixtures



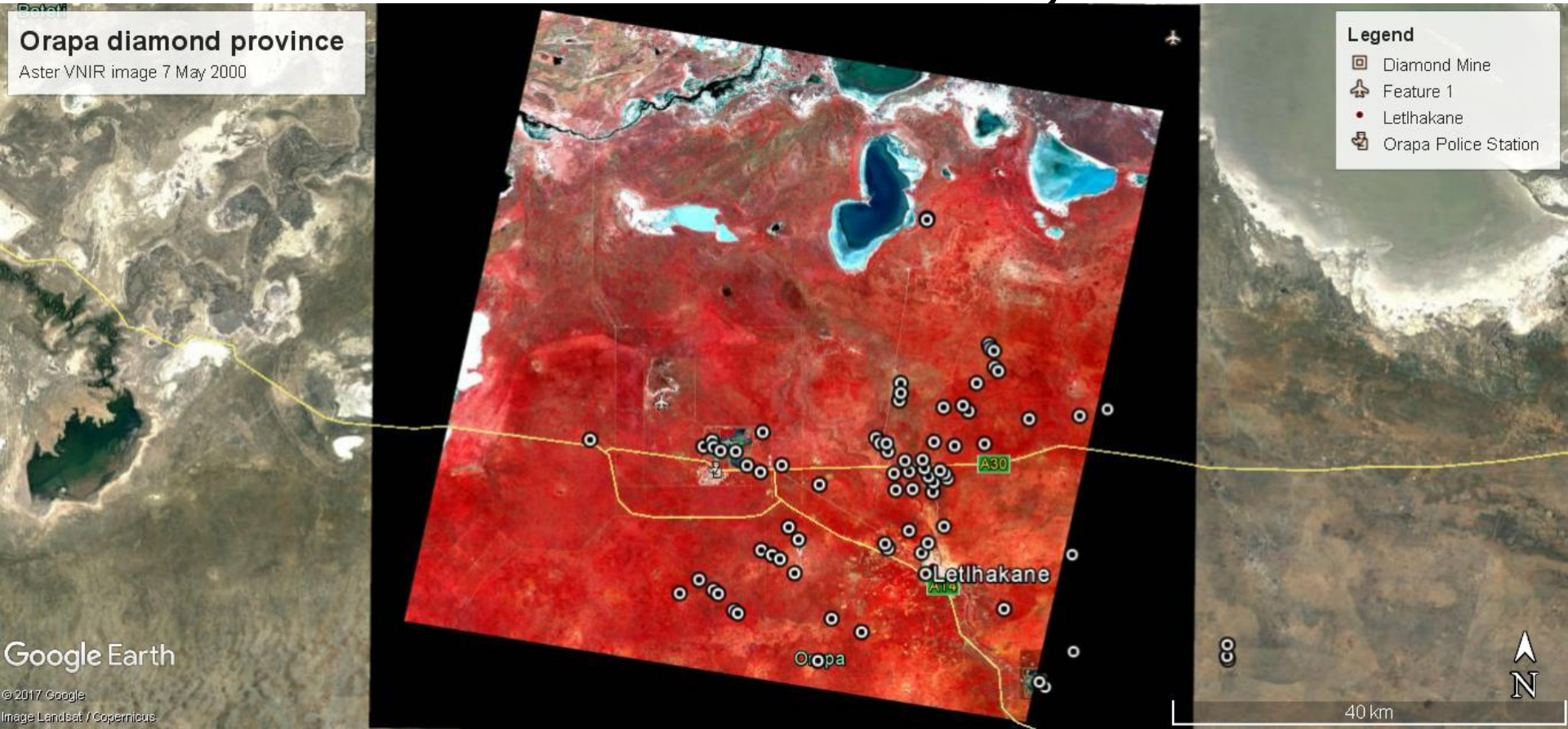
# Spectral unmixing

Find endmembers
in scene
or external?

then unscramble
the egg



# Aster late autumn image taken 18 years ago known kimberlite locations indicated by o



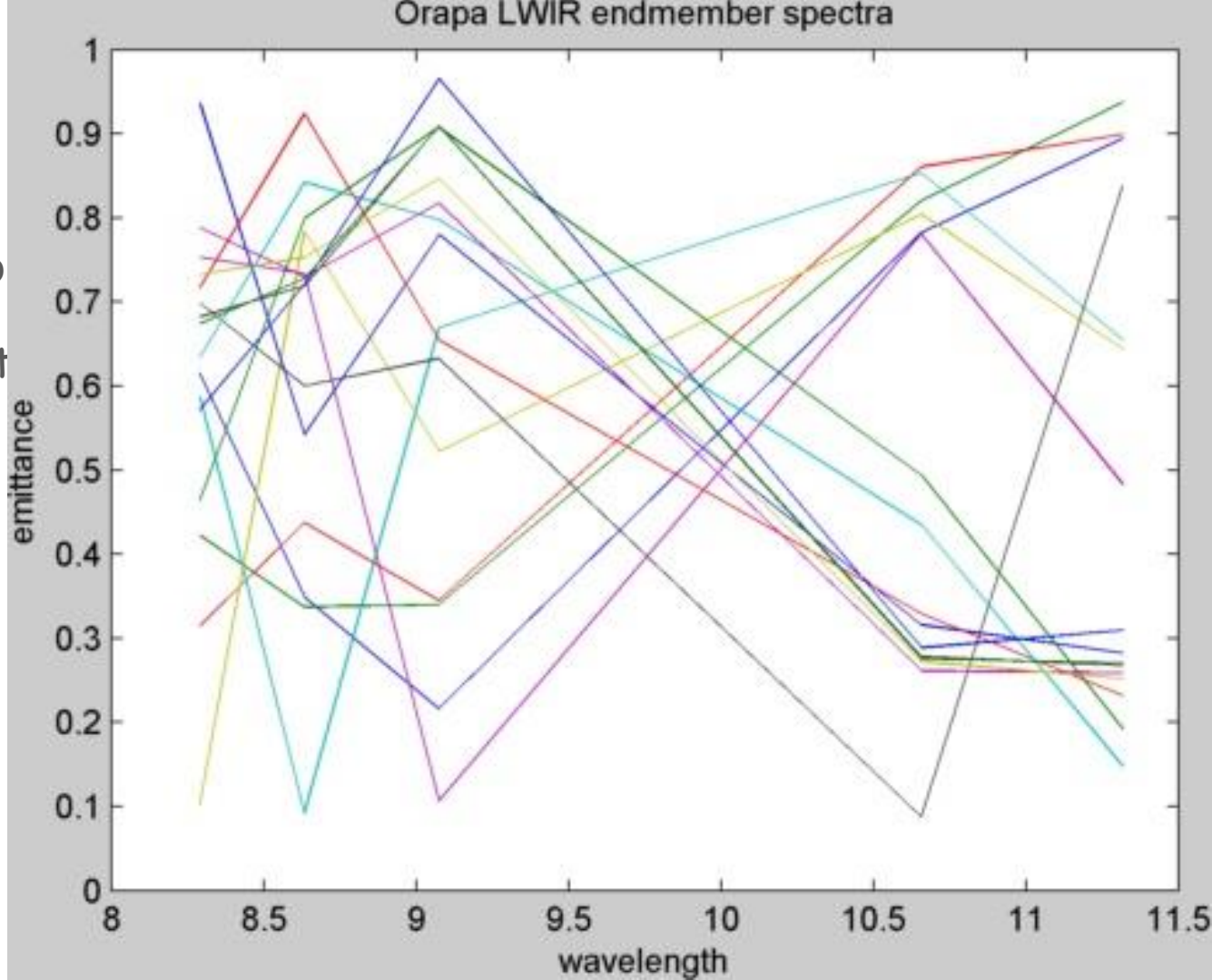
# Processing flowchart

Atmospheric correctio

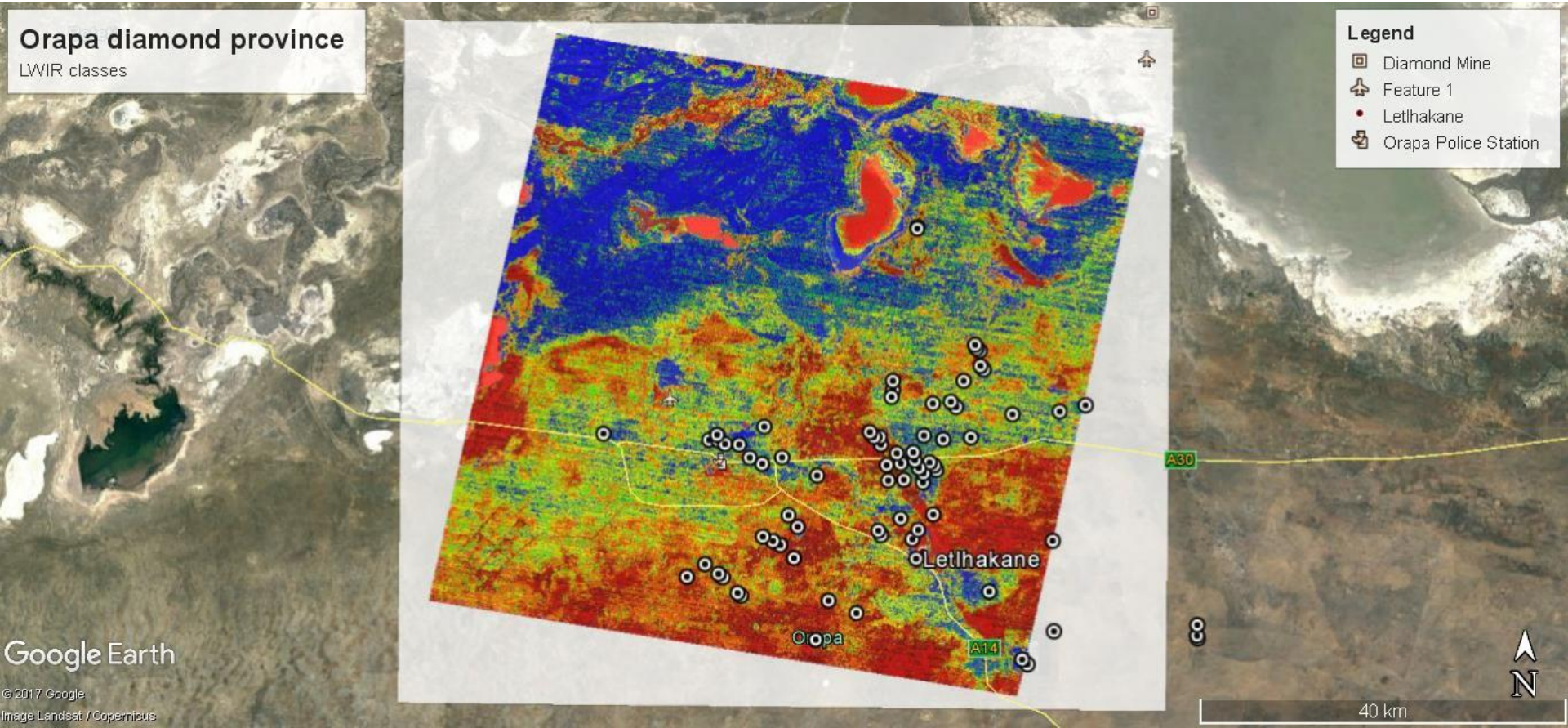
Temperature/emissivit separation

Find 16 endmembers to produce a spatially sparse representation

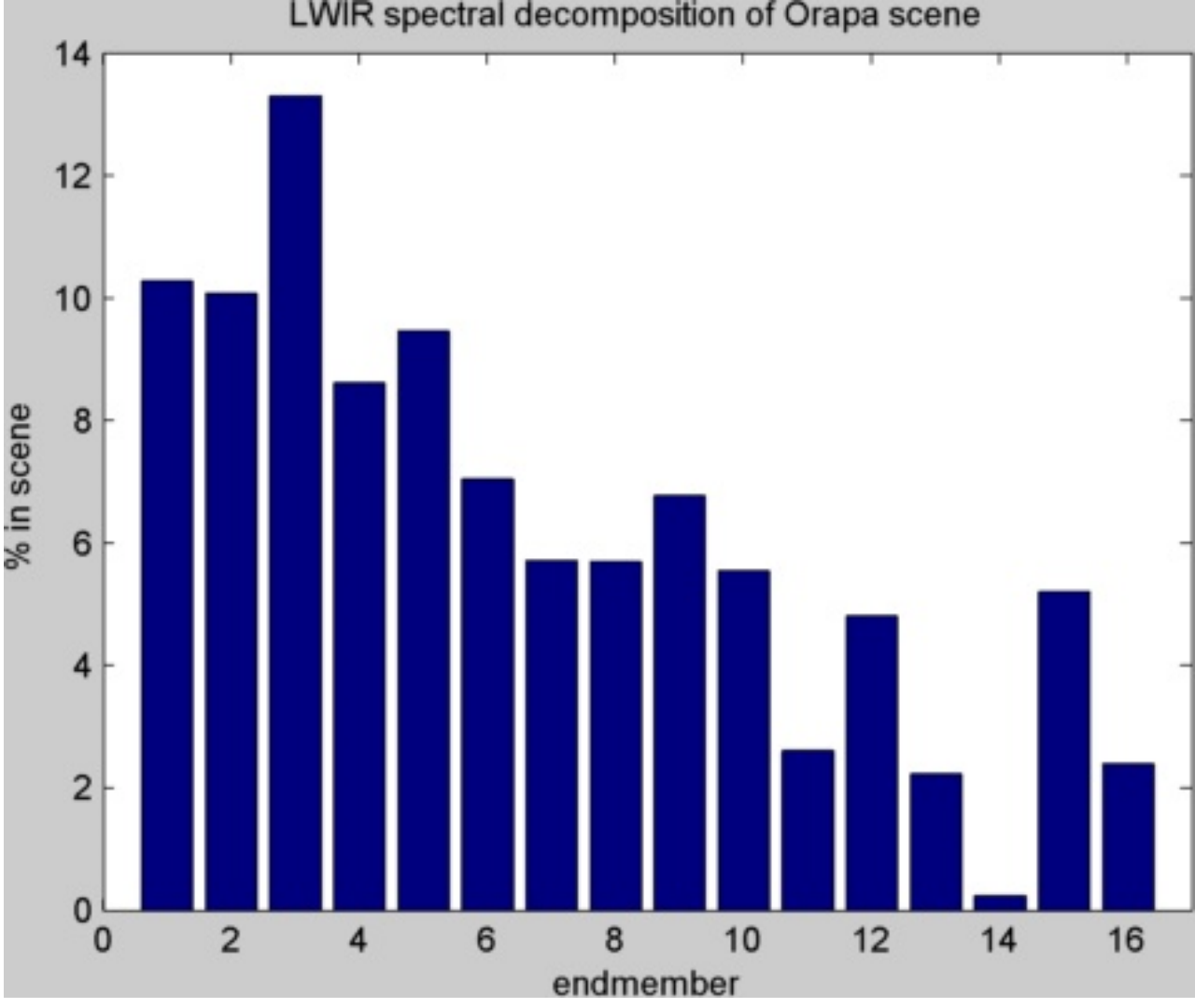
Project 5D LWIR into a 16D space



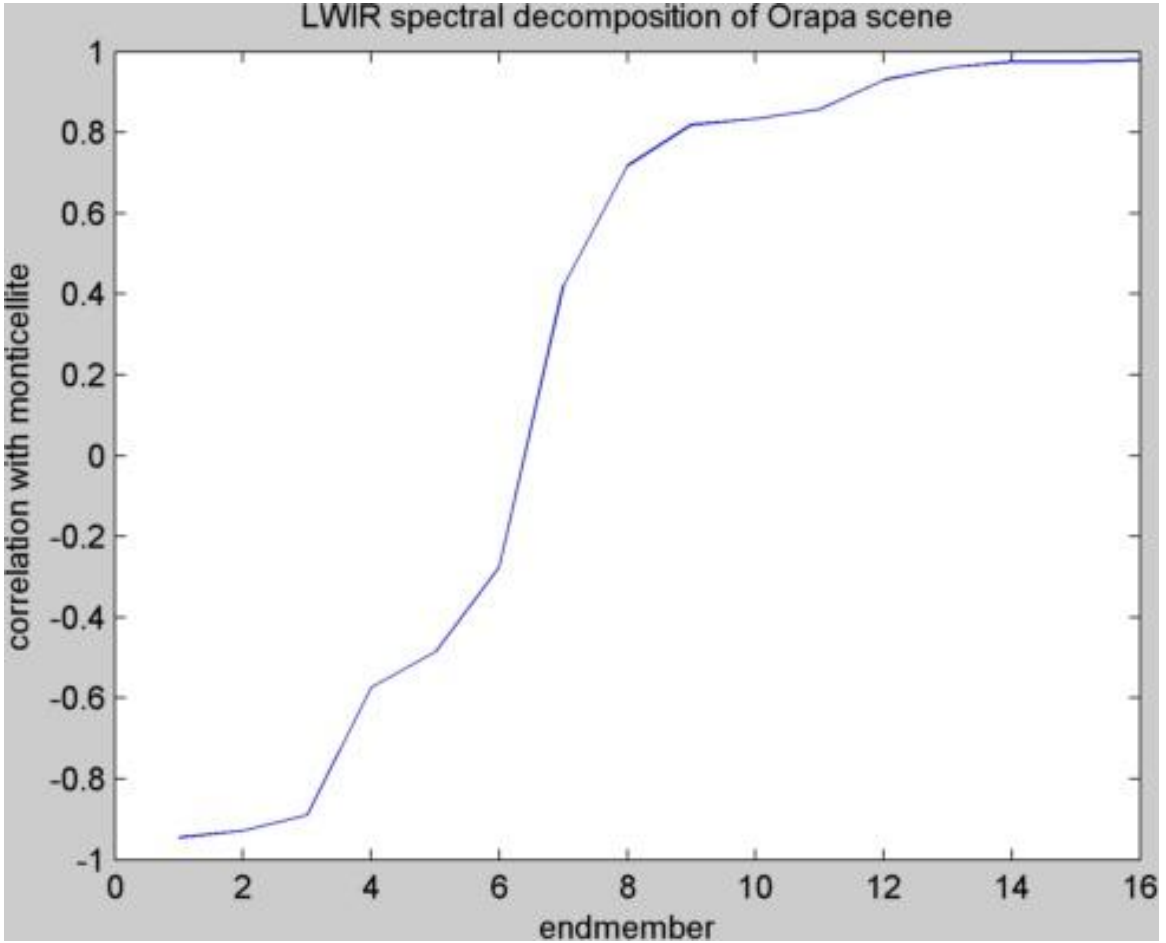
# LWIR classes coloured 1=blue through to 16=red



# Class abundances

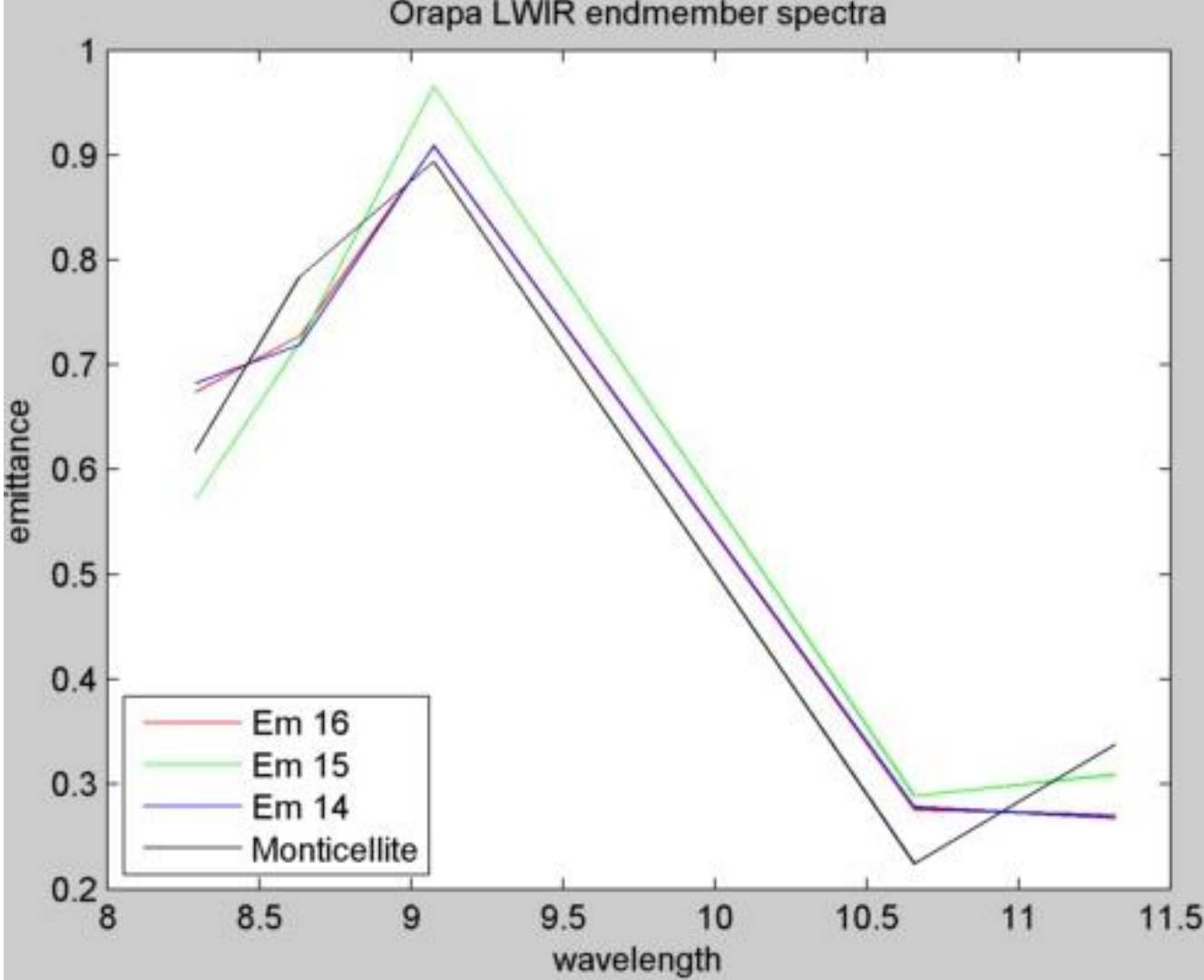


# Sorted on their similarity to monticellite, a calcic-olivine

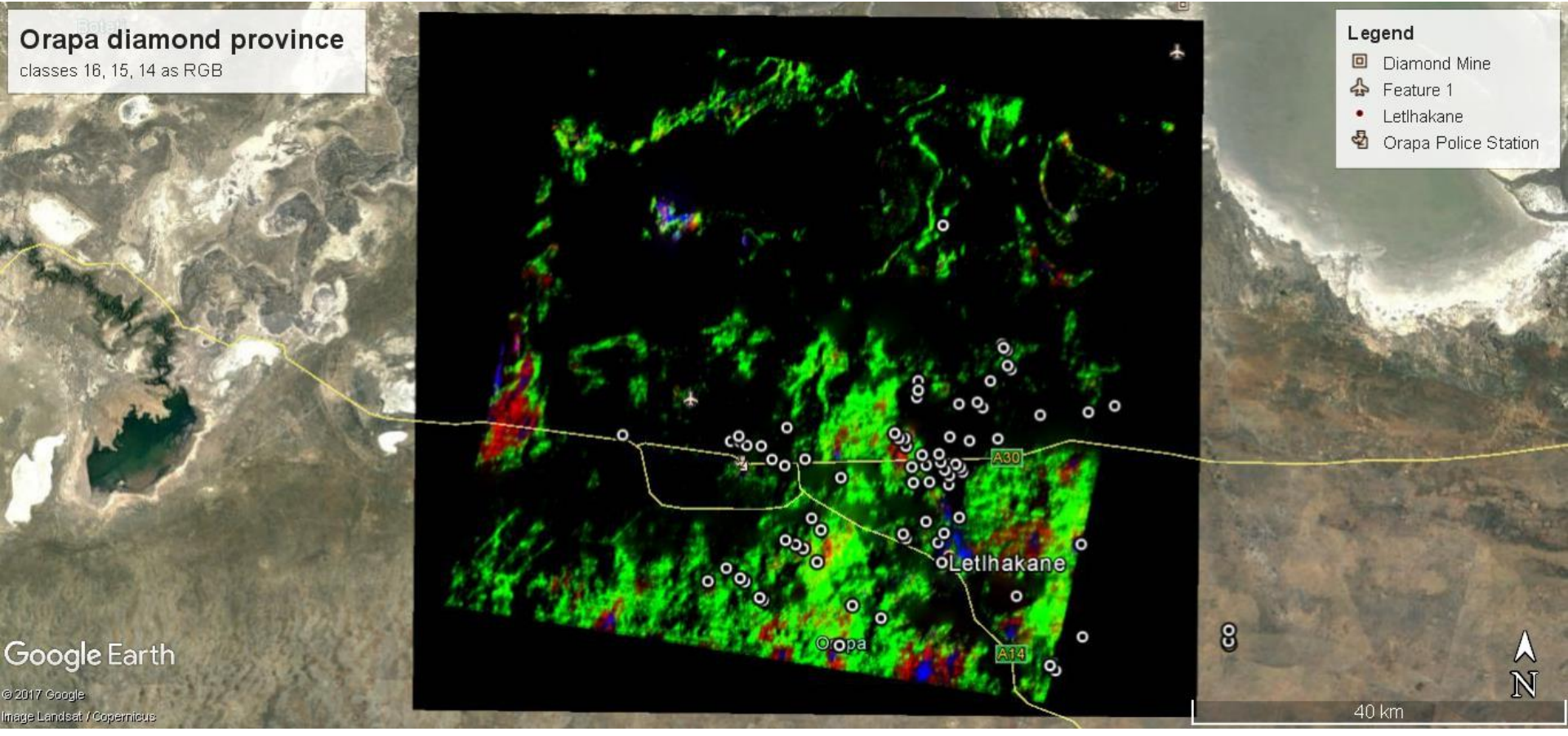



# Top classes

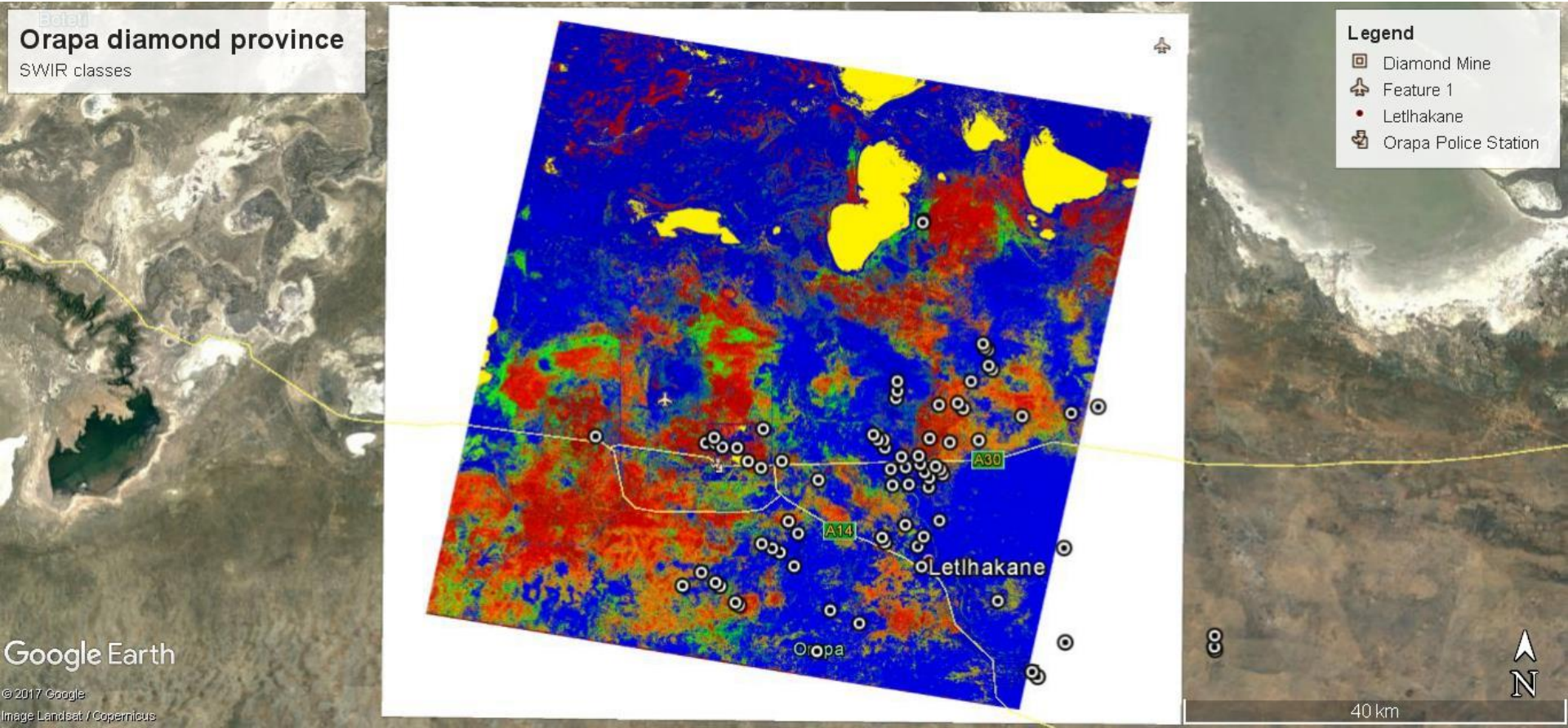
Emissivities penetrate vegetation and windblown sand



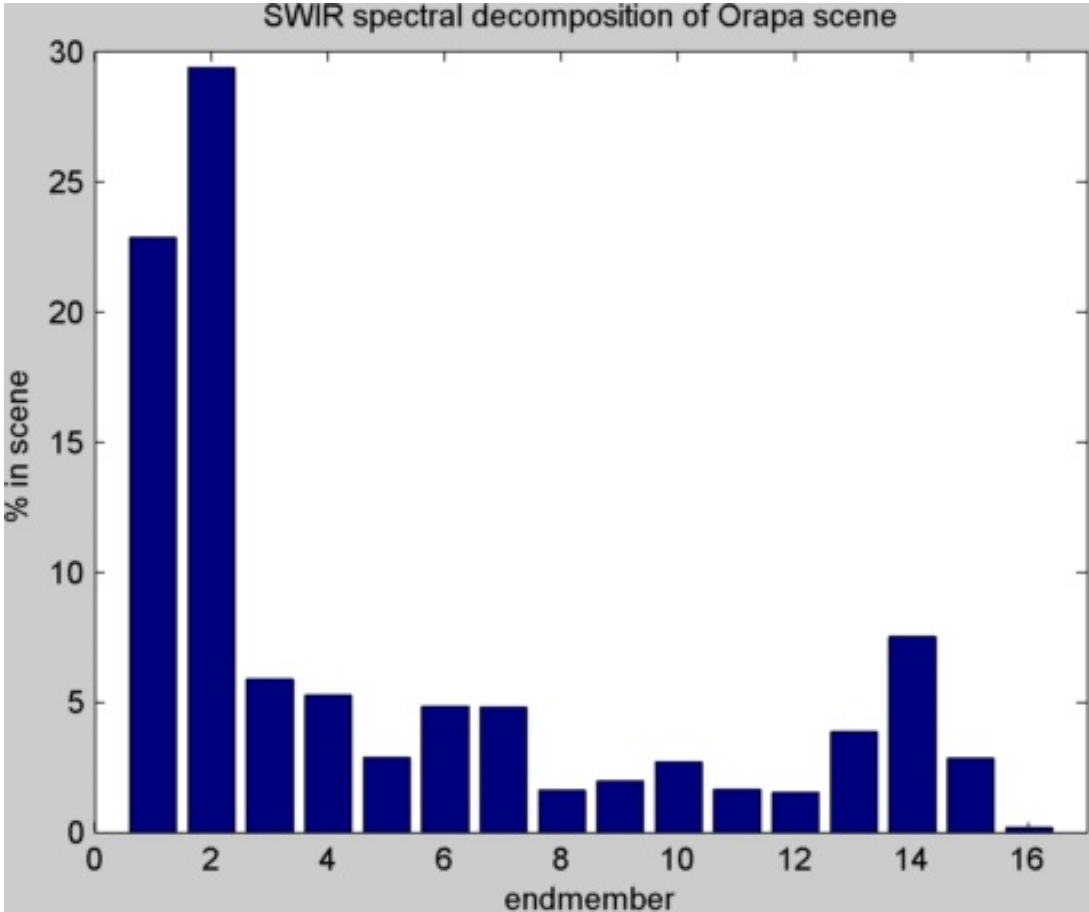
# Top classes are spatially coherent



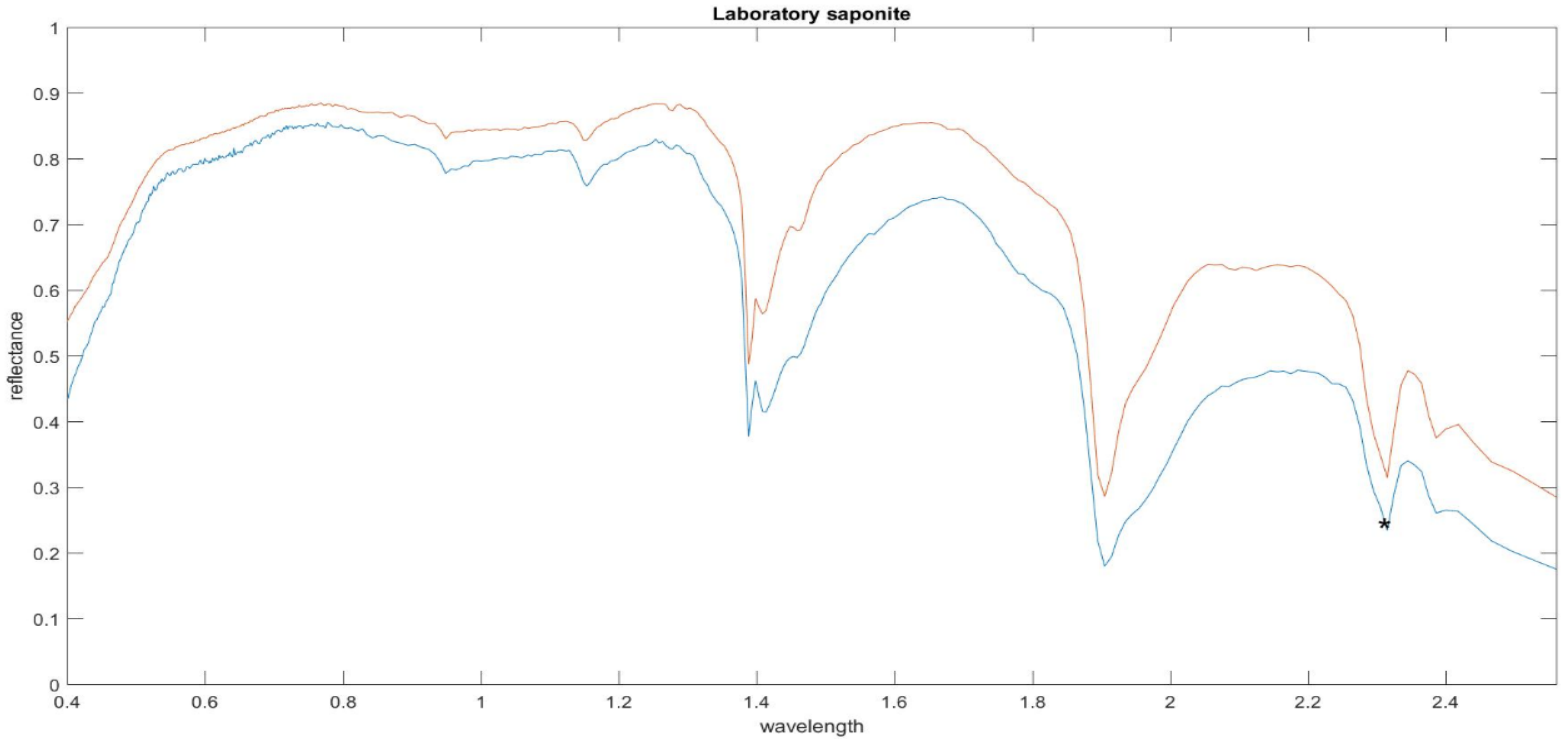
# Can do the same thing with SWIR



# Class 16 (Saponite) maps the kimberlites

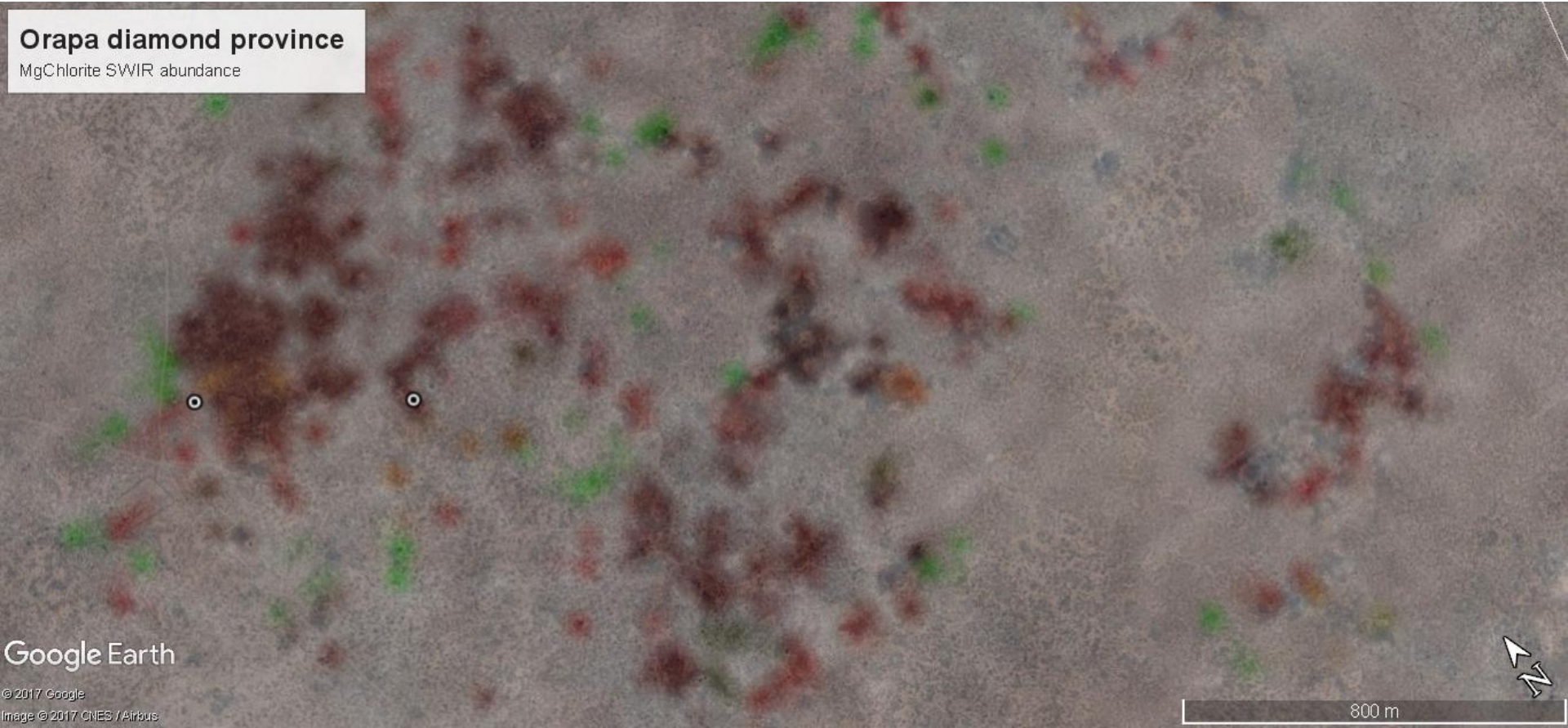



# Saponite SWIR reflectance spectrum
# focus on the 2.3 micron Mg feature, the reason De Beers pioneered hyperspectral kimberlite exploration

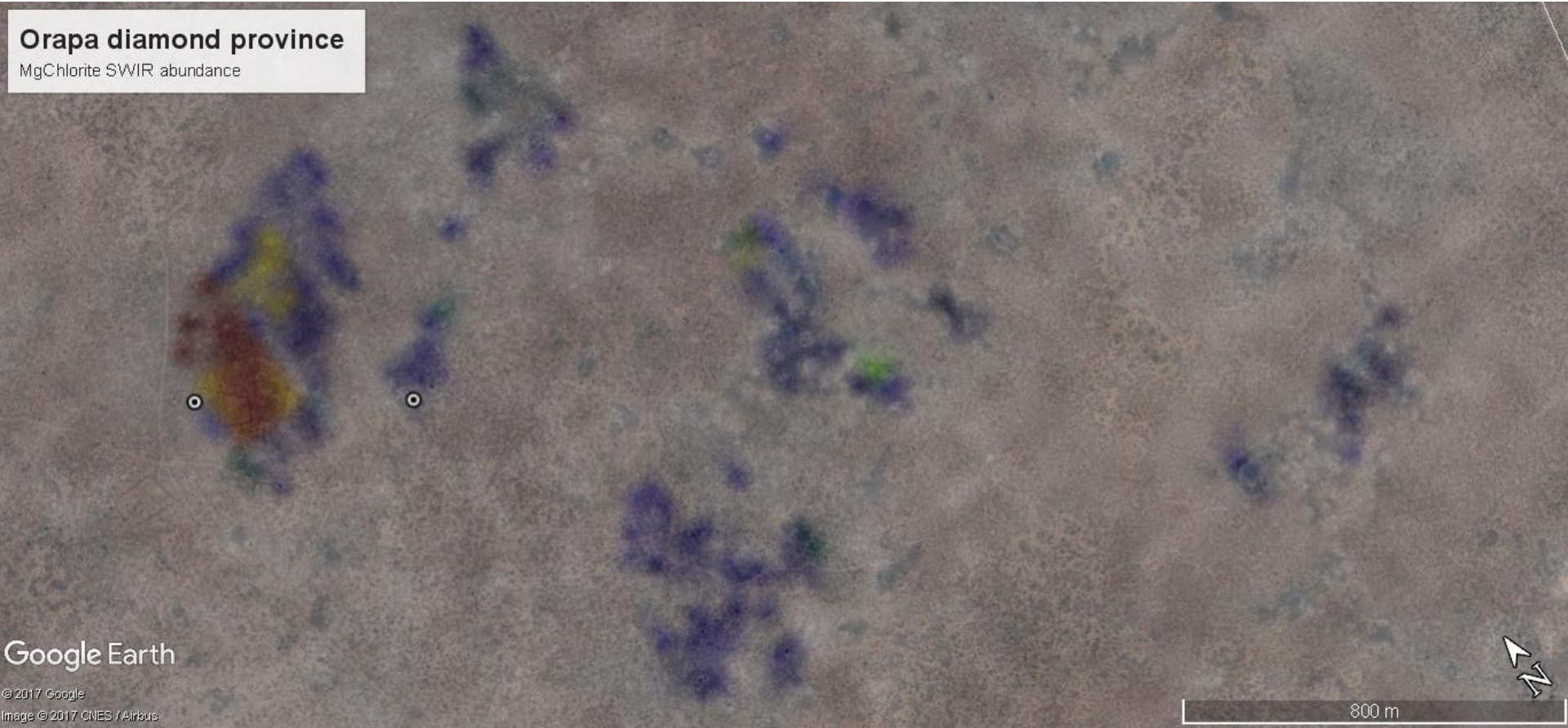


# A scatter of saponite in the desert worth drilling?

- are known kimberlites



# Do a bit of Kriging



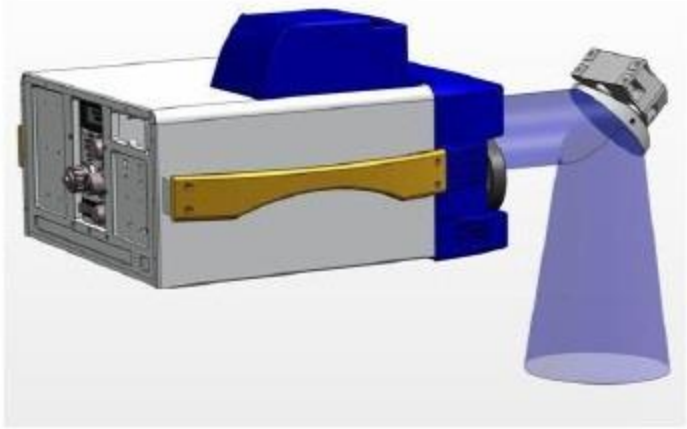
# The next step: a Botswana group shoot

- 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)

DIRT

GyroLAG

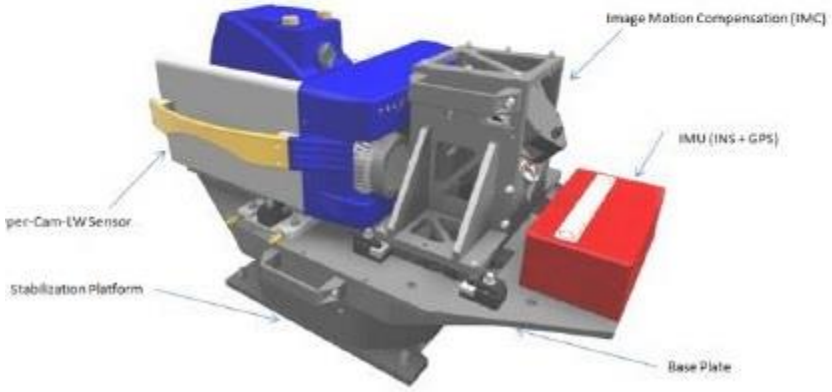
- Facilitates vertical measurements at ground level
- 45° tilted gold coated mirror that is located in the instrument's field of view
- 0.25x telescope
  - FOV at a sensor-target distance of 1.5 m is 672 x 538 mm
  - Resulting pixel size is 2.1 mm
- Airborne mode at 1500 m
  - FOV: 672 / 168 m
  - Pixel size: 2.1 / 0.53 m

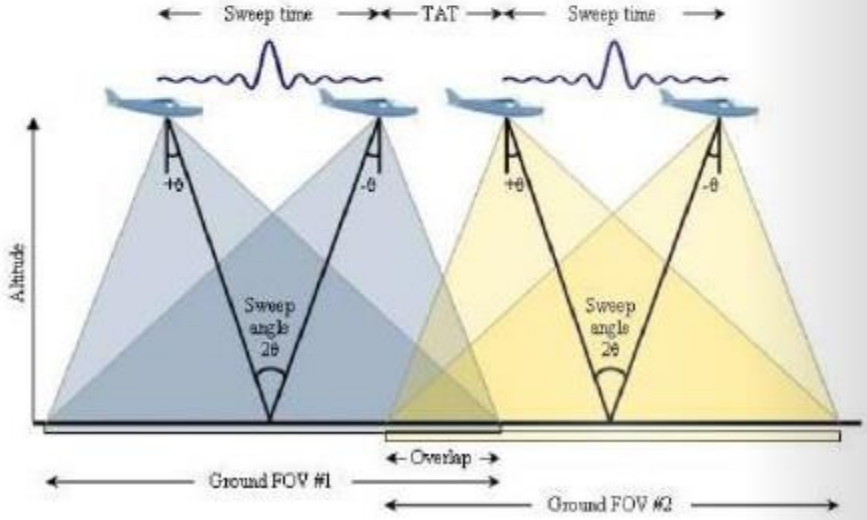


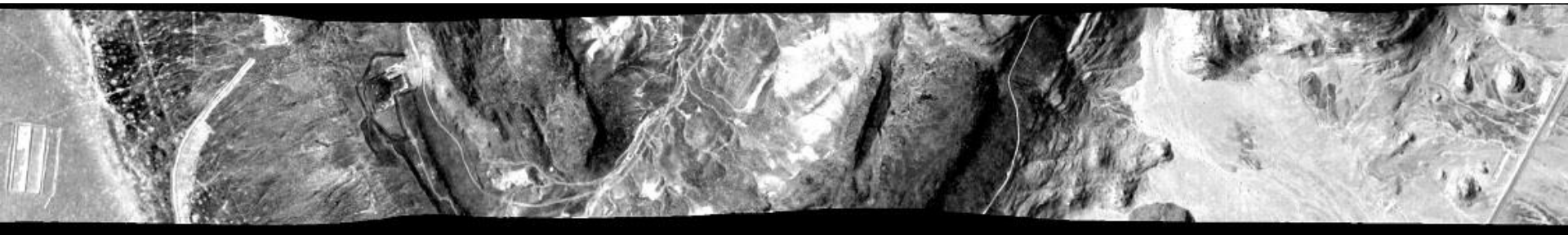
**Hyper-Cam-LW specifications**

| Parameter | Unit | Hyper-Cam-LW |
|---|---|---|
| Spectral Range | μm | 7.7 – 12 |
| Spectral Resolution | $cm^{-1}$ | 0.25 to 150 (user adjustable) |
| Image Format | - | 320 x 256 pixels |
| Field of View | Degrees | 6.4 x 5.1 (nominal) |
| | Degrees | 25.6 x 20.4 (0.25X telescope) |
| Typical NESR | $nW/cm^2srcm^{-1}$ | < 20 |
| Radiometric Accuracy | K | <1 |

- 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




2090000
2100000
2110000
0 2.5 5 7.5 10 km
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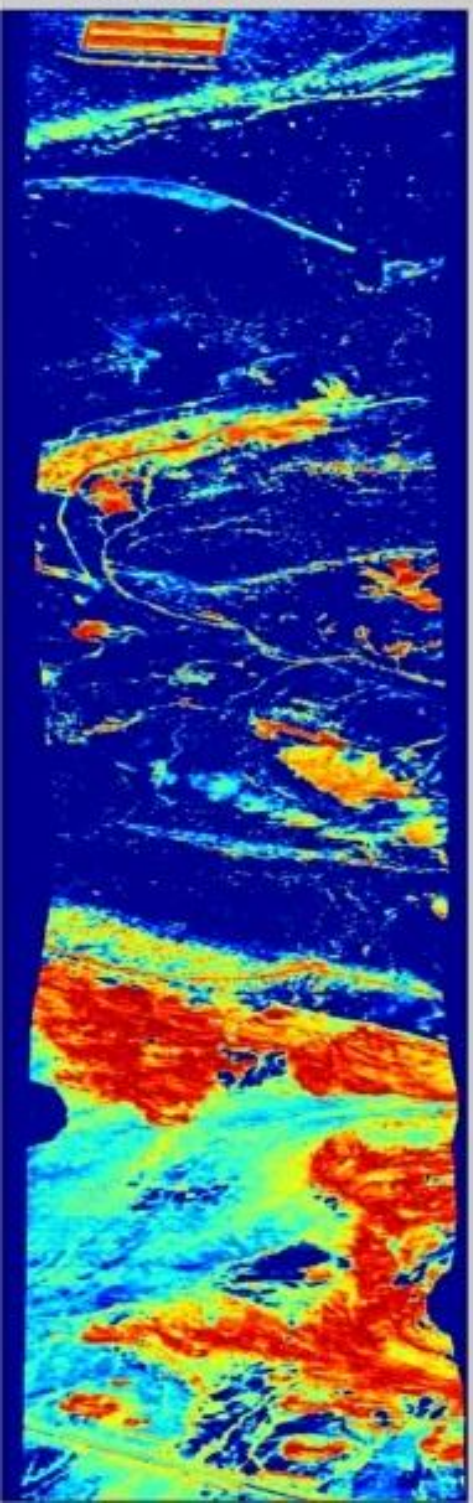
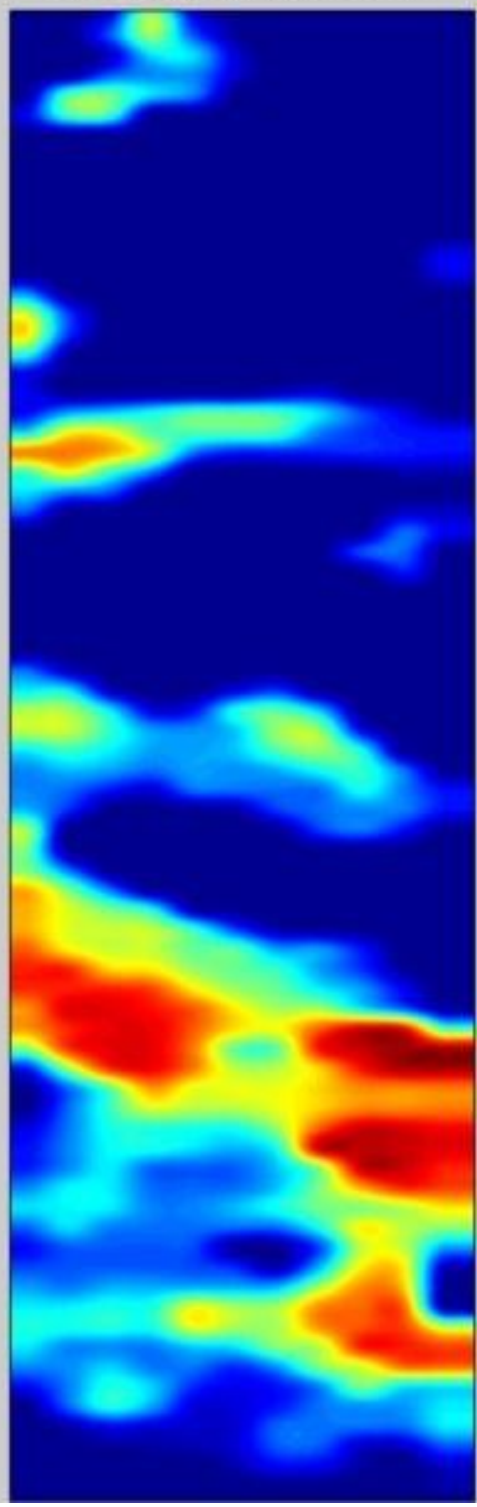
-3400000
-3410000
Big Syncline
Swartberg
Broken Hill
Gamsberg
Localities
Big Syncline Schist
Big Syncline Gossan
Swartberg Schist
Cu Rich Gossan
Quartz Magnetite
Garnet Quartzite
Barite
Swartberg Quartzite
Gamsberg Pink Gneis
Gamsberg White Quartzite
Gamsberg Schist
Gamsberg Amphibolite
Swartberg Rock Dump
Gamsberg Gossan
Gamsberg Quartz Magnetite

# Spectral abundances

Telops thermal quartz 2.5m



Aster thermal quartz 90m



# 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