A geologist’s guide to the comparison of hyperspectral satellite sensors for geological mapping

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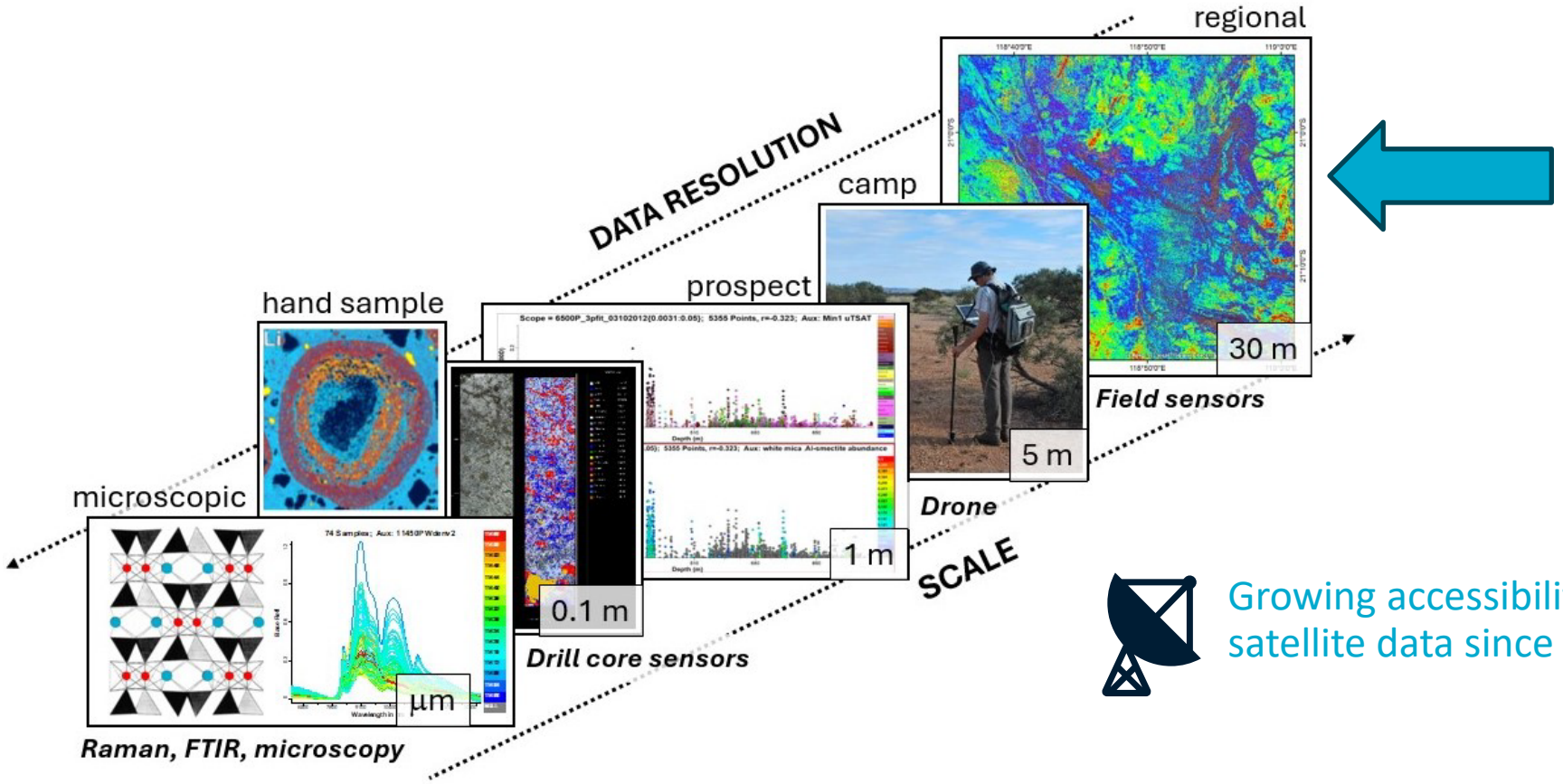
CSIRO Mineral Resources

Geologists using hyperspectral data



Growing accessibility of satellite data since 2019

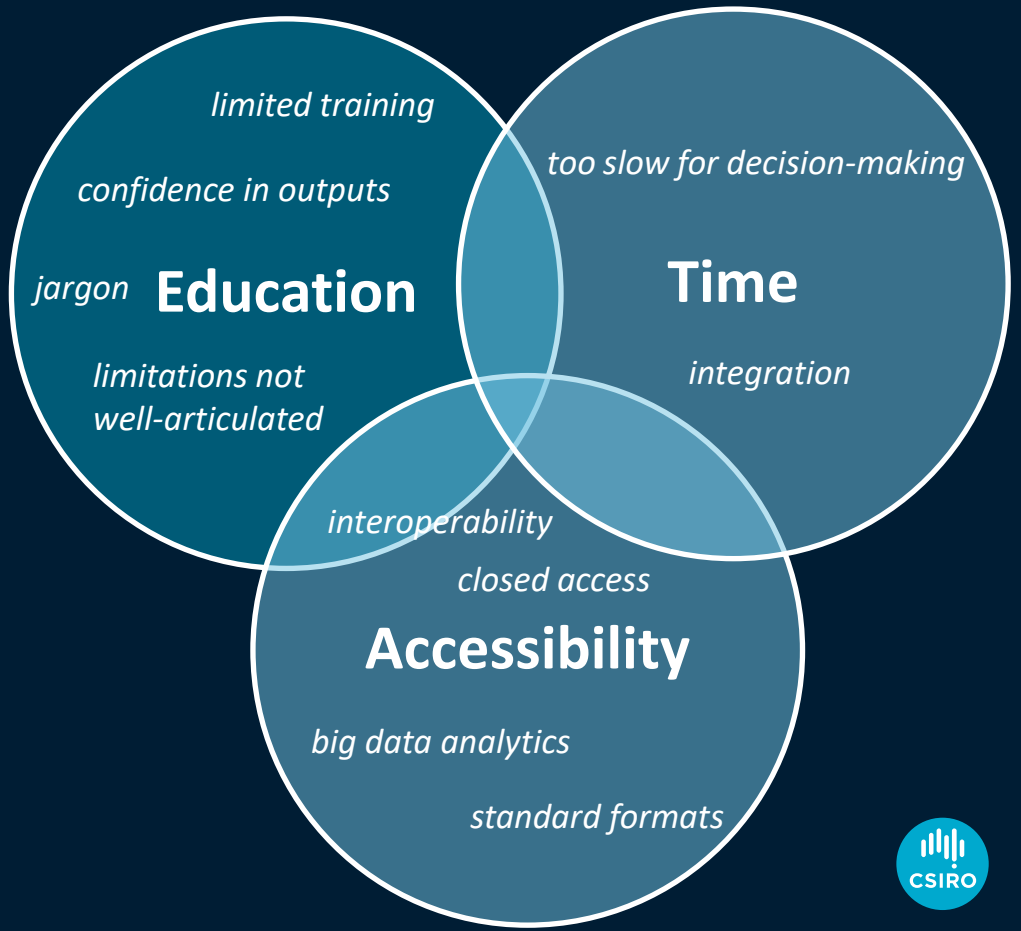
Aims

Compare PRISMA, EnMAP, and EMIT imagery

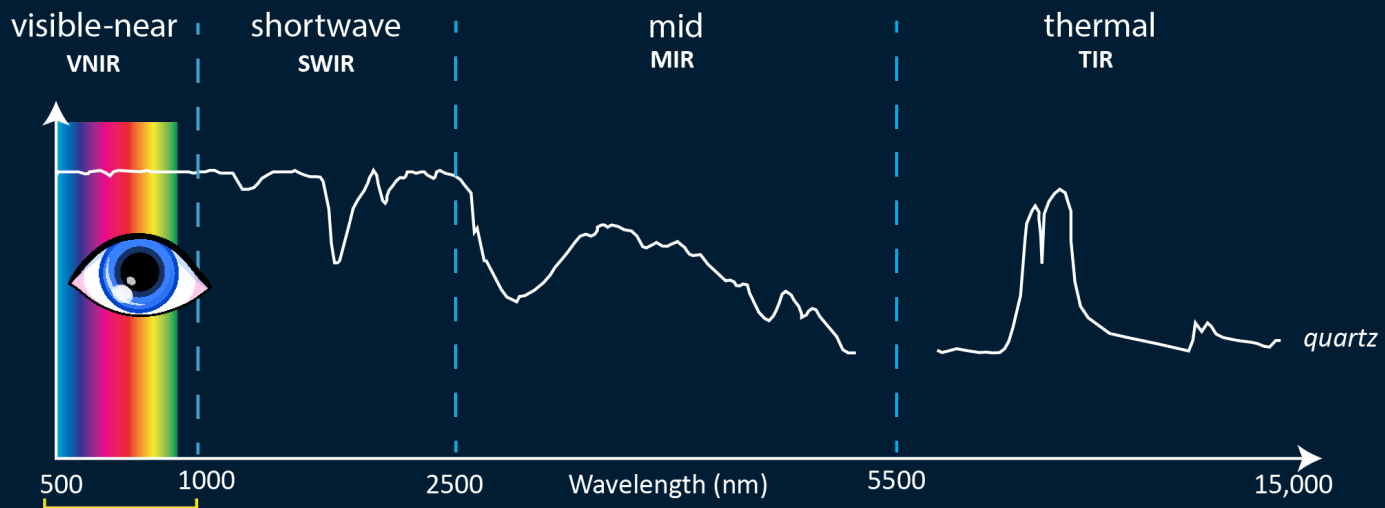
Demonstrate reproducibility and integration

Improve accessibility for geologists

Barriers geologist's face with EO data

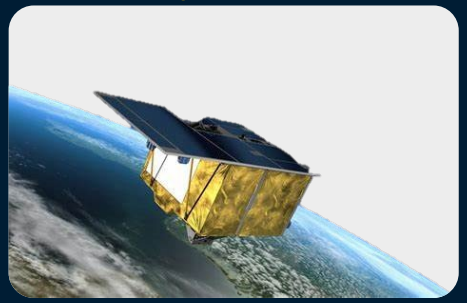


Electromagnetic (EM) spectrum

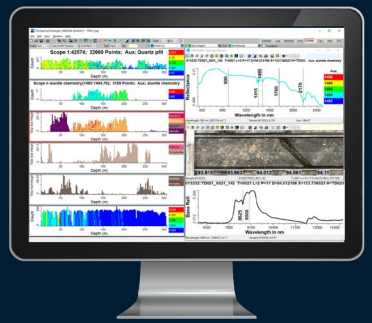


Approach

Acquisition

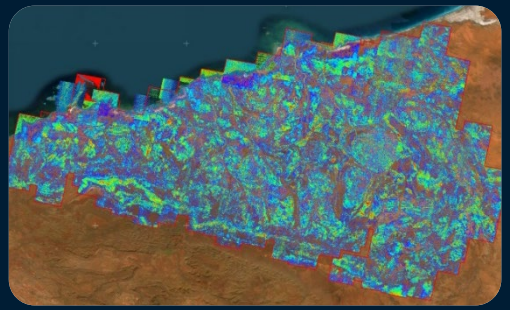


Mineralogy



Fieldwork

Mineral map product



Reinvestigate ← Refine

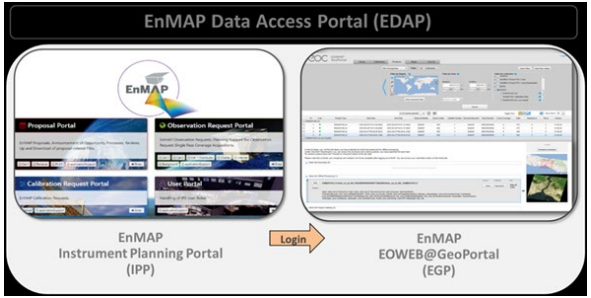
Reacquire ← Missing imagery

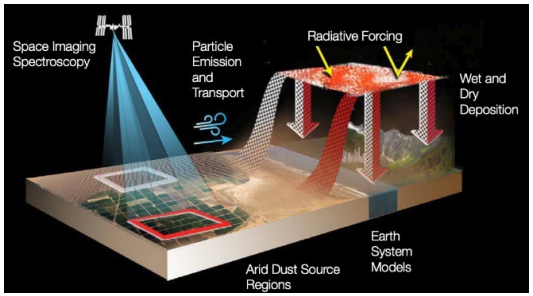
Automate ← Yes

Do the mineral maps accurately represent the rocks?

Hyperspectral satellite sensor comparison

	PRISMA Italian Space Agency (ASI)	**EnMAP** German Aerospace Center/ GeoForschungsZentrum (DLR/GFZ)	**EMIT** NASA/JPL
Pixel size (m)	30x30	30x30	60x60
Swath (km)	30	30	75
VNIR range *SWIR range (nm)*	400 – 1010 (66B) 920 – 2500 (174B)	400 – 1000 (90B) 920 – 2450 (132B)	381 – 2493 (258B)
Spectral resolution (nm)	<14	<12	<9





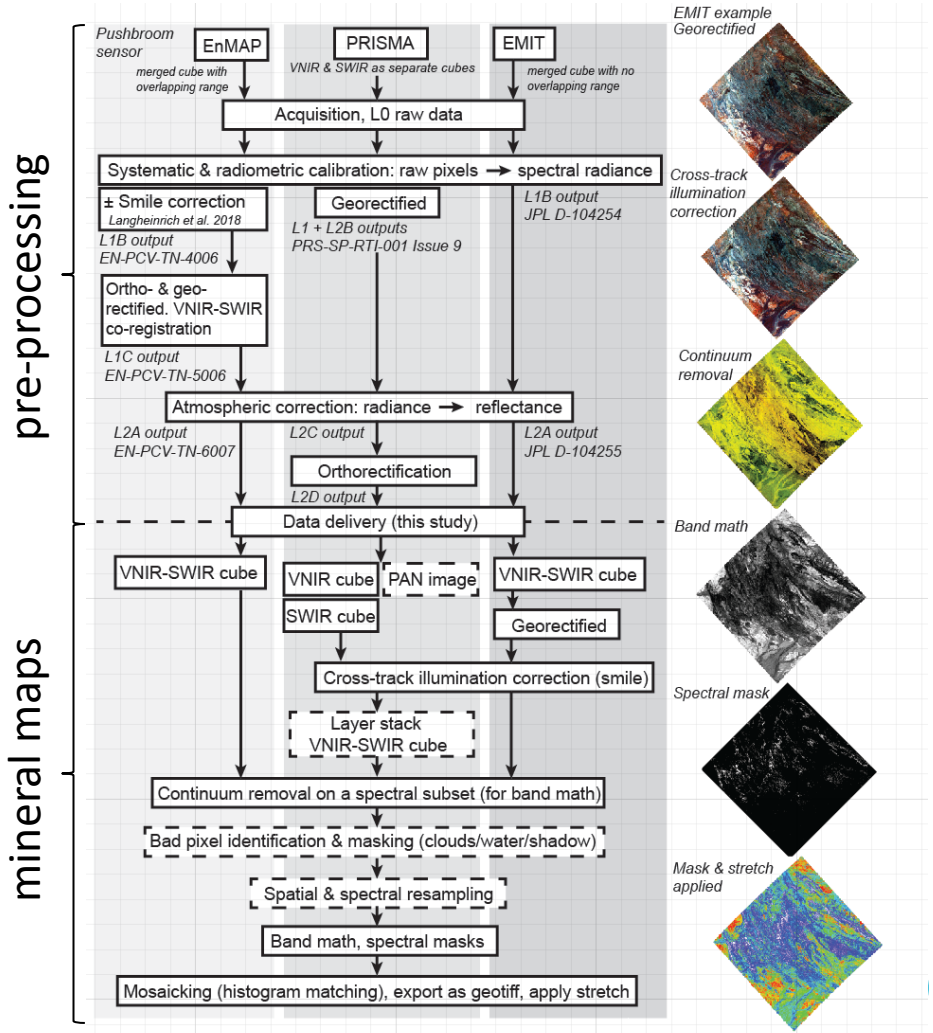
https://www.asi.it/en/earth-science/prisma/

https://www.enmap.org/

https://earth.jpl.nasa.gov/emit/

Data processing workflow

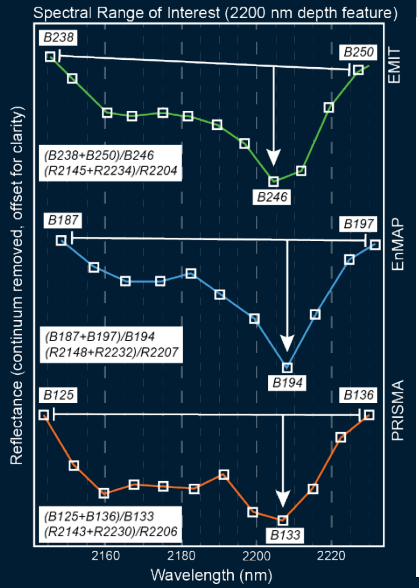
- Pre-processing conducted by data providers
- Processing levels used as input for processing mineral maps:
  - PRISMA: L2D
  - EnMap: L2A
  - EMIT: L2A
- Cross-track illumination correction required for PRISMA and EMIT
- PRISMA VNIR-SWIR cubes have to be stacked
- After that, hyperspectral imagery from all three sensor are treated in the same way:
  - Continuum removal on spectral subset
  - Band math and masking
  - Mosaicking

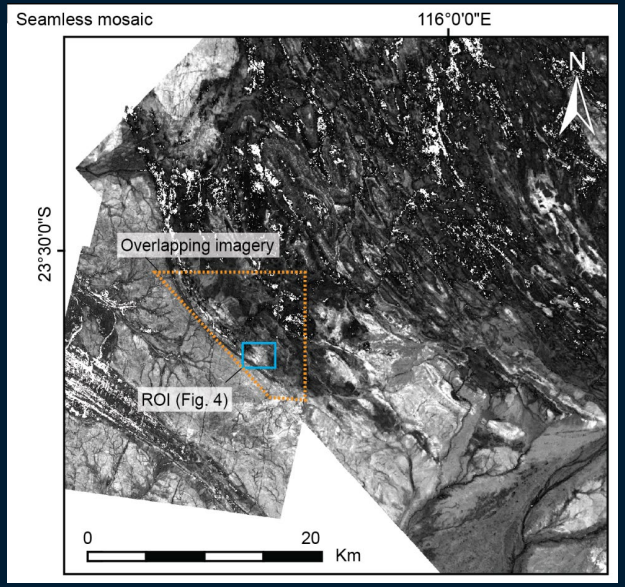


Multi-sensor comparison, Gascoyne

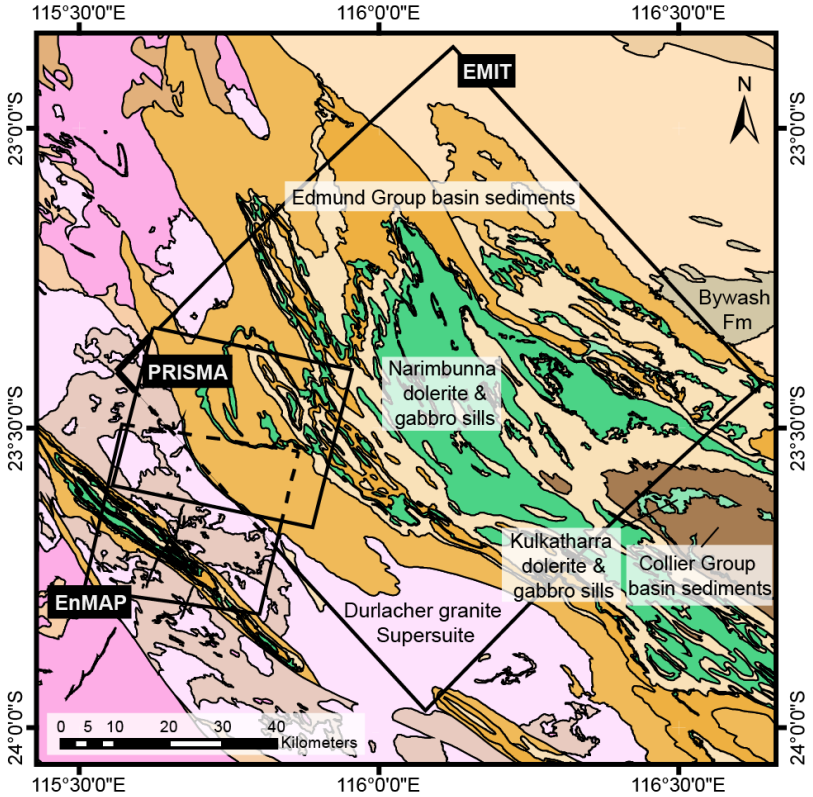
Understand variations in sensor configurations and corresponding data

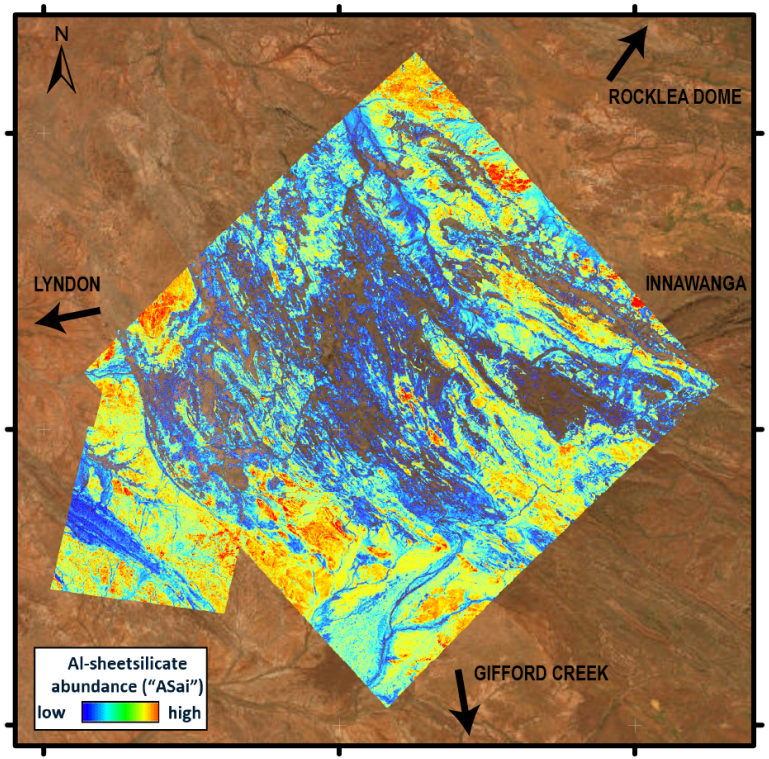
Targeting diagnostic absorption features





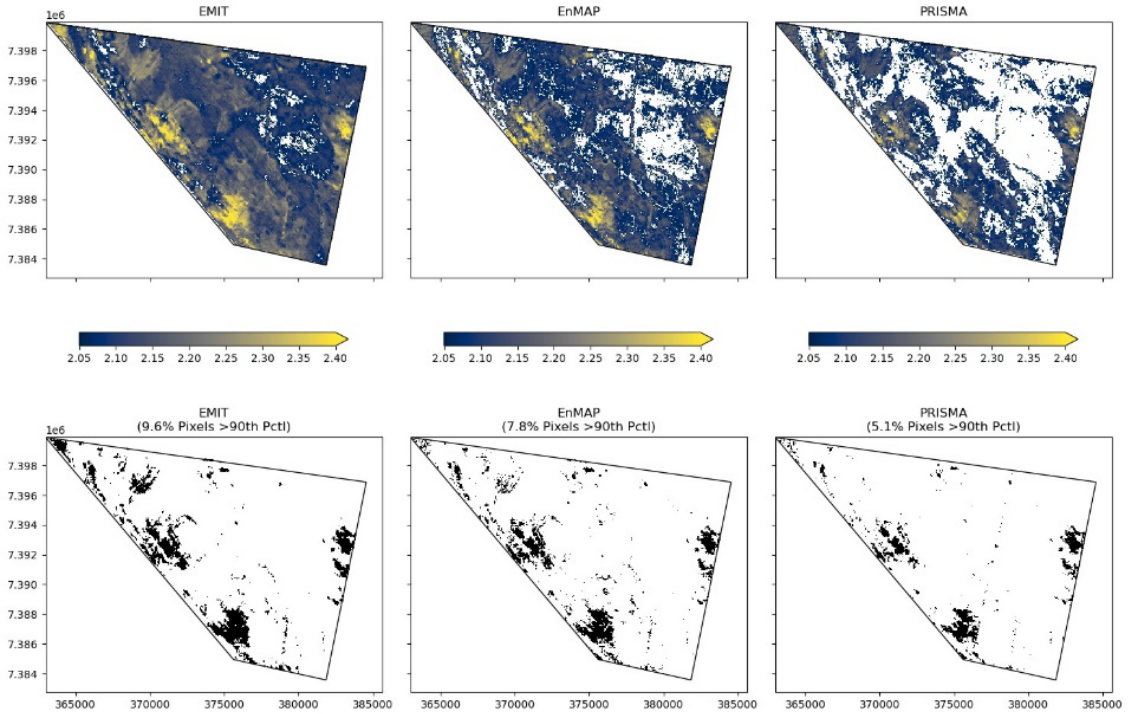
Mapping Al-sheet silicates (ASai)



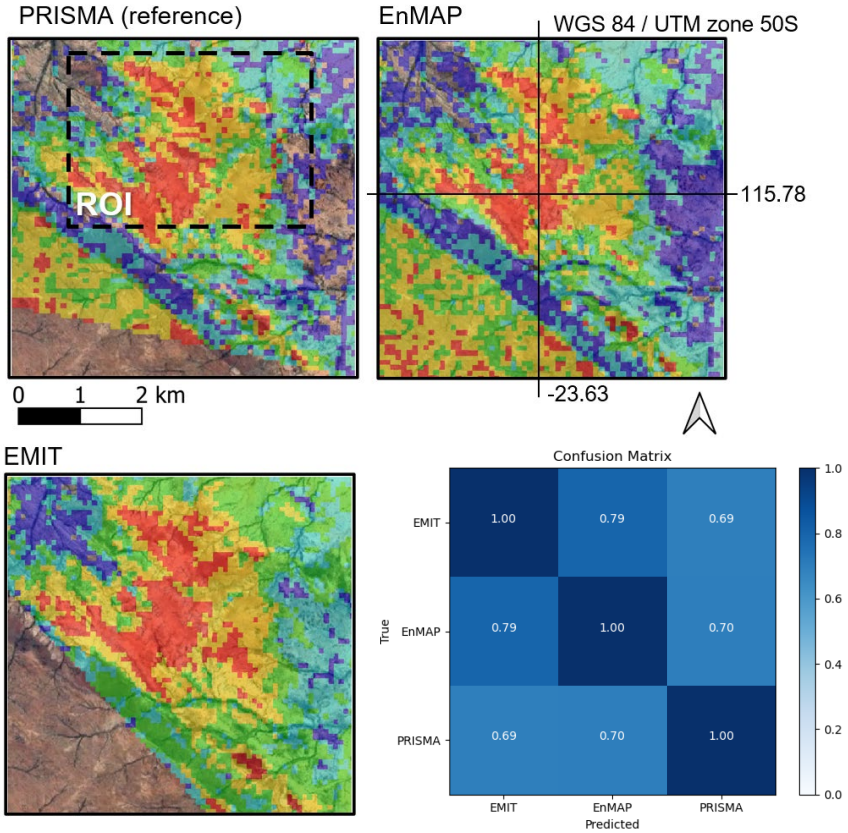


Multi-sensor result comparison

- Reprojected into the same coordinate system
- Spatially resampled
- 90th percentile used as a threshold to a stretch range of 2.05 – 2.40
- Boolean ‘And’ operation combined images, and summed pixels above this threshold
- Calculated the % of matching pixels



ASai maps – multi-sensor confusion matrix



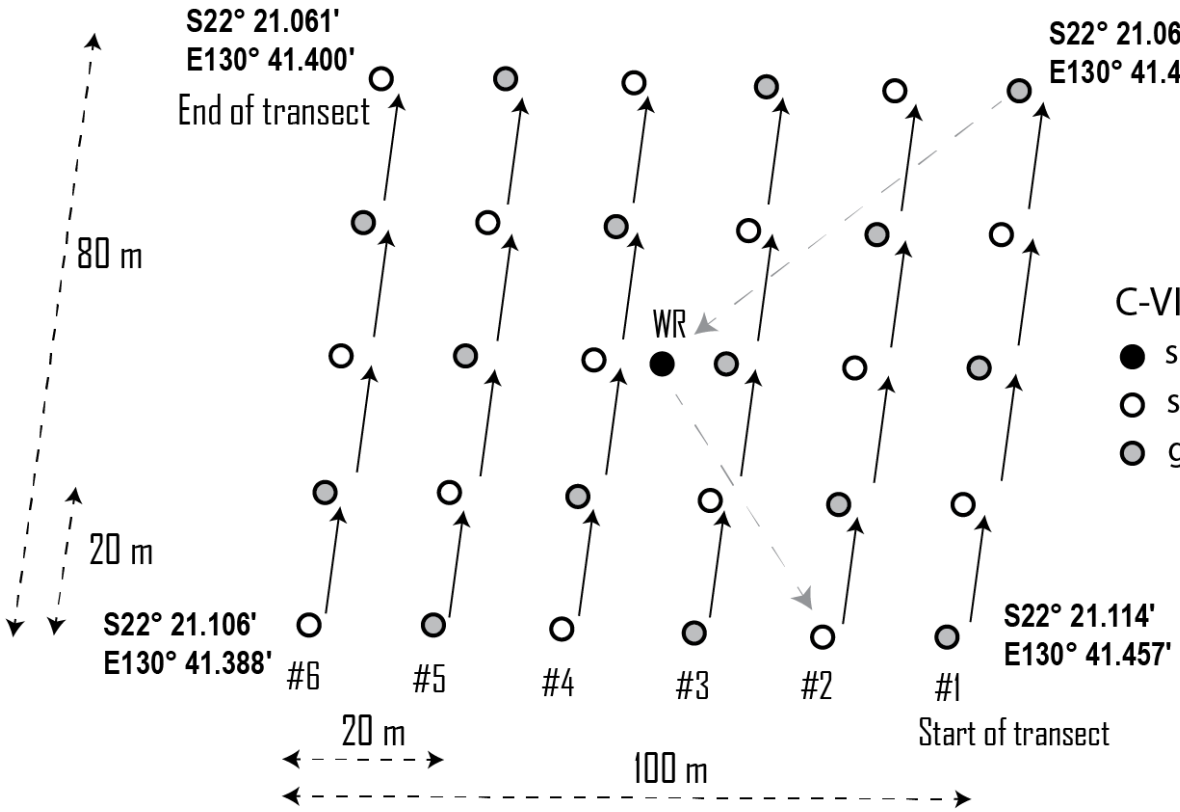
- Consistency in high-abundance features
- Discrepancies occur at low-abundance features, likely associated with sensor-specific SNR

e.g. EnMAP high ASai zones show 70% likeness to that of PRISMA

(acquired at different times)

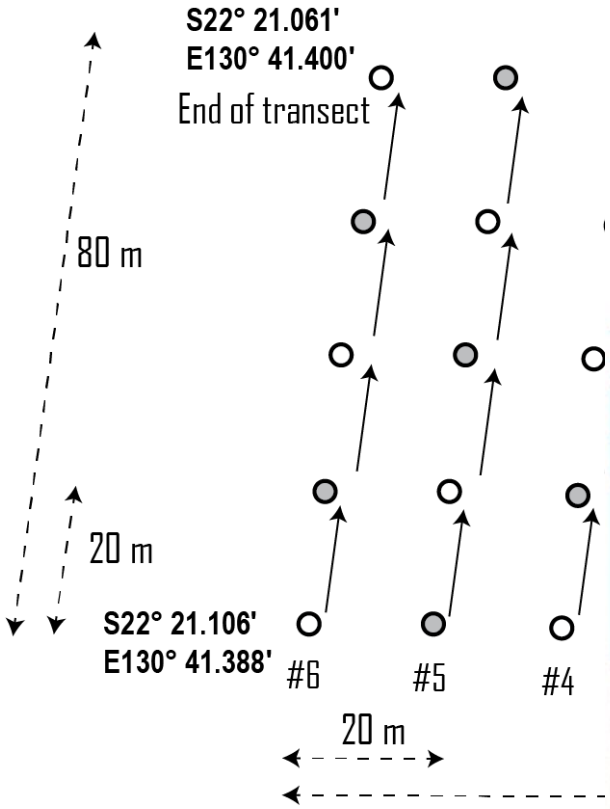
Ground validation

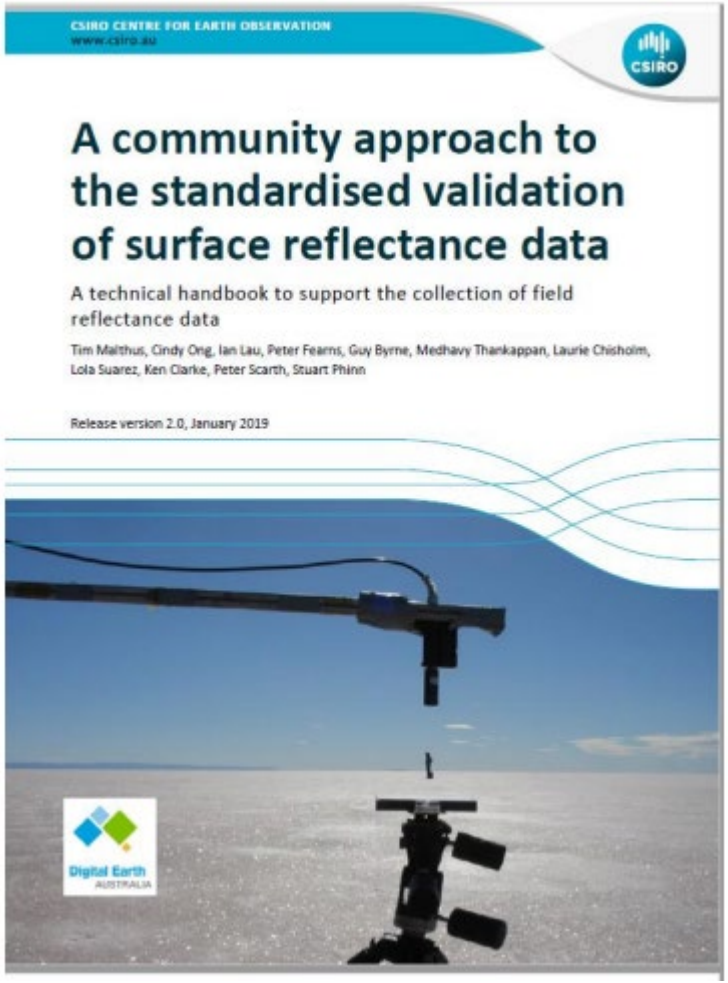
- EnMAP satellite overpass during field sampling
  - Reflectance of soil, bedrock and regolith with handheld TerraSpec ASD and Spectral Evolution oreXpert *(VNIR-SWIR)*
  - Mineral ID with portable Agilent FTIR *(SWIR-MIR-TIR)*
- Geochemistry: Bruker Titan S1 pXRF
  - Work towards quantitative mineral maps



C-VIRS-T1

- spectralon white reference (WR)
- spectral start point for continual data collection
- geochemistry & mineralogy sample





white reference (WR)

rt point for continual data collection

try & mineralogy sample

Implications for the geologist

- Integration potential of hyperspectral sensors
- Applications in the geosciences and mineral exploration
- Building trust in the techniques, and improving accessibility for geologists

Government of **Western Australia**
Department of **Mines and Petroleum**

Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

CSIRO Mineral Resources at IGARSS

- Hyperspectral exploration for Li-pegmatites in Angola: Partial Least Squares Regression (PLSR) modelling – Lampinen et al. *> Tuesday session TU4.P5.1*
- Mapping minerals across the Pilbara Craton using geoscience-tuned satellite hyperspectral imagery – Laukamp et al. *> Tuesday session TU4.P5.3*
- Towards mapping the Australian continent with the next generation of hyperspectral satellite imagery – Laukamp et al. *> Thursday session TH4.PT5.1*

Thank you

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