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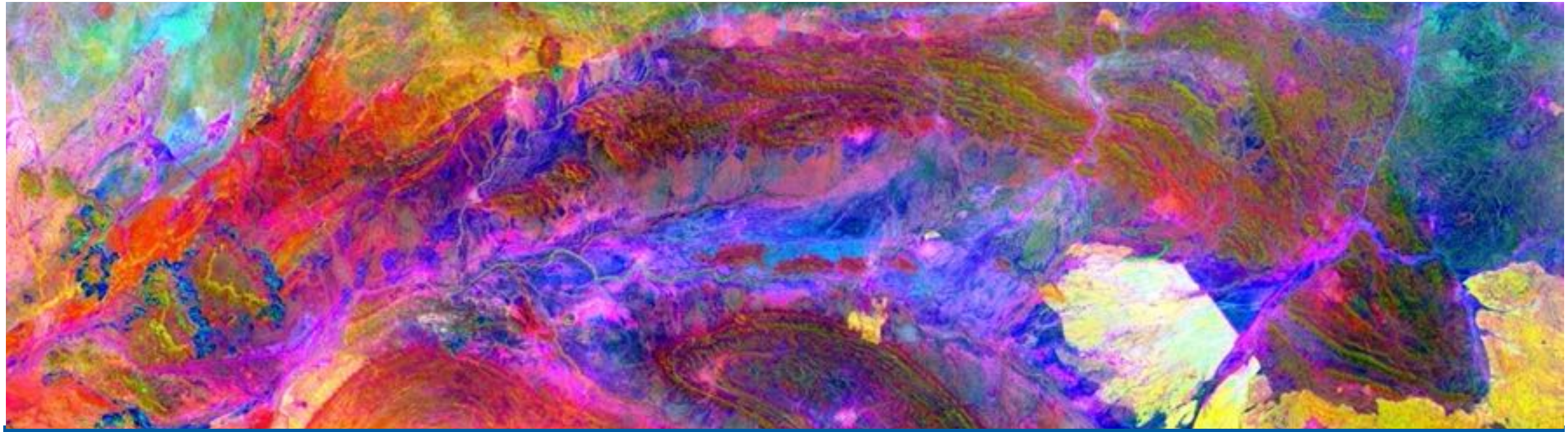

How can we enable the full potential of spaceborne hyperspectral mineral mapping?

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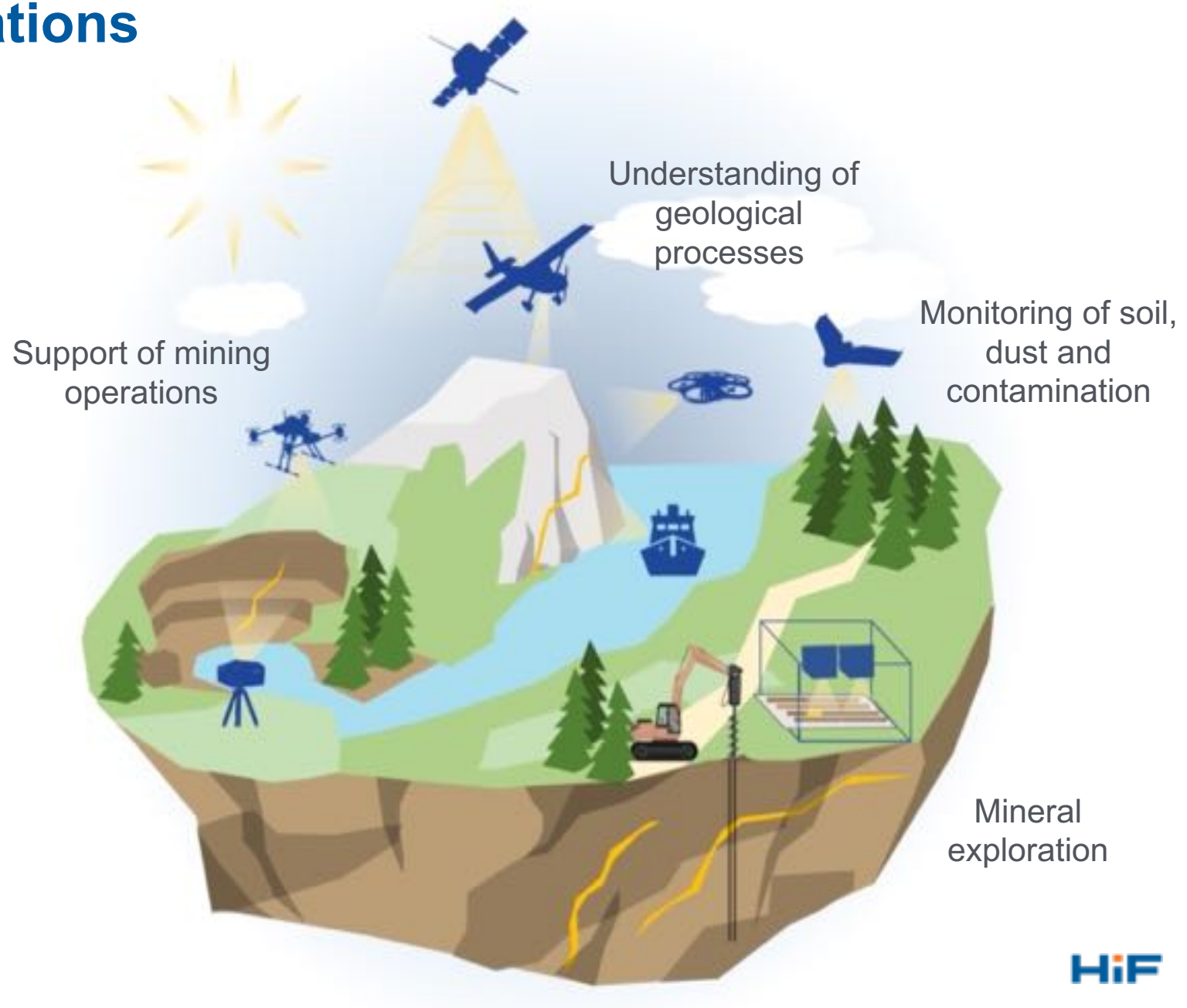
Mineral mapping applications

Challenges and requirements

- Relevant processes at mm to km scale
- Obscured target surfaces due to steepness, shadows, vegetation and soil cover
- High relevance of textural and topographical (3D) information
- Complex composition and delicate spectral features
- Fundamental information outside the VNIR-SWIR
- Restricted access to validation data

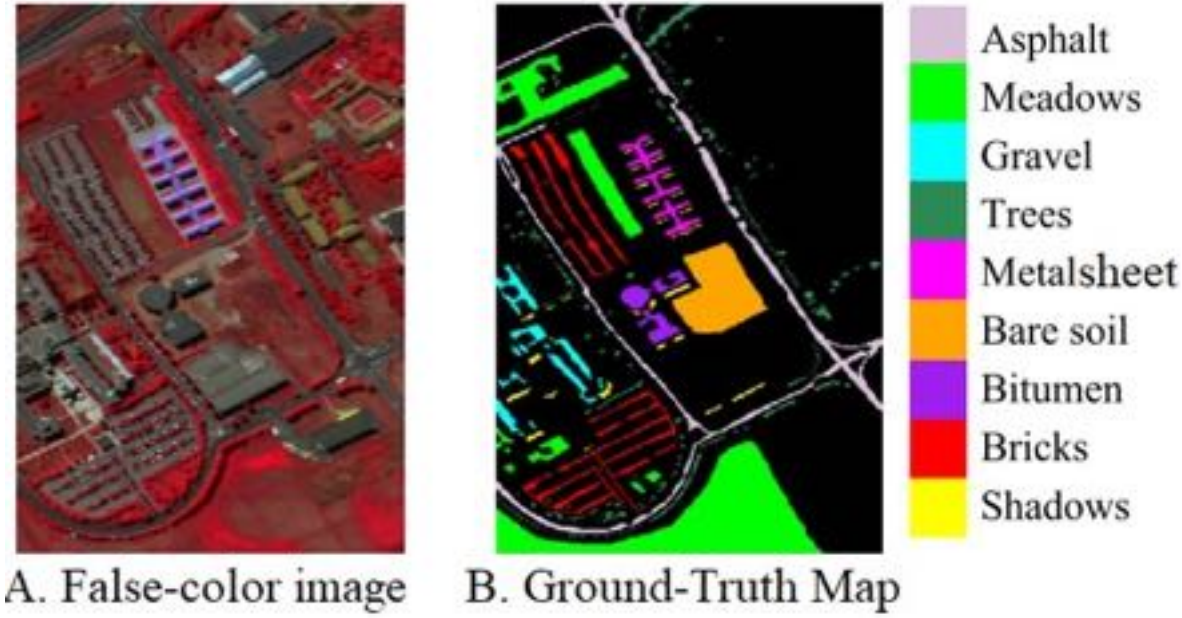


State of the art

Major relevant developments in HSI processing and machine learning,

which are mostly:

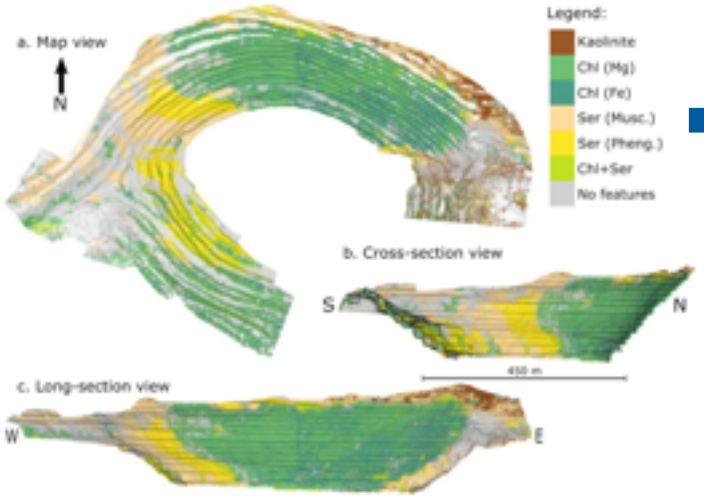
- Solely 2D
- Solely VNIR-SWIR
- Not representative of mineral mapping applications (artificial scenes, homogeneous classes, high number of training pixels)
- Testing on small, “light-weight” data sets
- Closed source and hardly reproducible by users

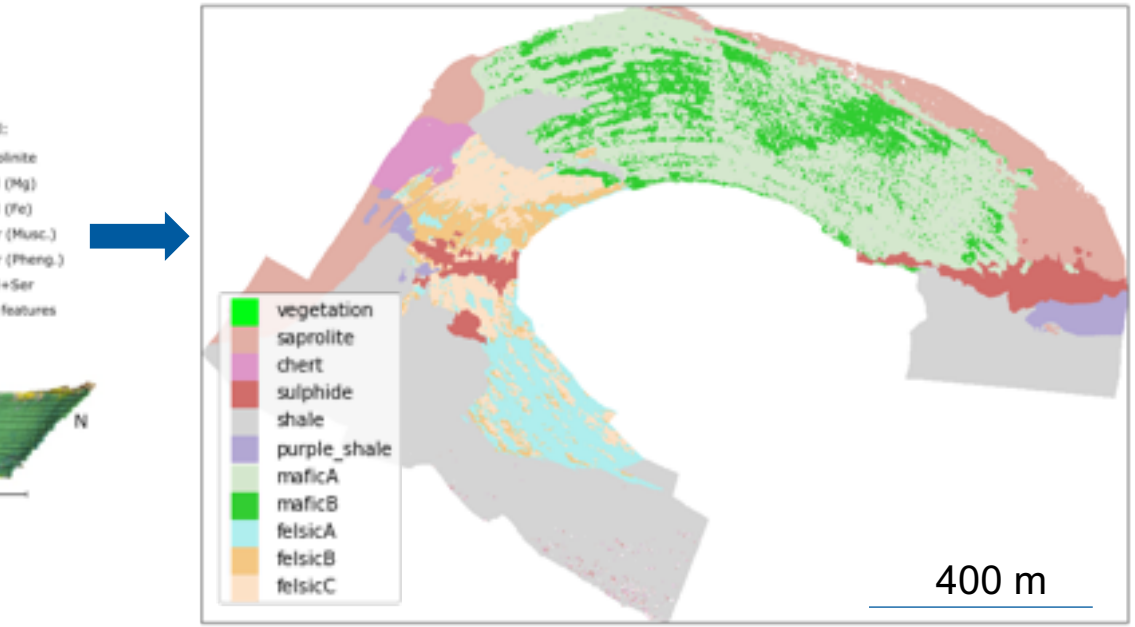


The Pavia University data set

Action 1: Establish relevant benchmark data and reference sites

- Complex and realistic mineralogical information
- Adaptable lithological classes (domains)
- Preserved 3D information
- Wealth of expert knowledge due to state-of-the-art sensing and validation

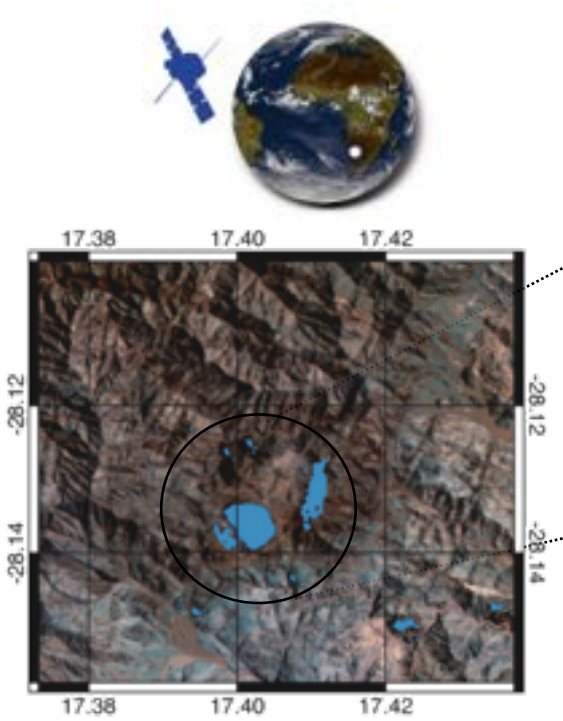




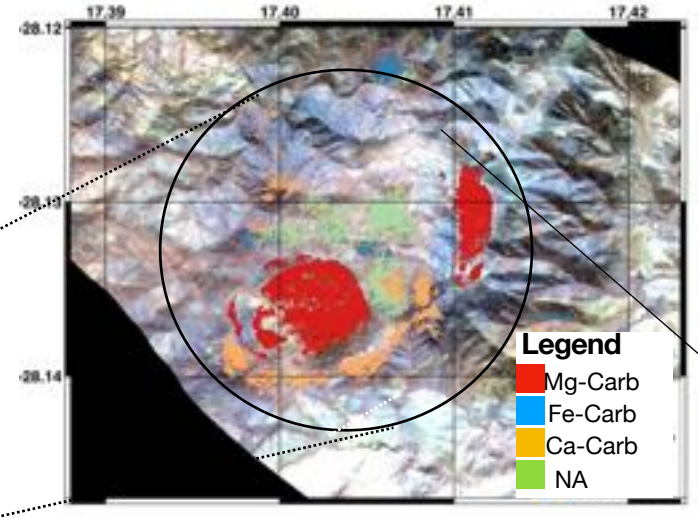
Thiele et al., 2021, Ore Geology Reviews

Action 2: Enable digital twins across scales

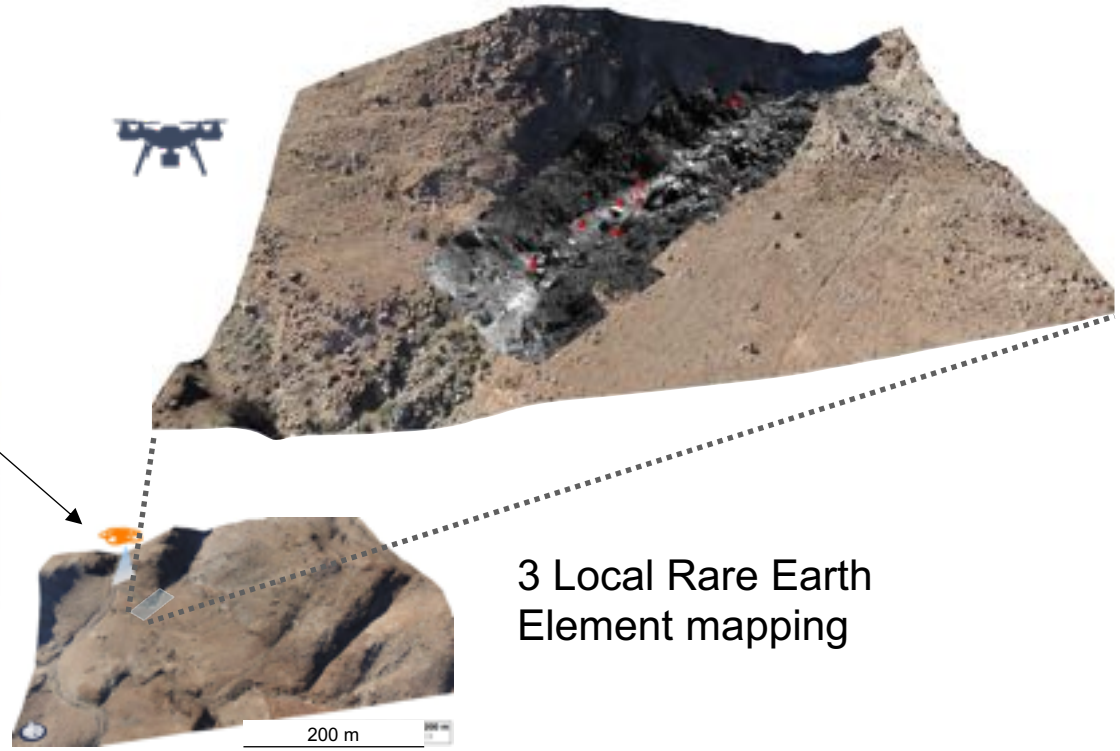
Unlocking the full potential of multi-scale HSI mapping



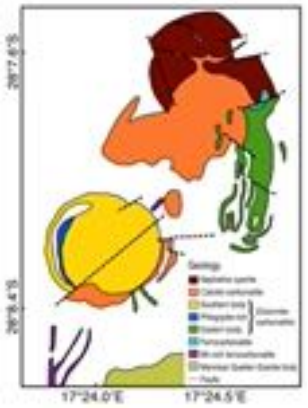
1 Carbonatite detection



2 Carbonatite type mapping



3 Local Rare Earth Element mapping

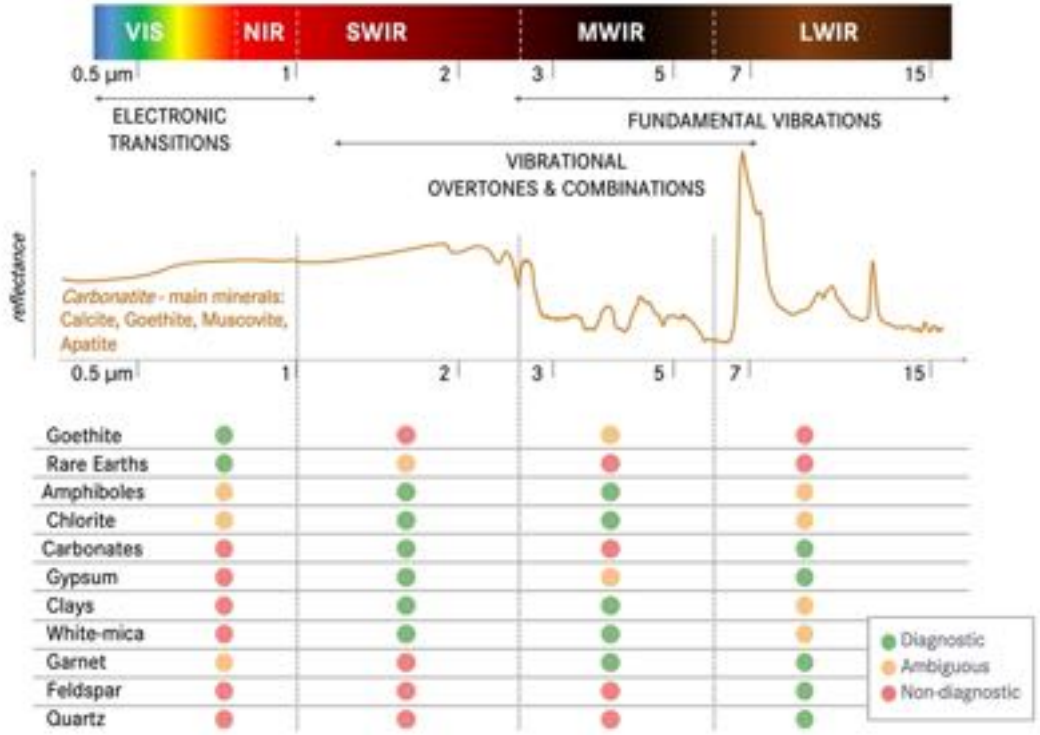


4 Upscaling of information to satellite scale

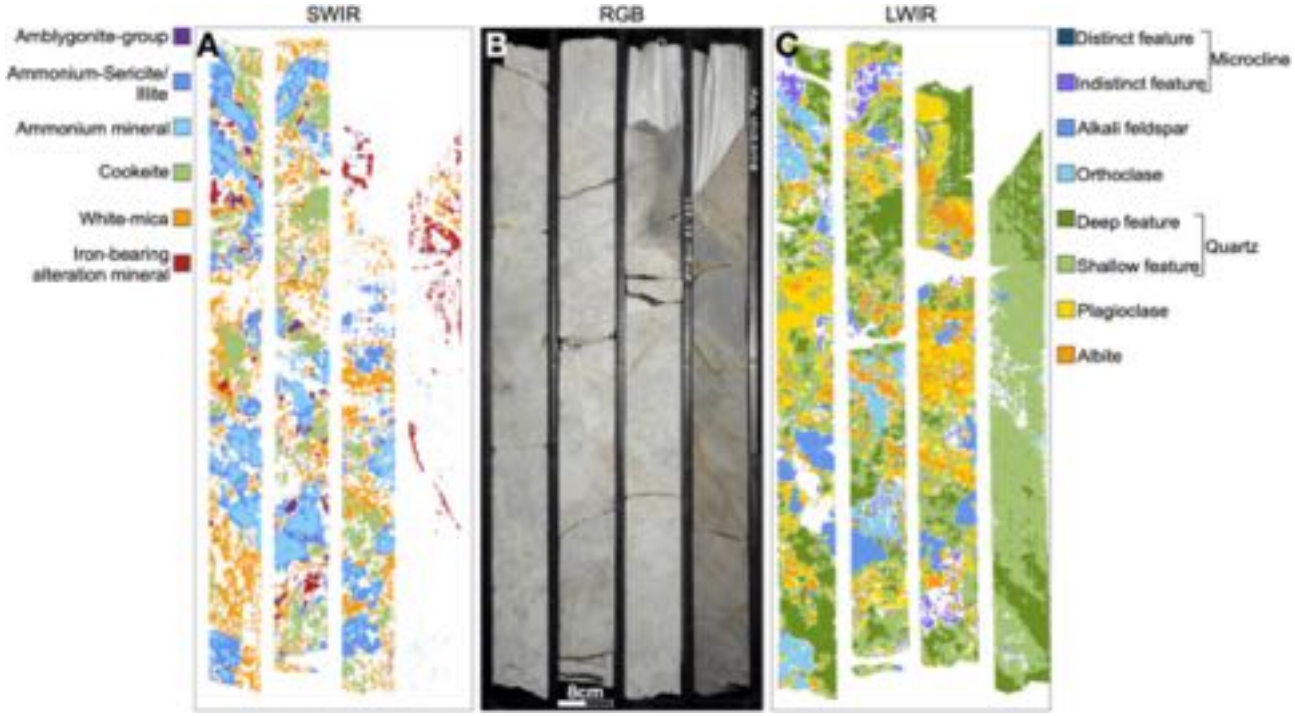
Booysen et al., 2019, Remote Sensing
Booysen et al., 2020, Scientific Reports

Action 3: Maximize the informative spectral value

Utilize the full spectral information



Proven value in combining SWIR and LWIR spectral ranges for mineral mapping!



Lorenz 2019, PhD Thesis
Booysen et al., 2021, Remote Sensing of Environments

Summary

How can we enable the full potential of spaceborne hyperspectral mineral mapping?

- Establish relevant **benchmark sites**
- Adapt state-of-the-art **machine learning** developments to real applications (big data, complex scenarios, “imperfect” data, sparse training data)
- Utilize the **extended wavelength range** (up to long-wave infrared) for full mapping potential
- Boost the development of **multi-scale** data processing (important: operationalize drone- and terrestrial data acquisition and processing)
- Develop from maps to **multi-temporal, multi-modal 4D digital twins**
- Publish **open-source** and reproducible workflows

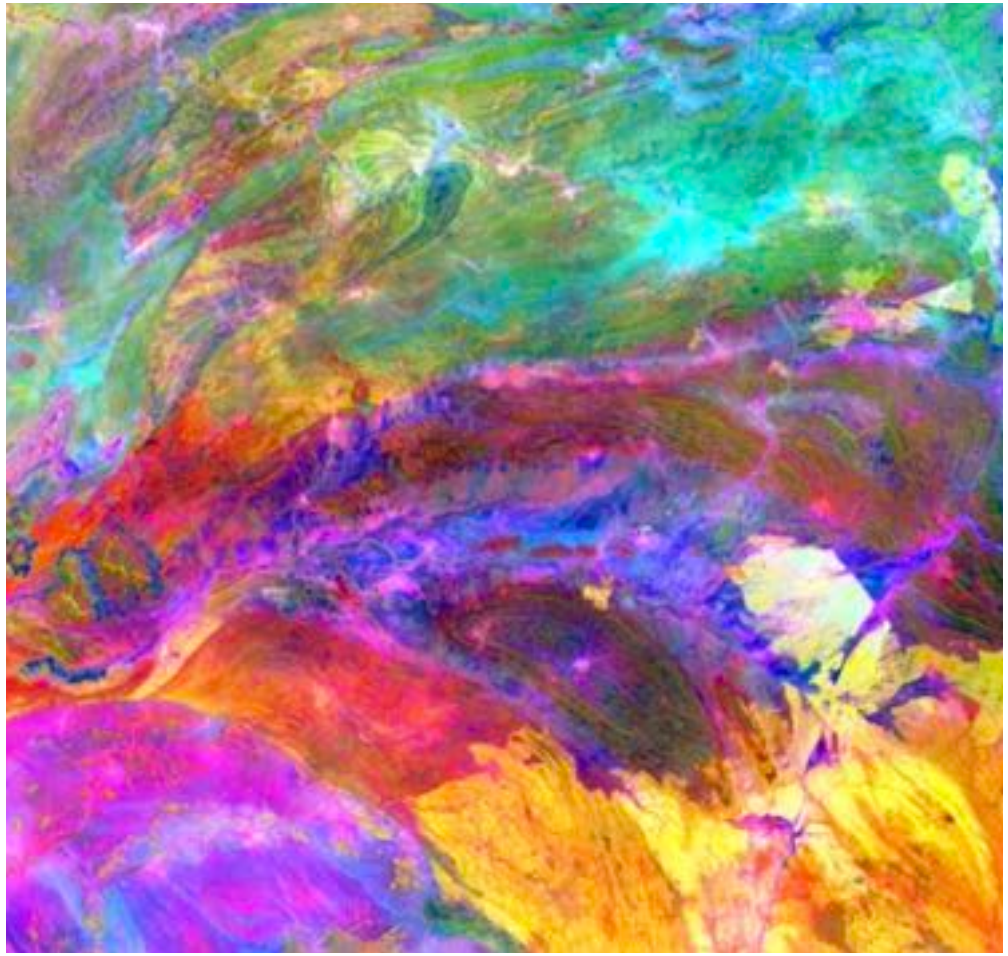


Image credit: René Booysen