Integrated AVIRIS and MASTER analysis for surface composition determination and mapping

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Overview

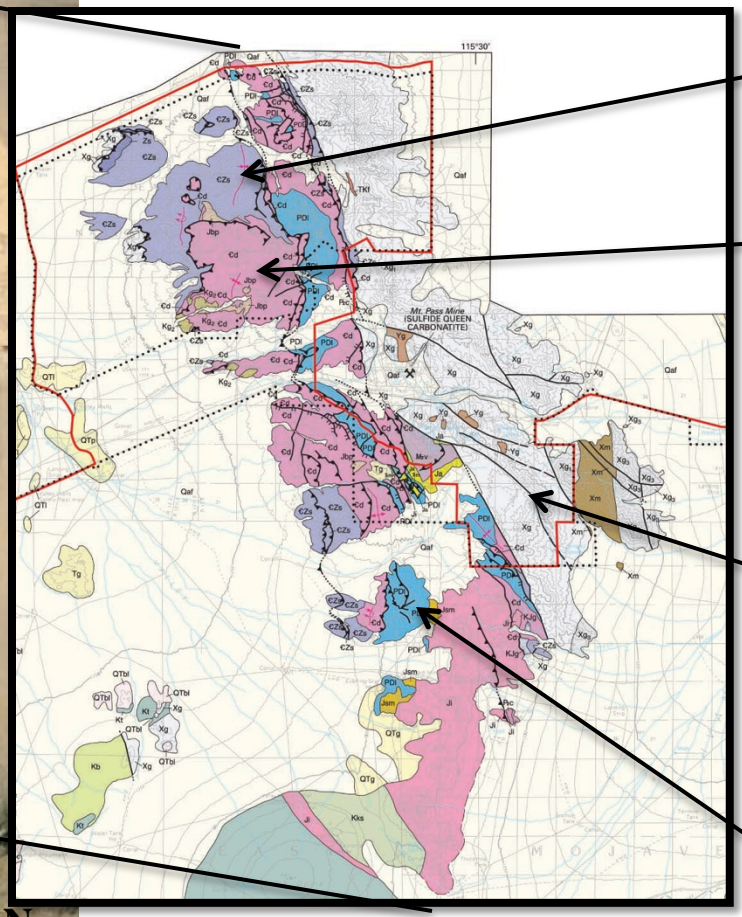
- Introduction
- Study area
- Data sets
- Approach
- Results
  - VNIR-SWIR
  - LWIR
  - Integrated VNIR-SWIR-LWIR
- Summary & ongoing work

Motivation & Objective

- Spectral remote sensing useful for mapping surface composition
- Application may be limited by spectral similarity of materials or lack of characteristic features in a single wavelength range
- Improve and extend identification and mapping capability by integrating VNIR-SWIR and LWIR data
- Relevant to HyspIRI combined science question on the composition of the terrestrial surface
- Applied to geology but concept could be used in other areas

Mountain Pass, California

Mountain Pass, California



Siliciclastic Rocks

Dolomite

Gneiss & Granitoids

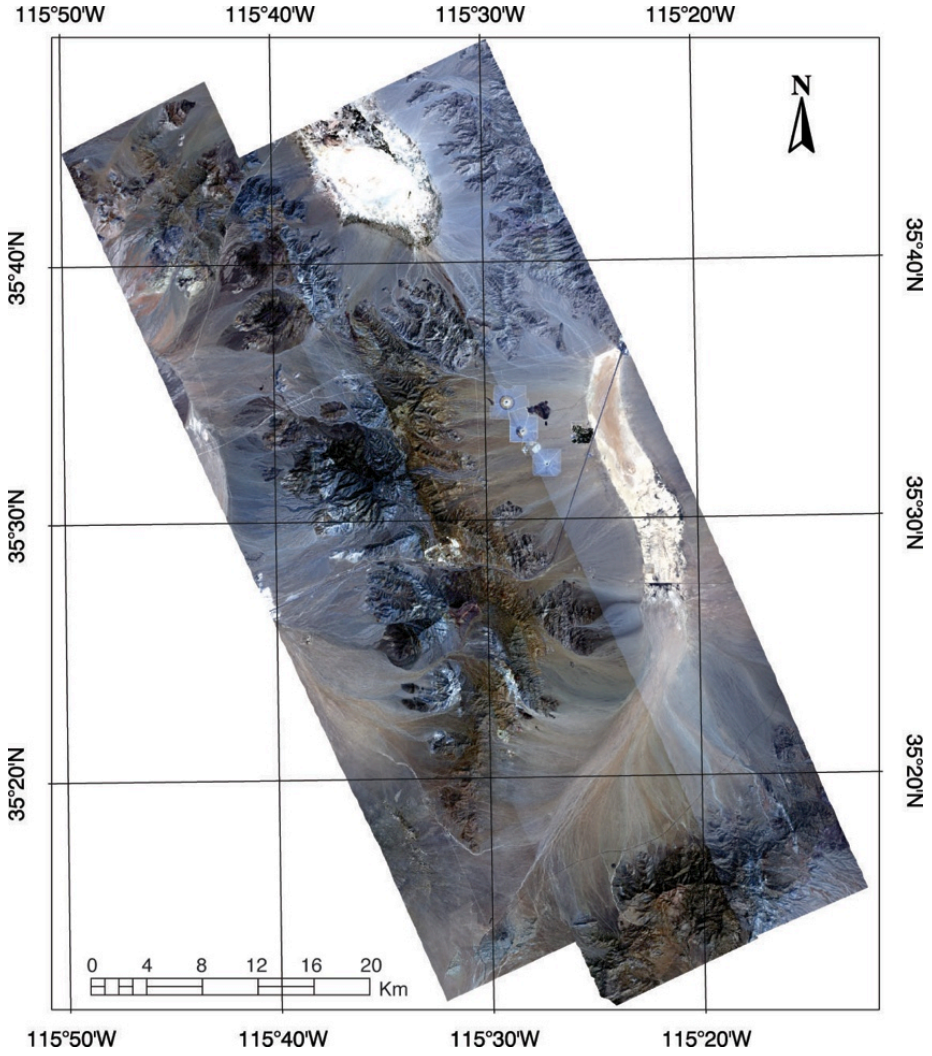
Limestone

Excerpt from Miller et al., 2007 in USGS Bulletin 2160

VNIR-SWIR

AVIRIS

- 0.4 – 2.5 µm, 224 bands
- 15.5 m/pixel
- FLAASH atmospheric correction



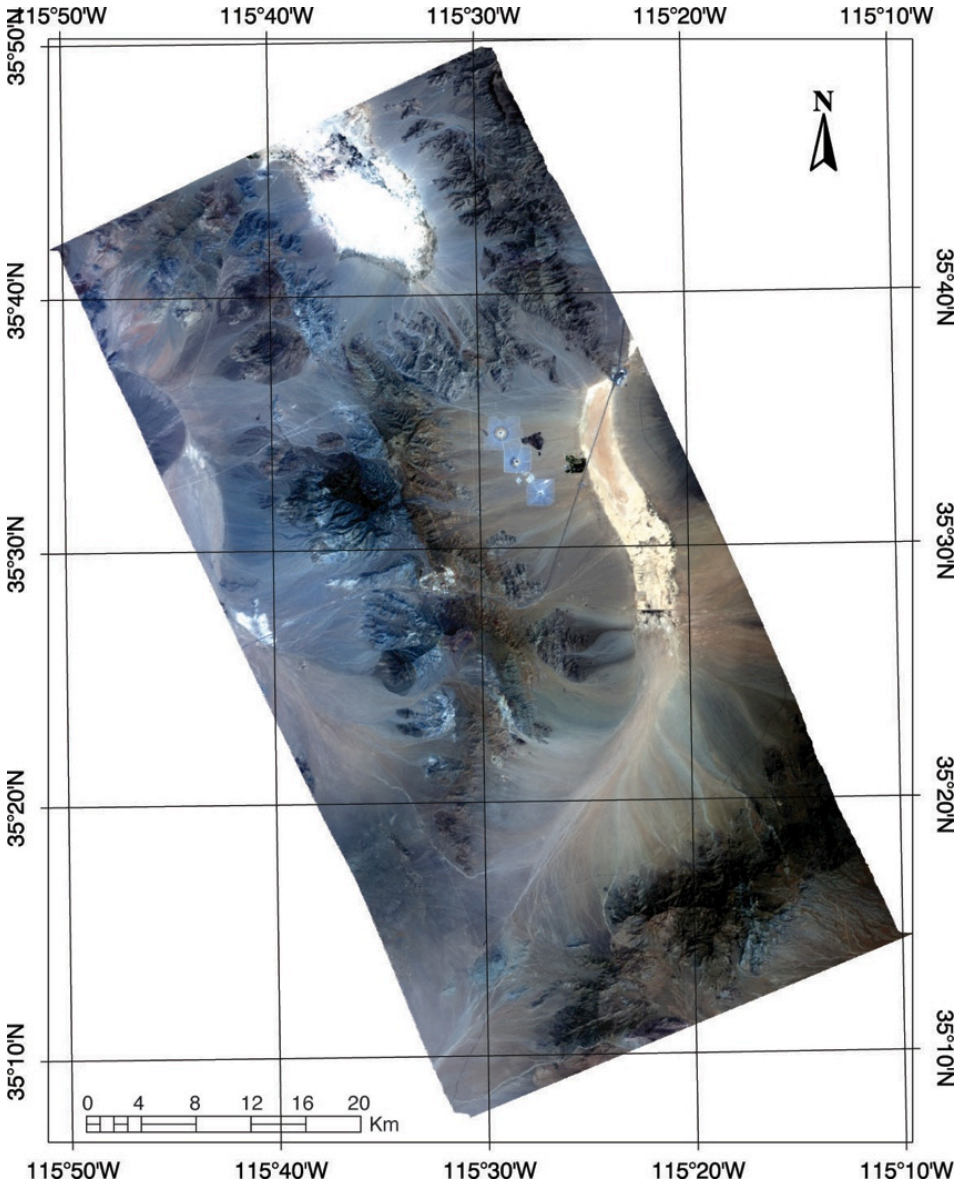
Images f130503t01 10,11,12
Acquired 05/03/2013

LWIR

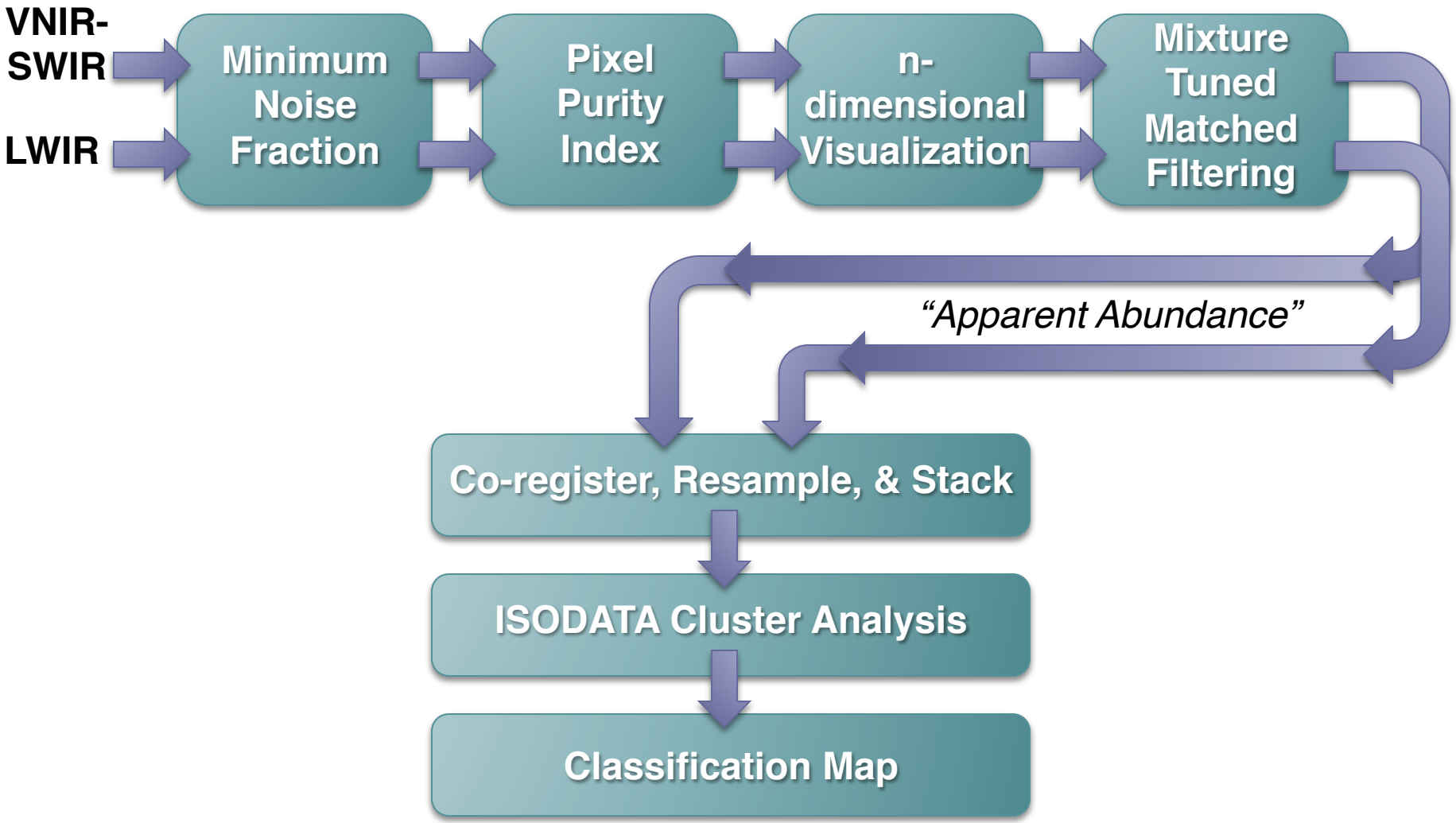
MASTER

- 7.8 – 12.8 µm, 10 bands
- 34.4 m/pixel
- In-Scene atmospheric correction
- Emissivity Normalization for temperature-emissivity separation
- Bands 41 (7.8 µm) and 45 (9.67 µm) removed due to excessive line to line noise

Image 1394200_06
Acquired 05/03/2013

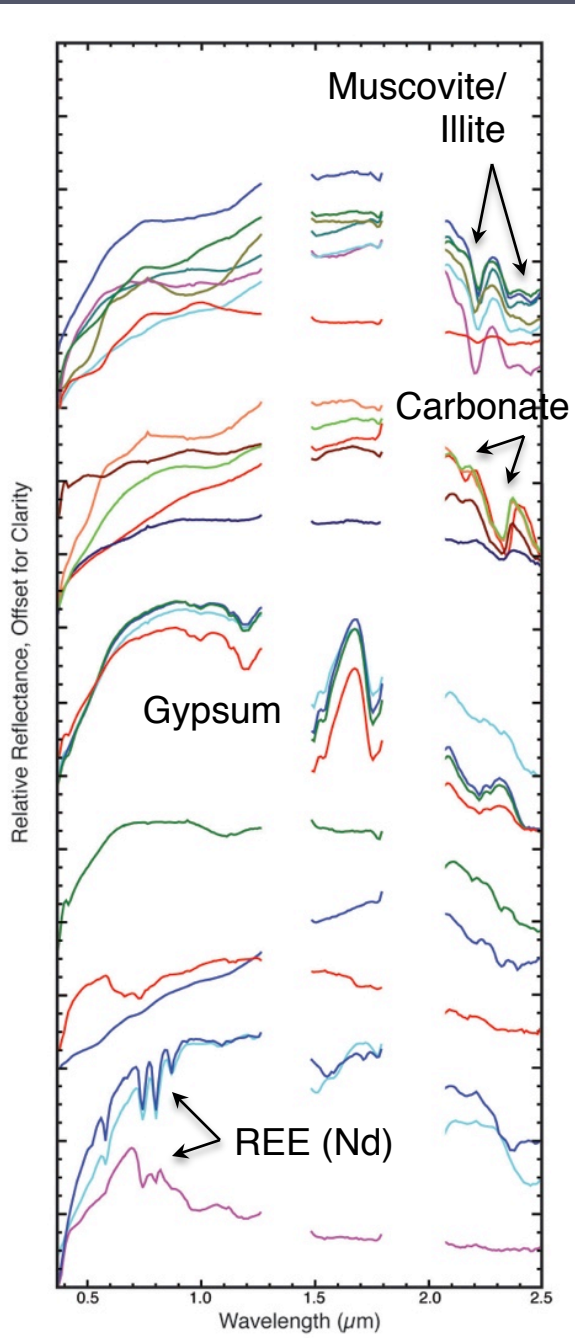


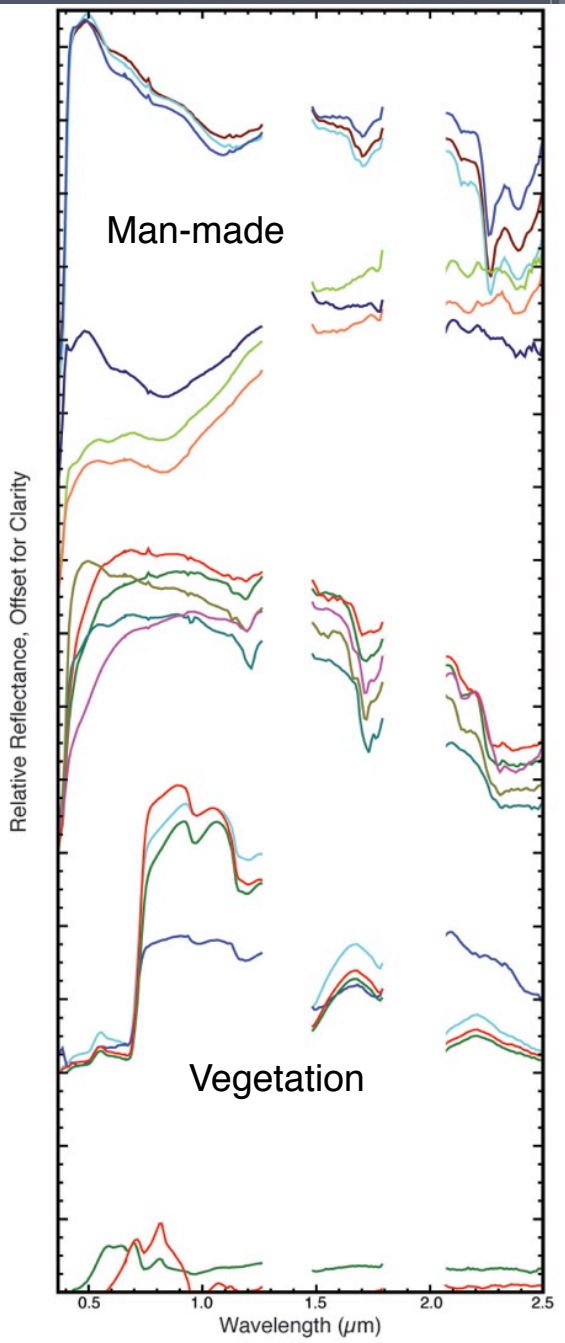
Approach


VNIR-
SWIR
LWIR
Minimum Noise Fraction
Pixel Purity Index
n-dimensional Visualization
Mixture Tuned Matched Filtering
"Apparent Abundance"
Co-register, Resample, & Stack
ISODATA Cluster Analysis
Classification Map

VNIR-SWIR

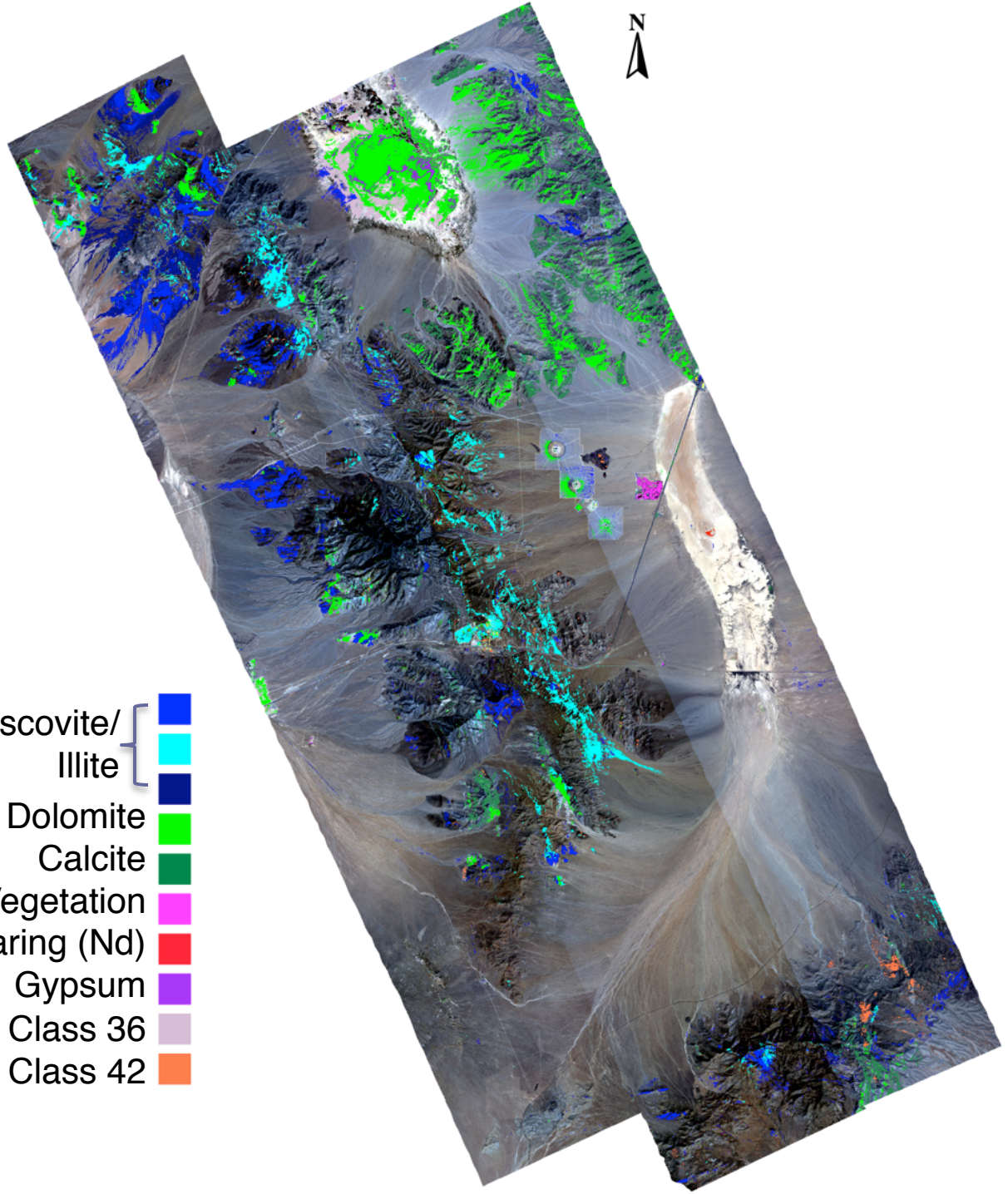
- 48 endmembers identified
- MTMF results show all endmembers have low (or zero) apparent abundance in most pixels
- Grouped similar endmembers and combined their apparent abundance





VNIR-SWIR

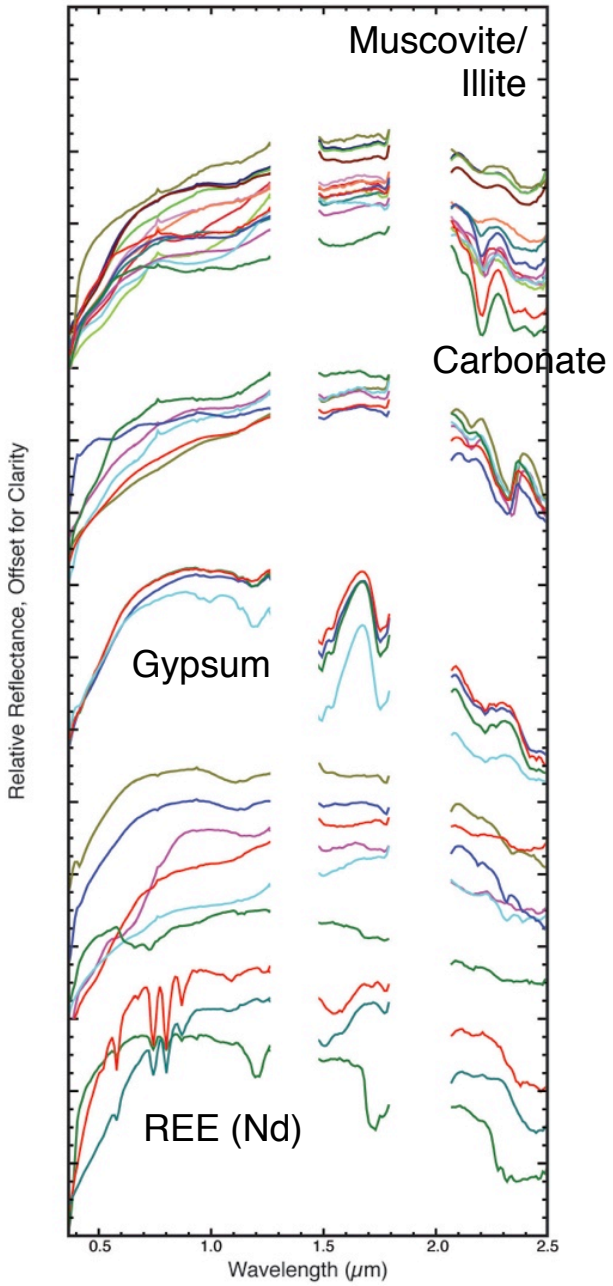
- Pixel assigned to the endmember group having the greatest apparent abundance
  - Must be >20% to be mapped
- Improved by grouping similar endmembers, but still most pixels not mapped
  - Missing endmembers?
  - Too many? Or too similar?

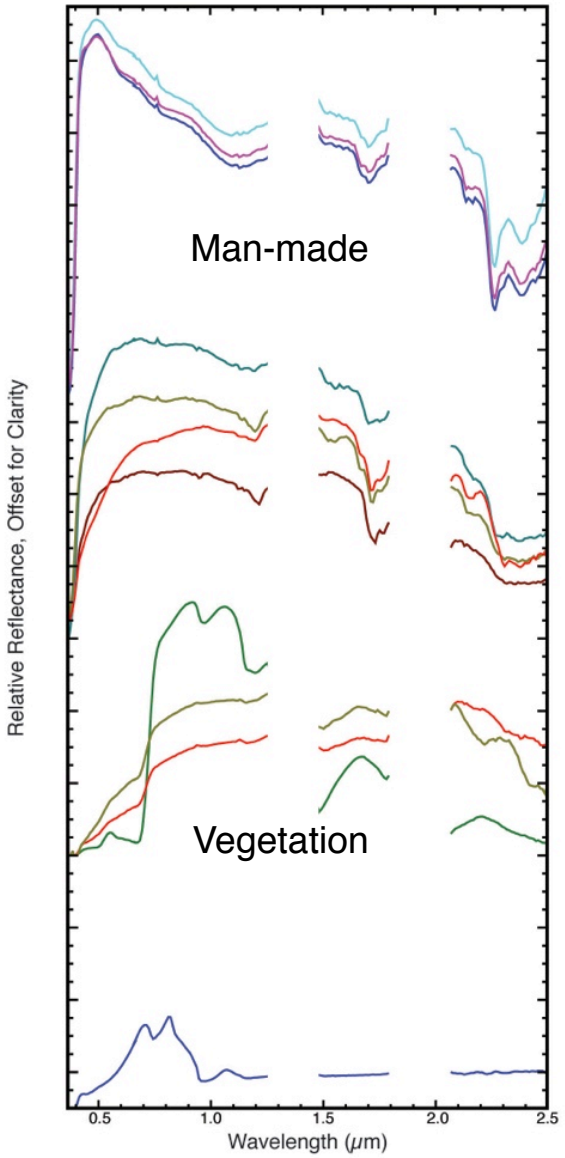


VNIR-SWIR

60 m/pixel

- 48 endmembers defined
- Spectra similar to those extracted with native AVIRIS resolution
- Similar endmember spectra grouped and apparent abundances combined

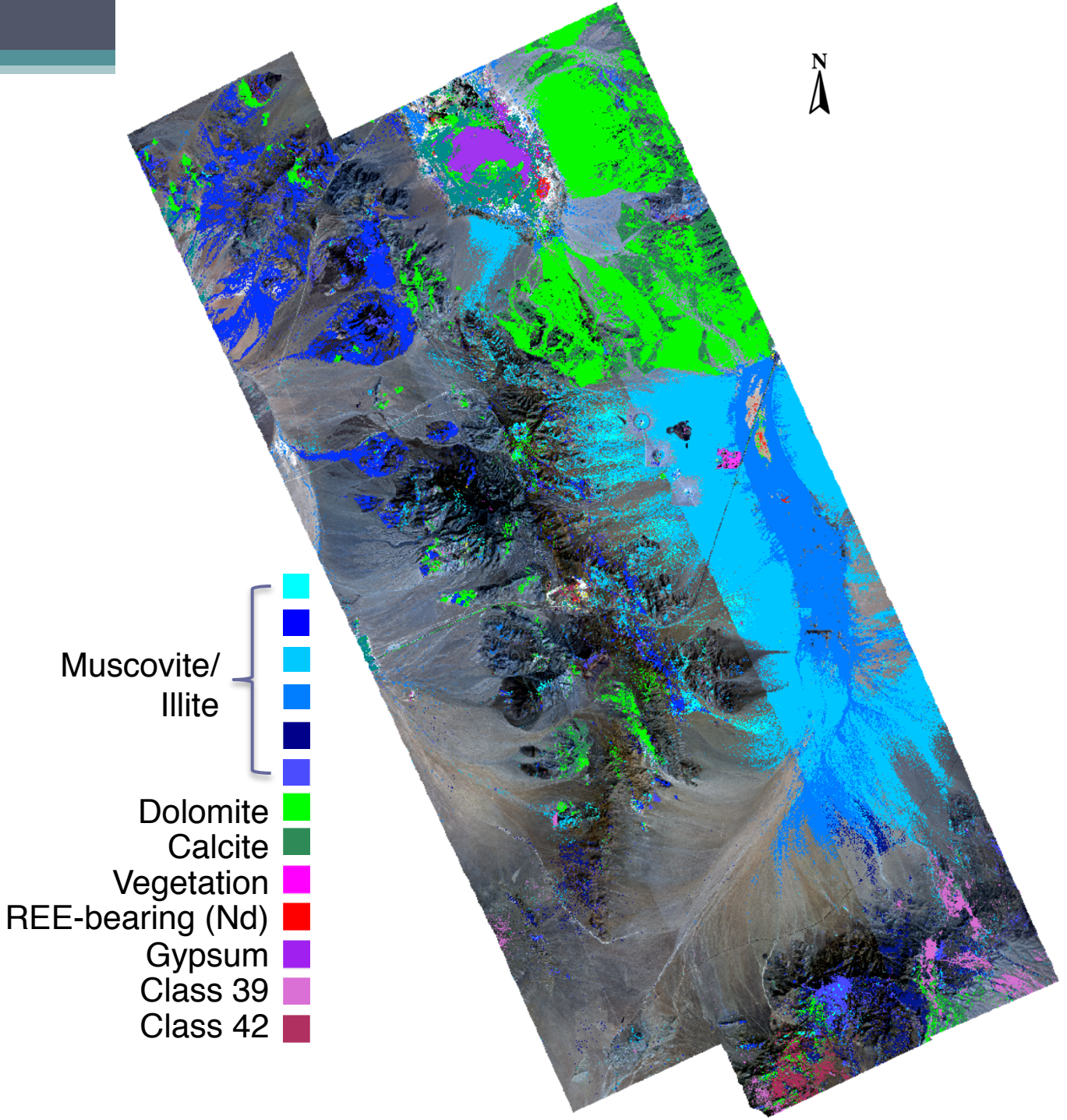




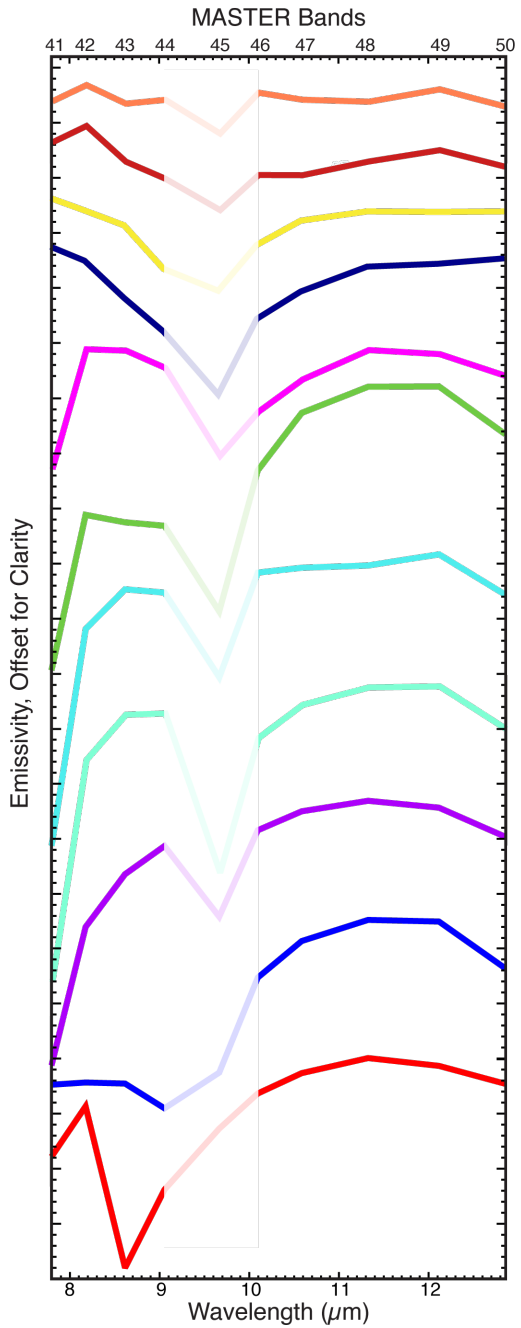
VNIR-SWIR

60 m/pixel

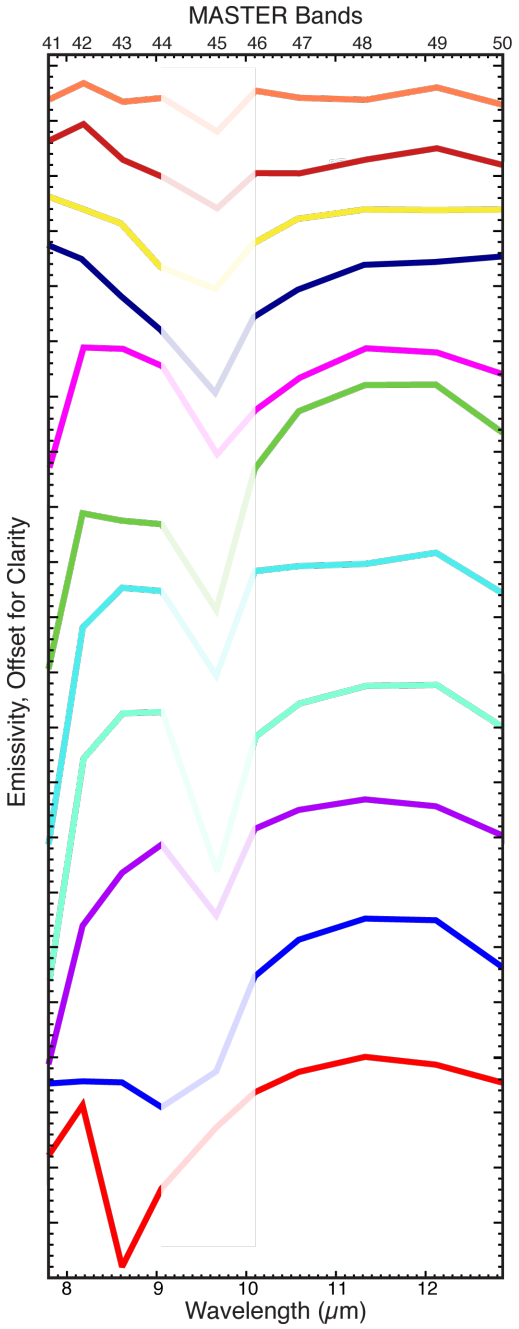
- Similar spatial distibution of endmember compositions
- Lose some fine detail
- Improved coverage

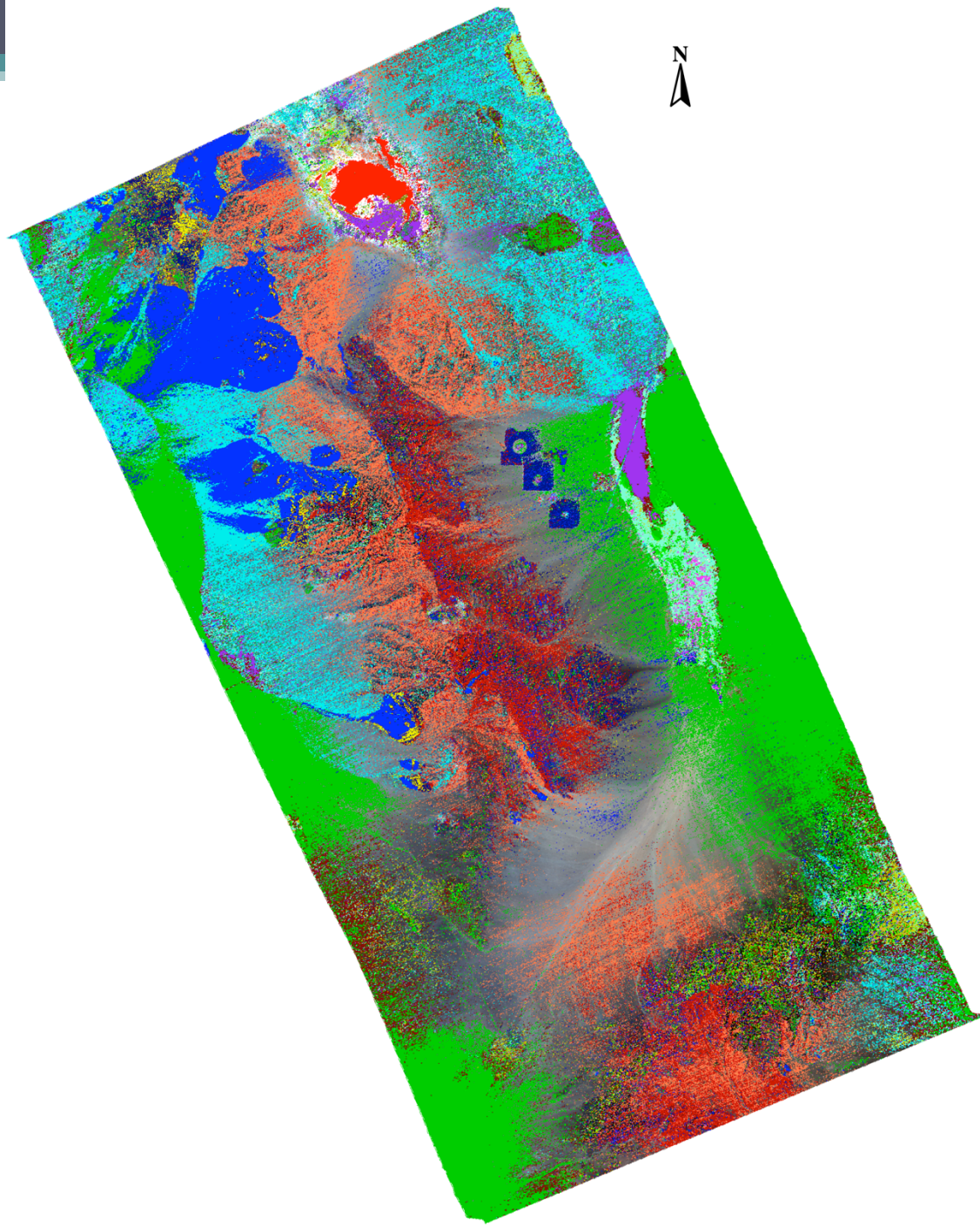


LWIR



- 28 endmembers
- No grouping
- Include silicates, sulfates, carbonates, man-made materials


MASTER Bands
41 42 43 44 45 46 47 48 49 50
Emissivity, Offset for Clarity
8 9 10 11 12
Wavelength (μm)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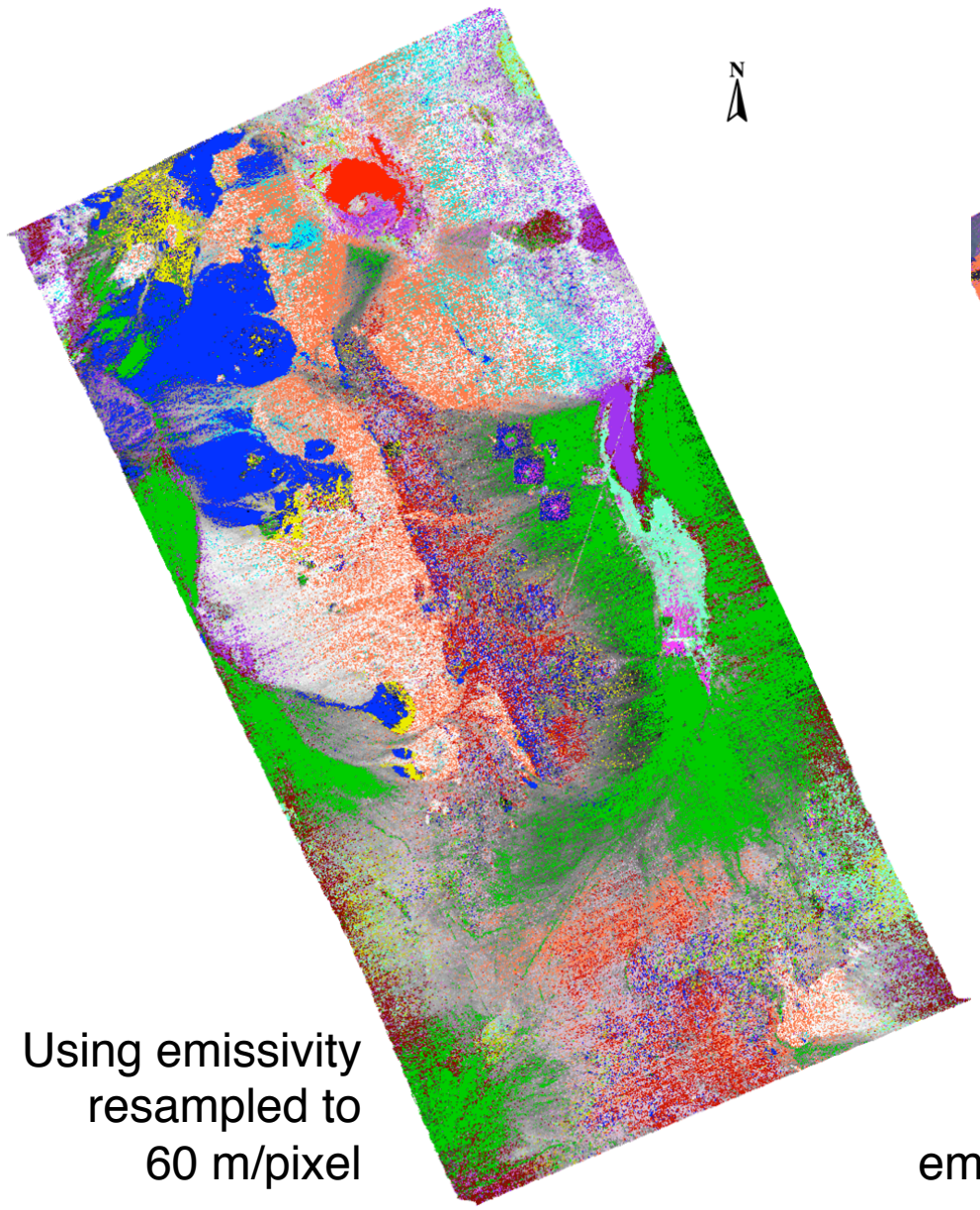
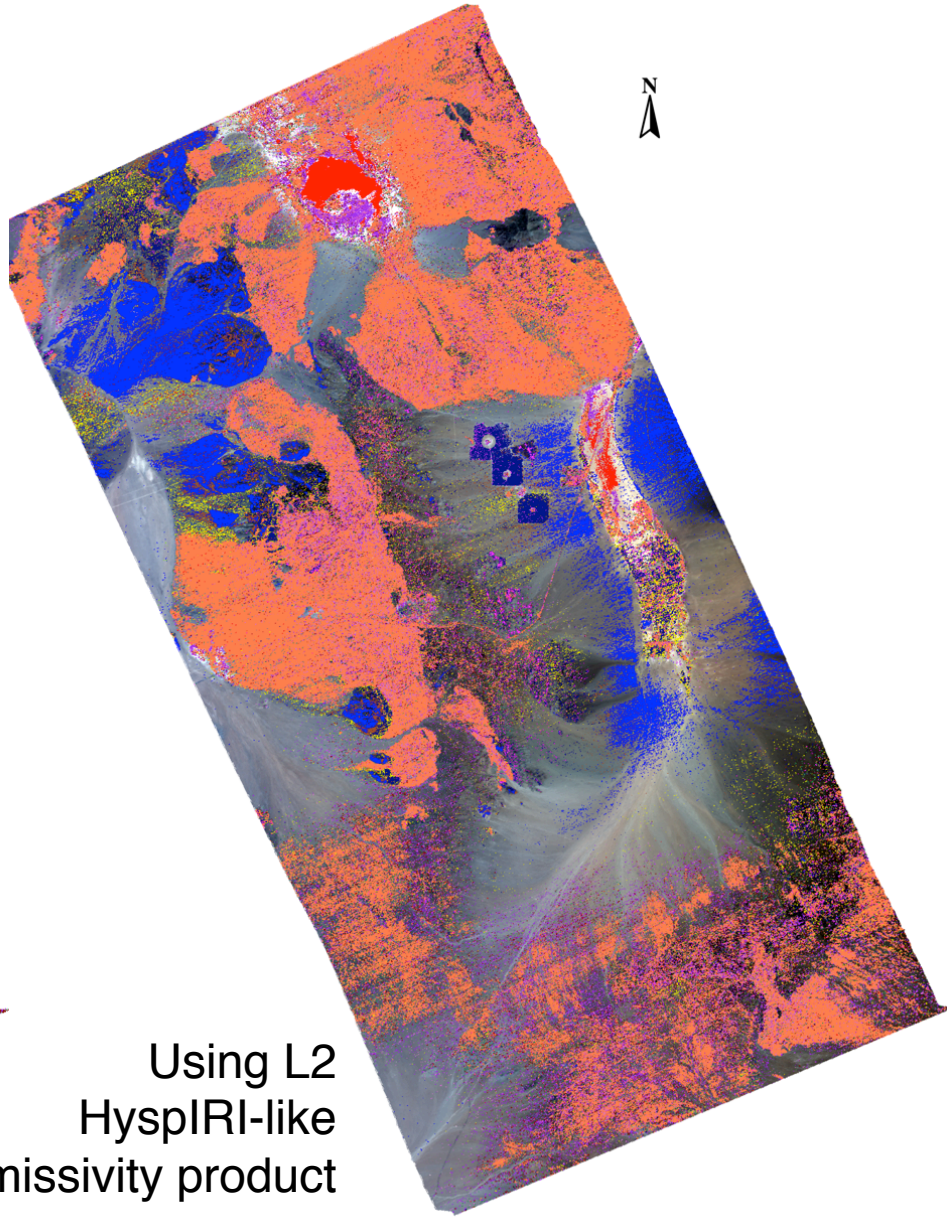


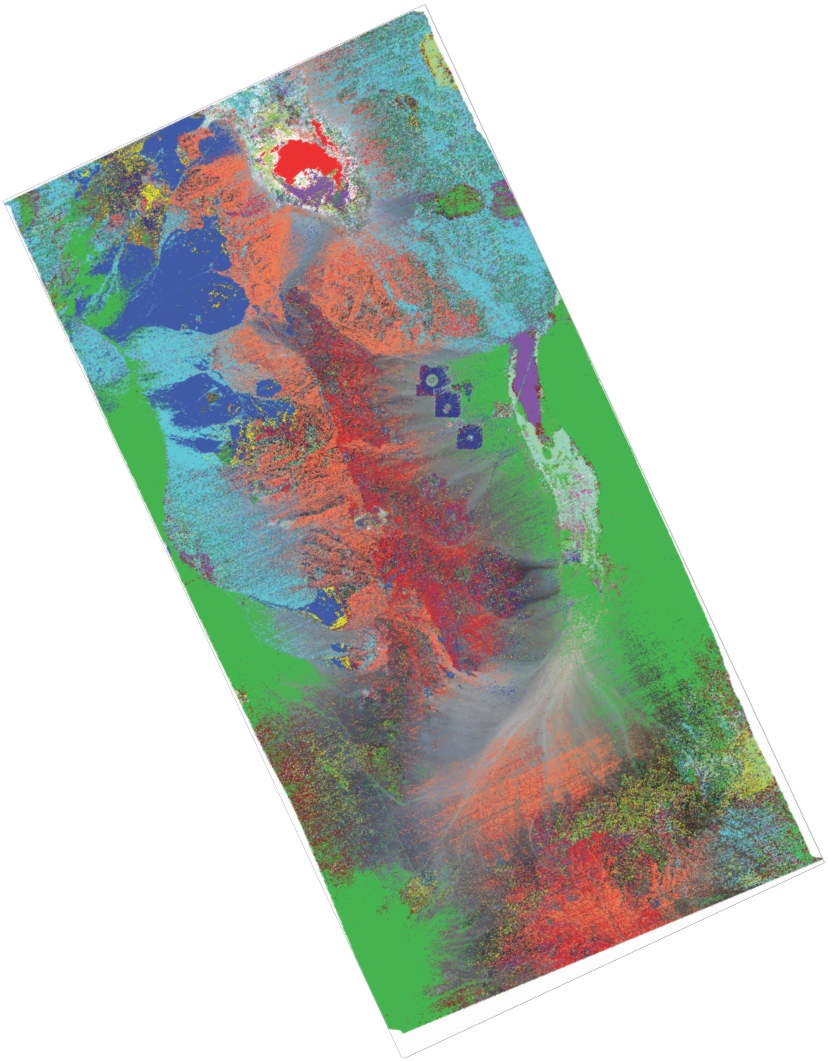
Using emissivity resampled to 60 m/pixel



Using L2 HyspIRI-like emissivity product

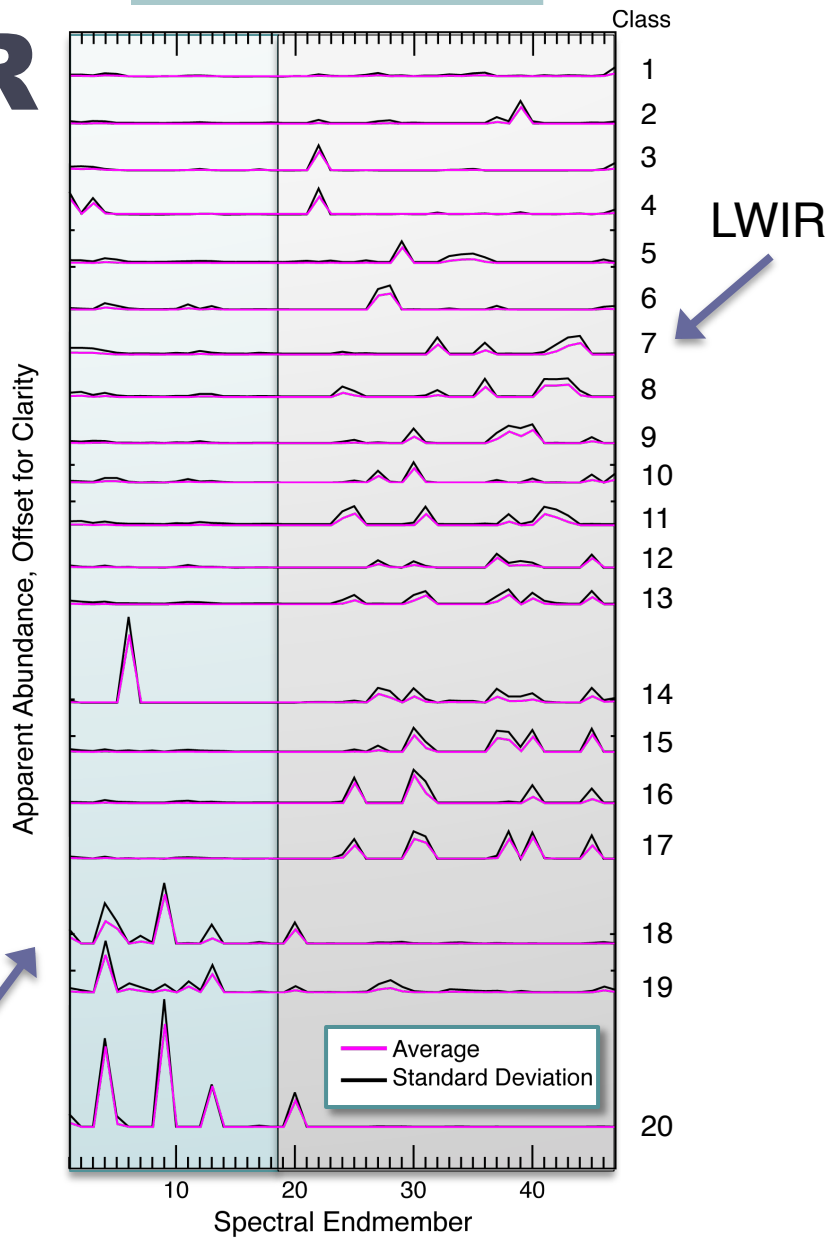
VNIR-SWIR

LWIR



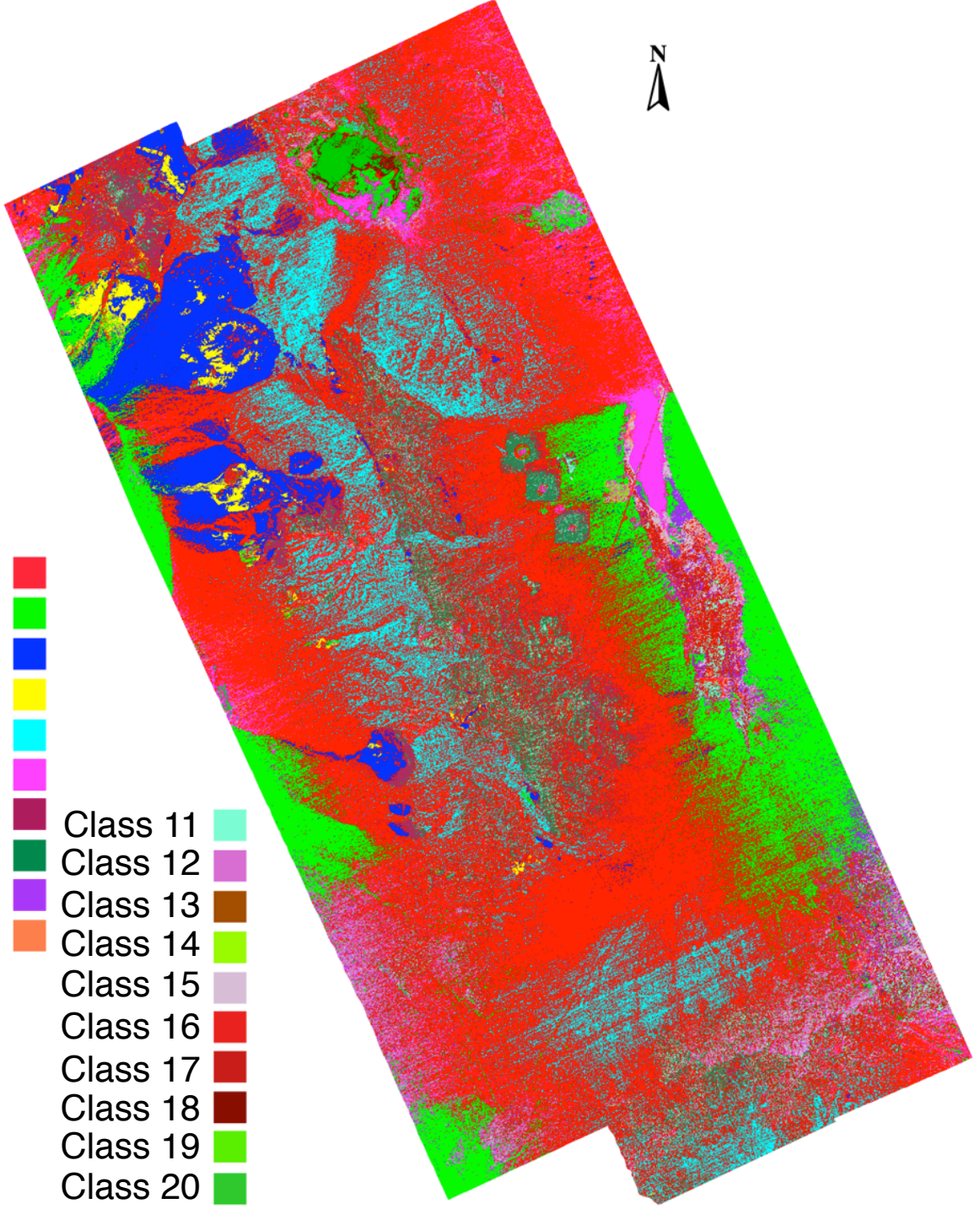
VNIR-SWIR-LWIR Integration

- 20 clusters/classes
- In most classes LWIR endmembers dominate
  - But several classes characterized by both VNIR-SWIR and LWIR endmembers



VNIR -SWIR -LWIR Integration

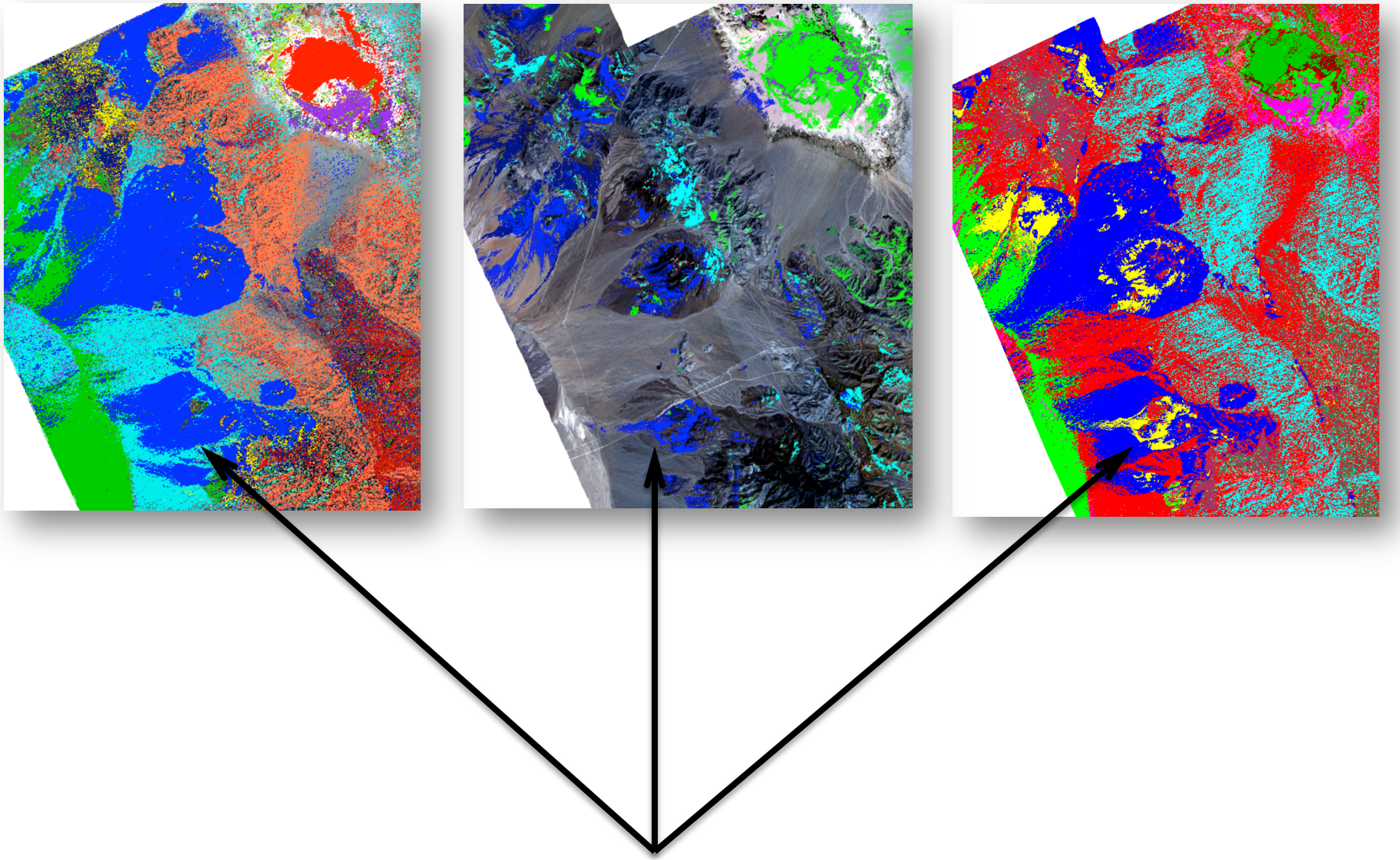
- Similar to LWIR map on large scale
  - But several small-scale differences influenced by VNIR-SWIR



LWIR

VNIR-SWIR

VNIR-SWIR-LWIR



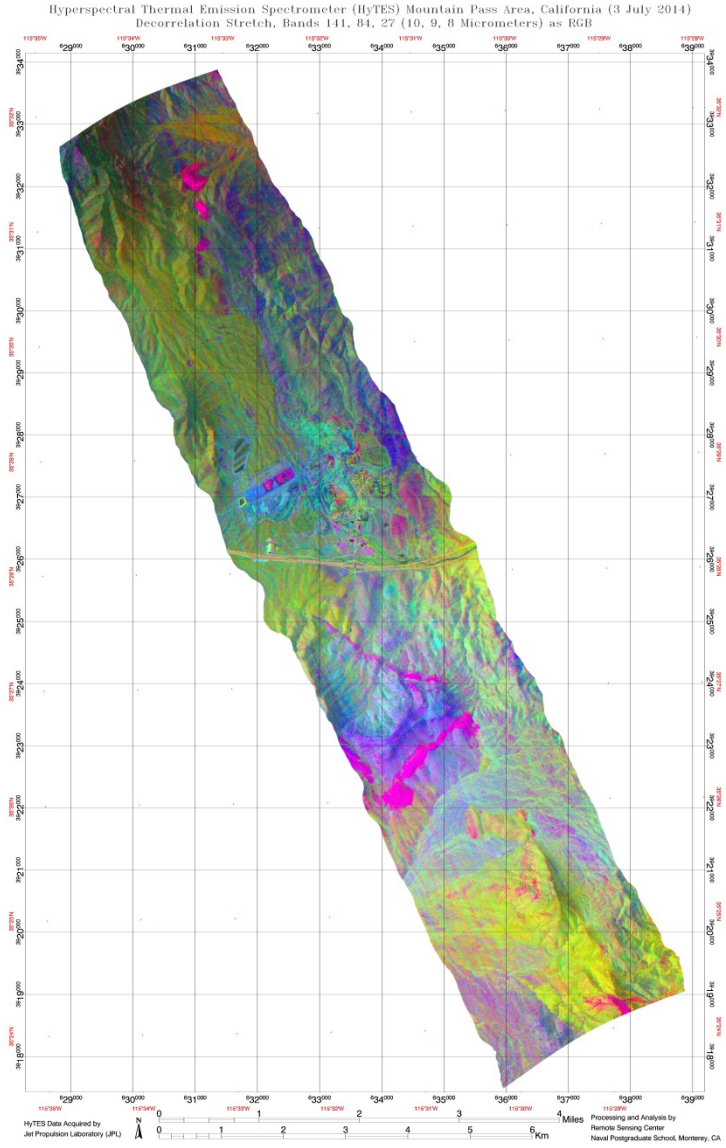
Summary & Ongoing Work

- Hyperspectral VNIR-SWIR data analysis produced many spectral endmembers but the majority of image pixels had very low abundance of these endmembers
  - Fine-tune this method, consider other options
- Multispectral LWIR data analysis exhibited fewer spectral endmembers but these had significant abundances over most of the image
- Analysis of the integrated apparent abundance values produced a classification map with features derived from both these wavelength ranges
  - Other approaches to full spectrum analysis may be tested as well
- Also investigating the effect of hyperspectral LWIR data – Mako and HyTES

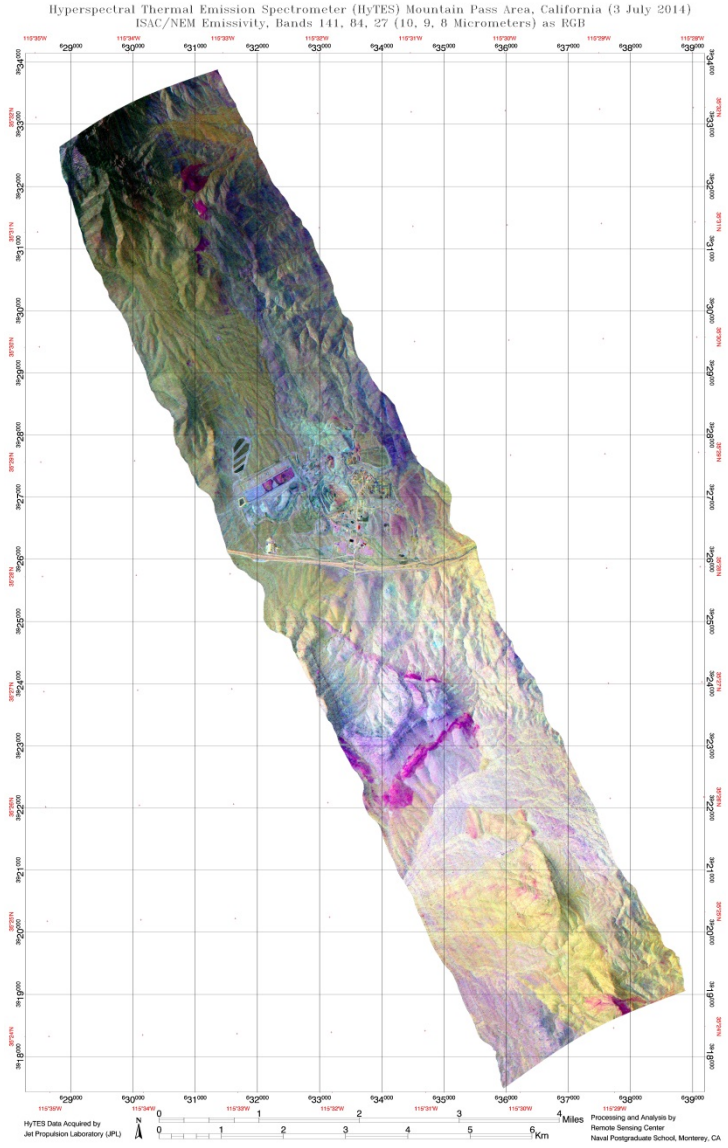
JPL Hyperspectral Thermal Emission Spectrometer (HyTES)

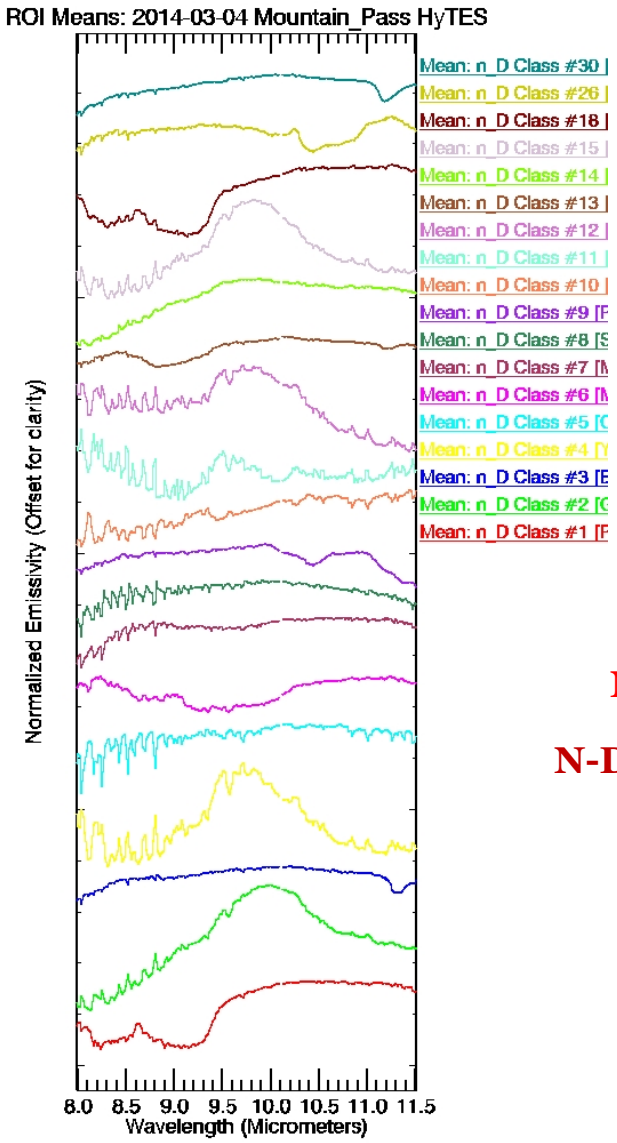
- Acquired for Mountain Pass area 6 July 2014
- 256 bands, 7.5 – 12 mm (17.6nm)
- ~2.3m spatial resolution
- ISAC atmospheric correction
- Normalized Emissivity temperature – emissivity separation
- Endmember extraction and mapping similar to previous
- Geocorrection, visual comparison to VNIR/SWIR
- Field reconnaissance and LWIR field spectral measurements (Agilent Exoscan 4100)

10/9/8 µm Decorrelation Stretch

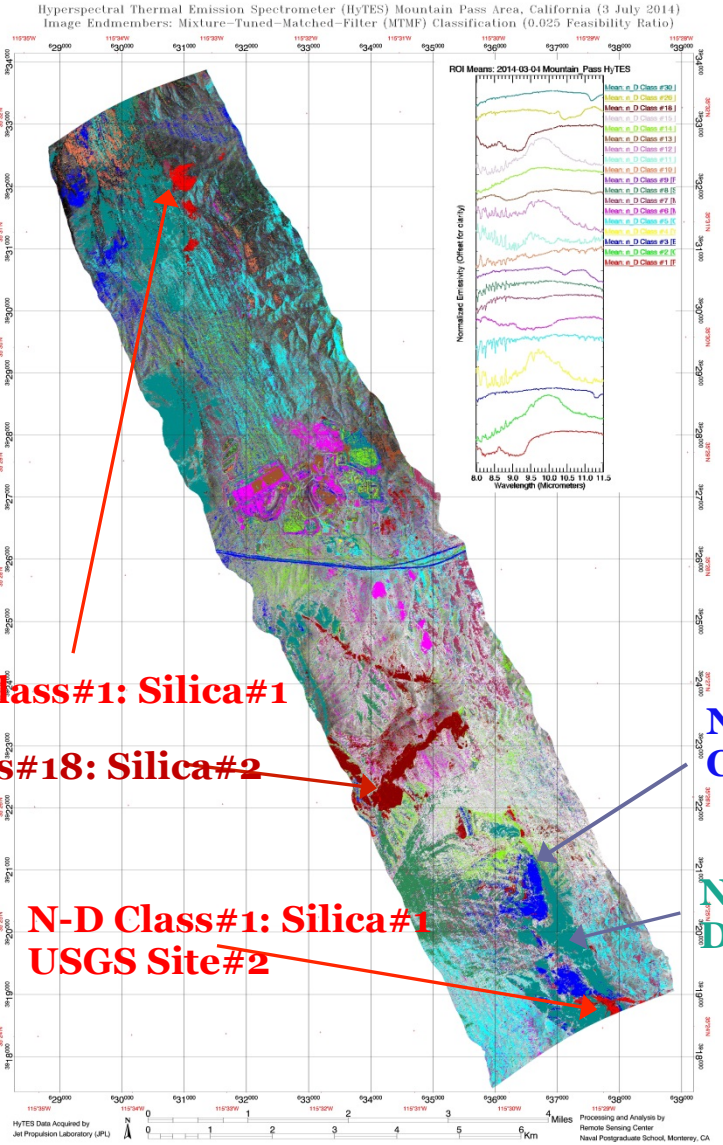


10/9/8 µm Normalized Emissivity





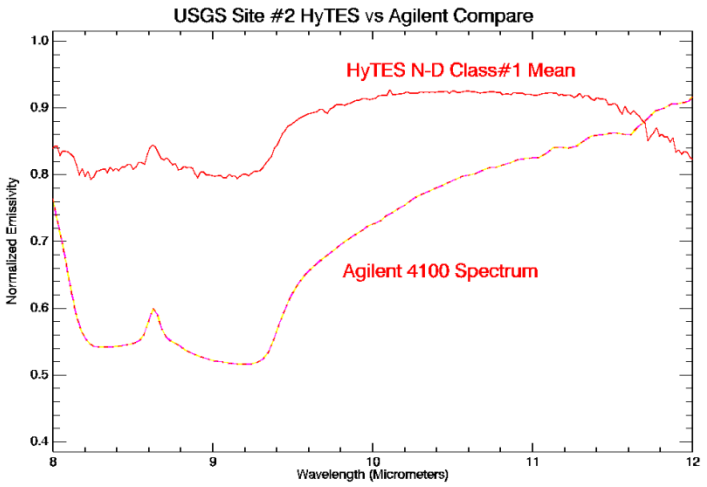
N-D Endmembers

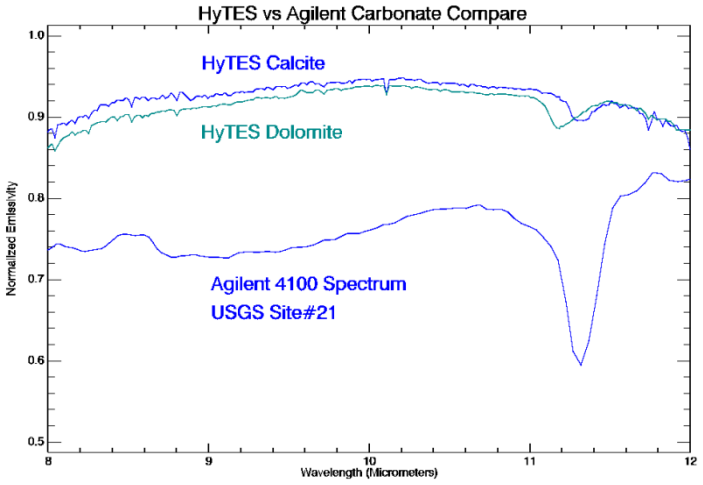


MTMF Material Map

Field Reconnaissance and LWIR Field Spectra

Agilent 4100 Exoscan





Compare HyTES and Agilent