Utilizing HyspIRI data for geological exploration:
A southern California case study

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Our Research

- Exploration for Renewable Energy (Geothermal)
- Signatures of Critical Mineral Resources
- Landscape change associated with large scale energy and mineral development
- Natural Hazards
  - Acid Mine Drainage Environments
  - Volcanic Activity
- Presented at IGARSS – 2015
- To be presented at GSA – Baltimore
  - Coordination of Civil Earth Observations

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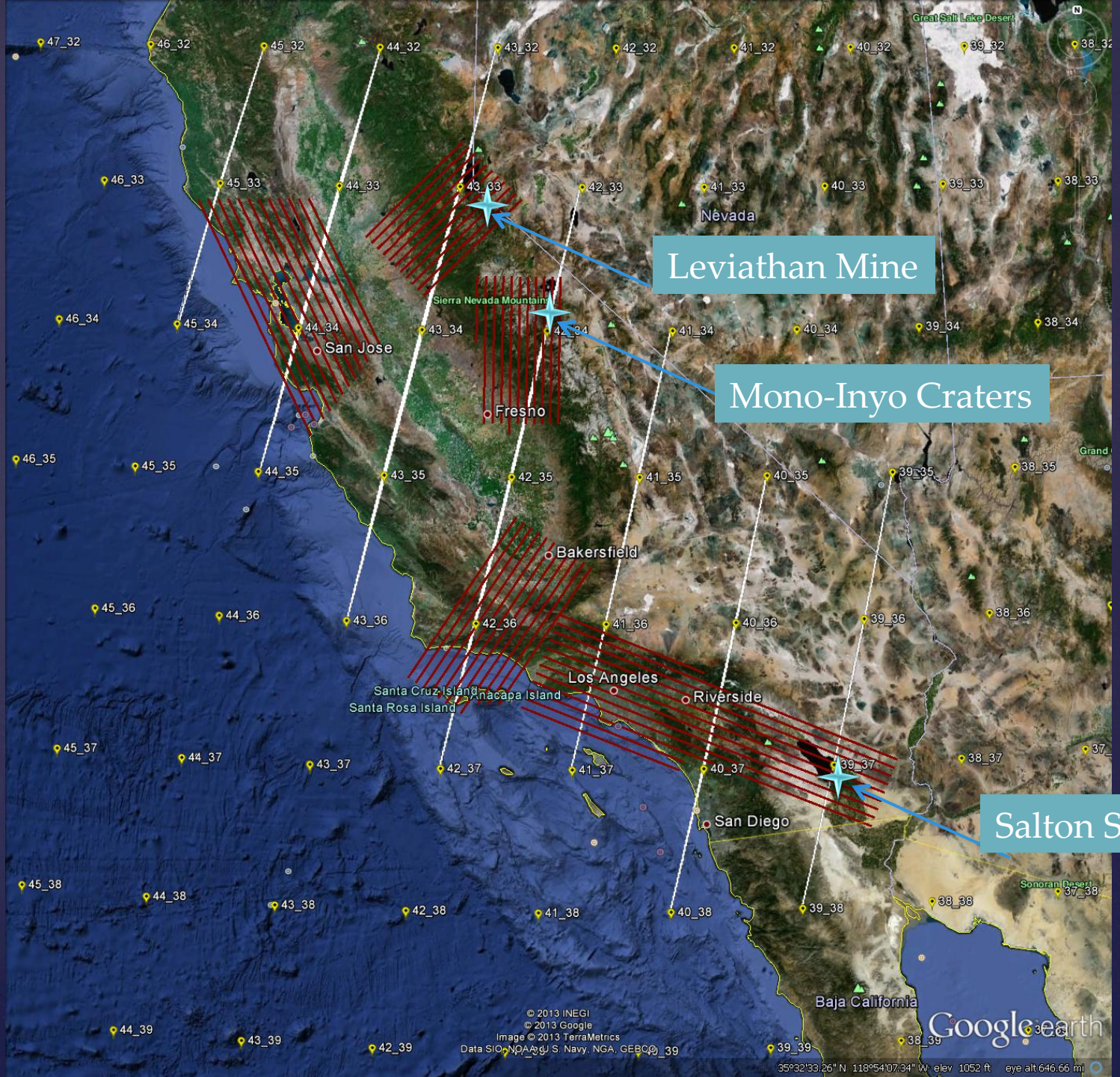
Leviathan Mine
Mono-Inyo Craters
Salton Sea
Great Salt Lake Desert
Nevada
Sierra Nevada Mountain
San Jose
Fresno
Bakersfield
Los Angeles
Riverside
Santa Cruz Island
Santa Rosa Island
San Diego
Baja California
Sonoran Desert
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

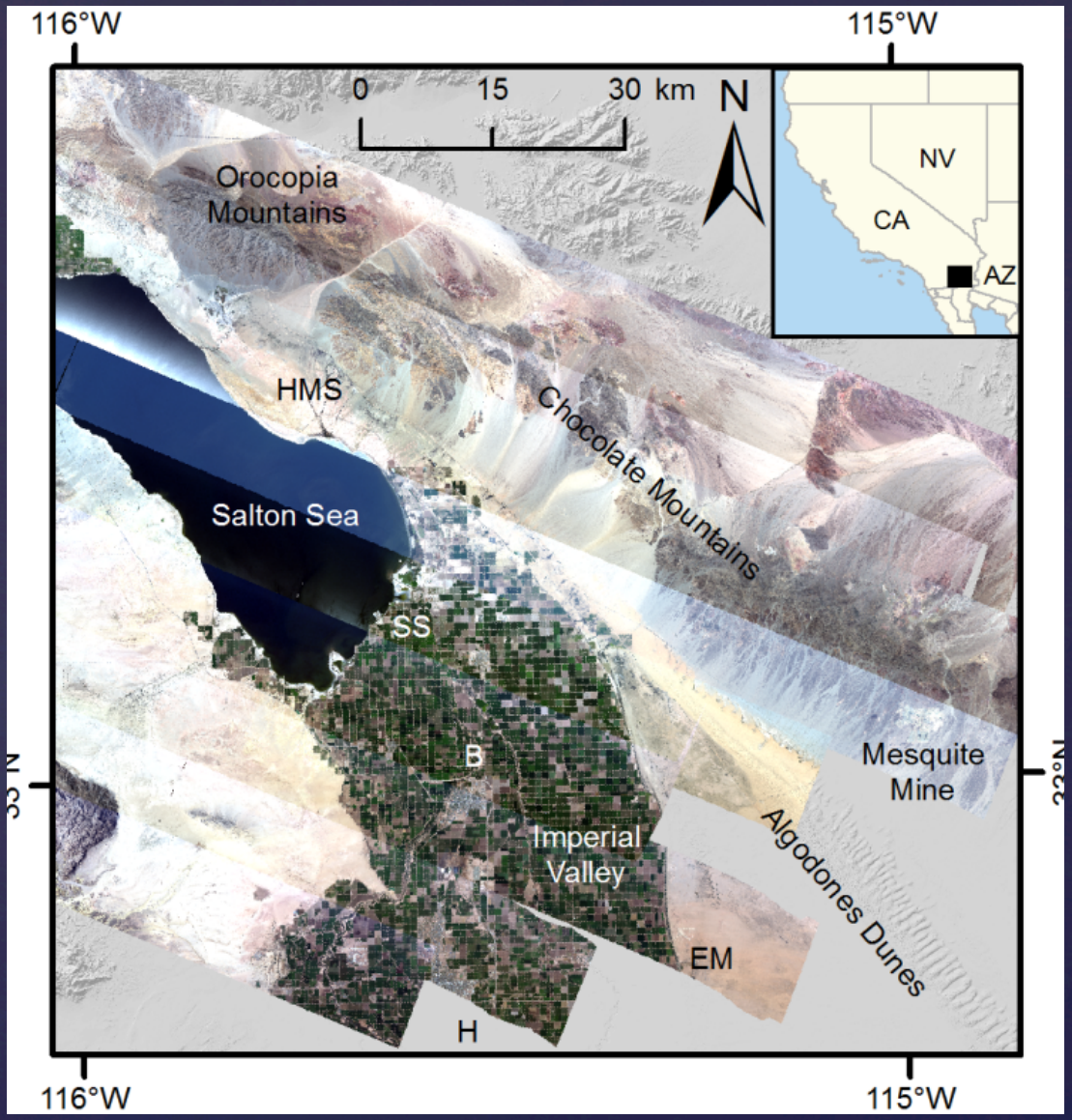
Study Area

- Salton Sea / Imperial Valley
  - Many geothermal resources
    - Associated fumaroles, mud volcanoes
    - Links to strain and fault step-over region of the San Andreas fault
    - Associated temperature anomalies
  - Large scale solar and wind development
  - Well exposed lithologies in Orocopia and Chocolate Mountains

Regional Setting

Known Geothermal Areas:

- HMS = Hot Mineral Spa
- SS = Salton Sea
- B = Brawley
- EM East Mesa
- H = Heber

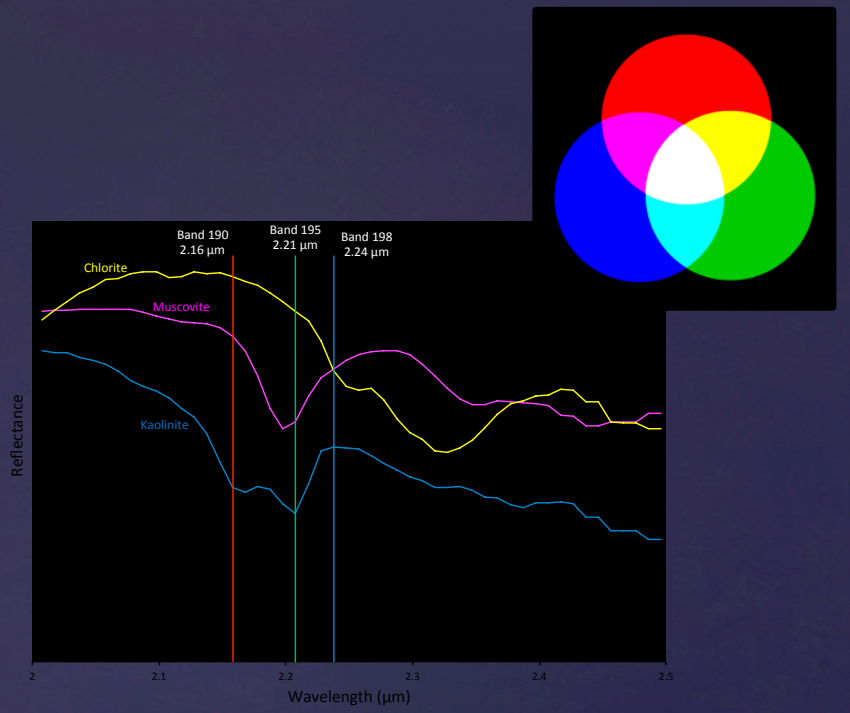


Geologic mapping in Imperial Valley

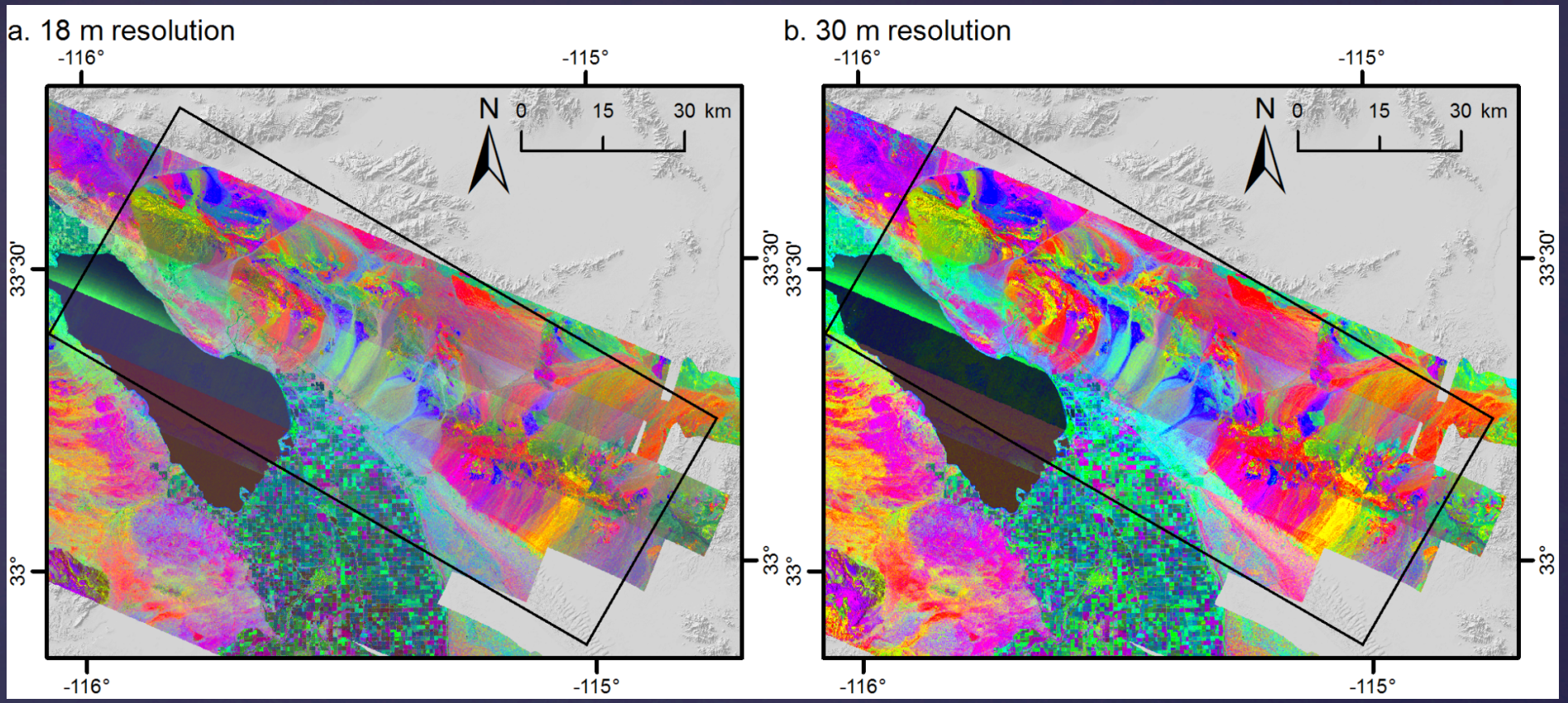
Approach

- Assessment of simple tools that could provide quick data products that rapidly highlight areas over large regions for subsequent detailed in-situ analysis.
- Validation of those tools with detailed spectral mineral mapping using the full HyspIRI wavelengths.
- Demonstration that HyspIRI-like products can be used in geologic assessments similar to many previously published studies.

- Decorrelation stretch of AVIRIS SWIR bands
- DCS bands **190**, **195**, **198** displayed as **RGB** (**2.16**, **2.21**, **2.24** um)
- Highlights
  - Kaolinite, alunite as **blue**
  - Muscovite, illite as **magenta**
  - Chlorite, calcite as **yellow**
  - Opal as **orange**

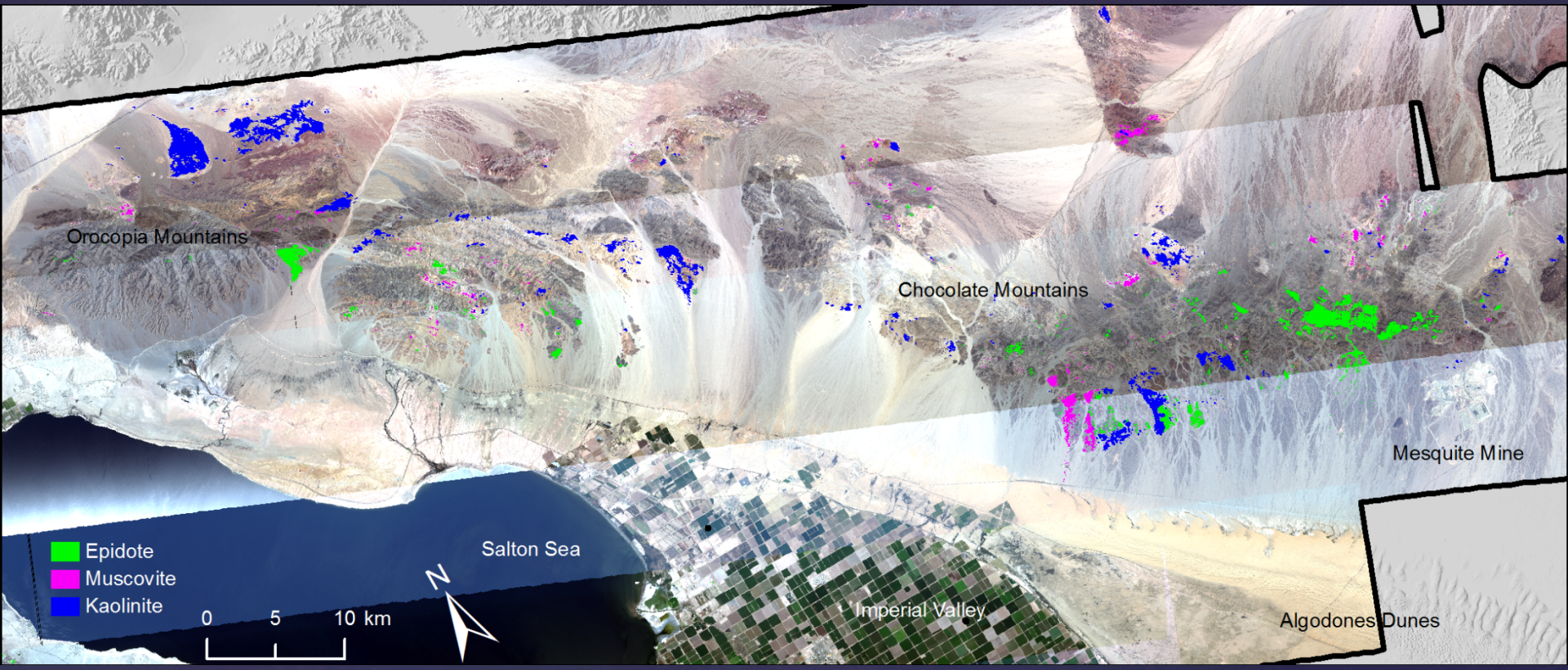


Simple DCS, but using narrow bands.



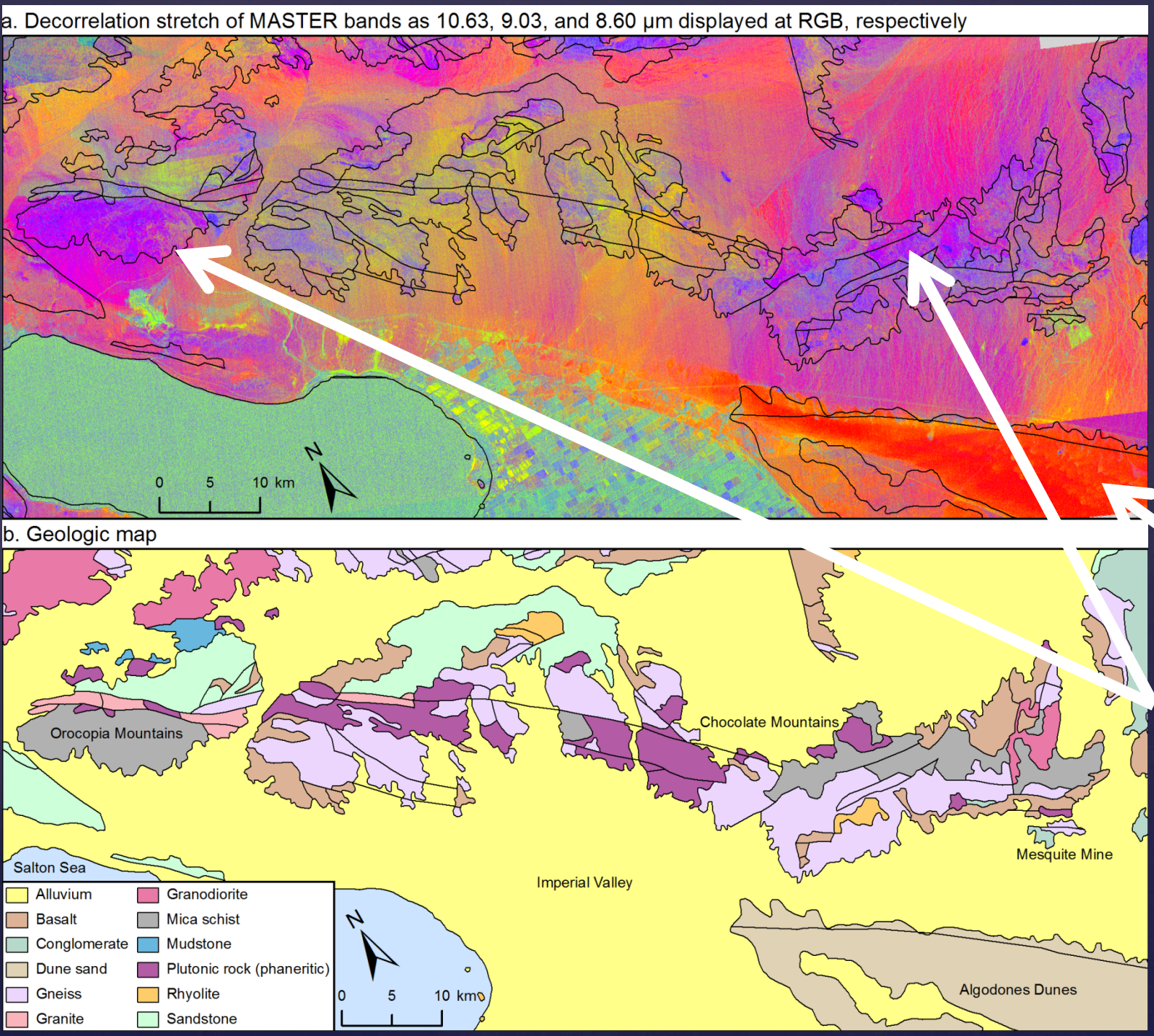
Quickly identify areas of alteration
Blue: kaolinite, alunite; Magenta: muscovite, illite: Yellow: chlorite, calcite
Yellow-green: epidote: Orange: weakly altered

Hydrothermal alteration trends



Using full spectral capabilities, DCS and statistical methods (MNF, PPI) drive mineral mapping

VSWIR Mineral mapping



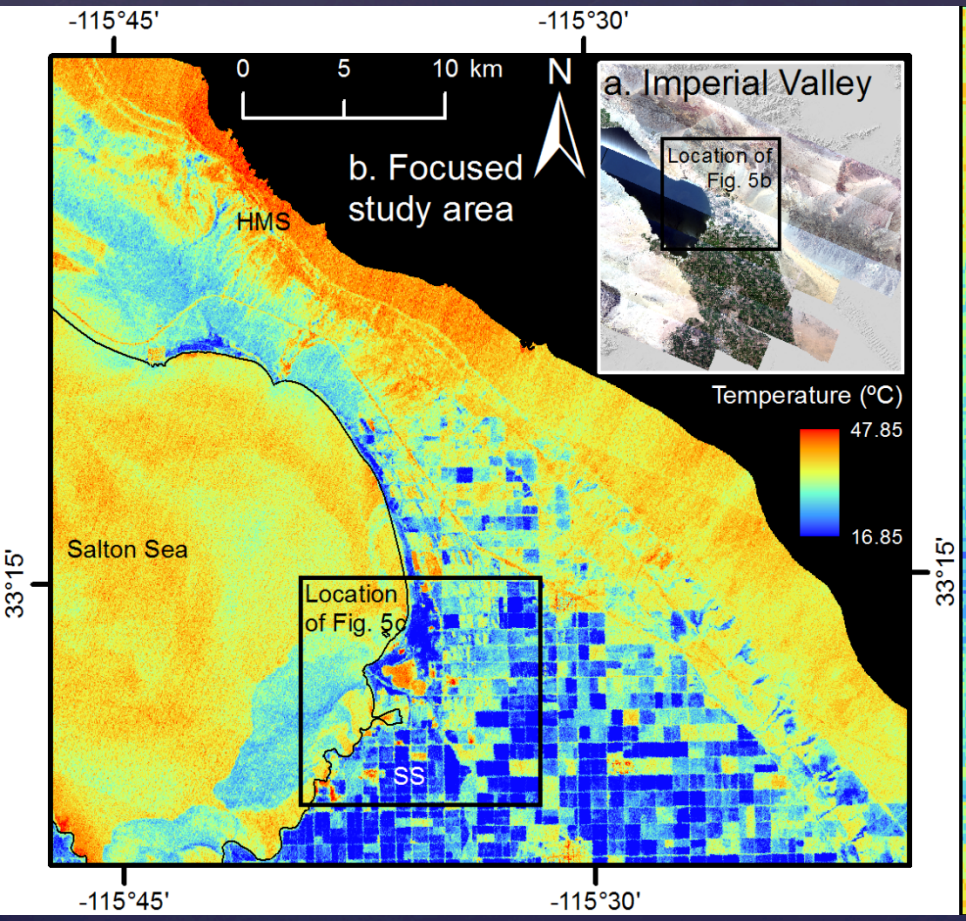
TIR data used for lithologic mapping

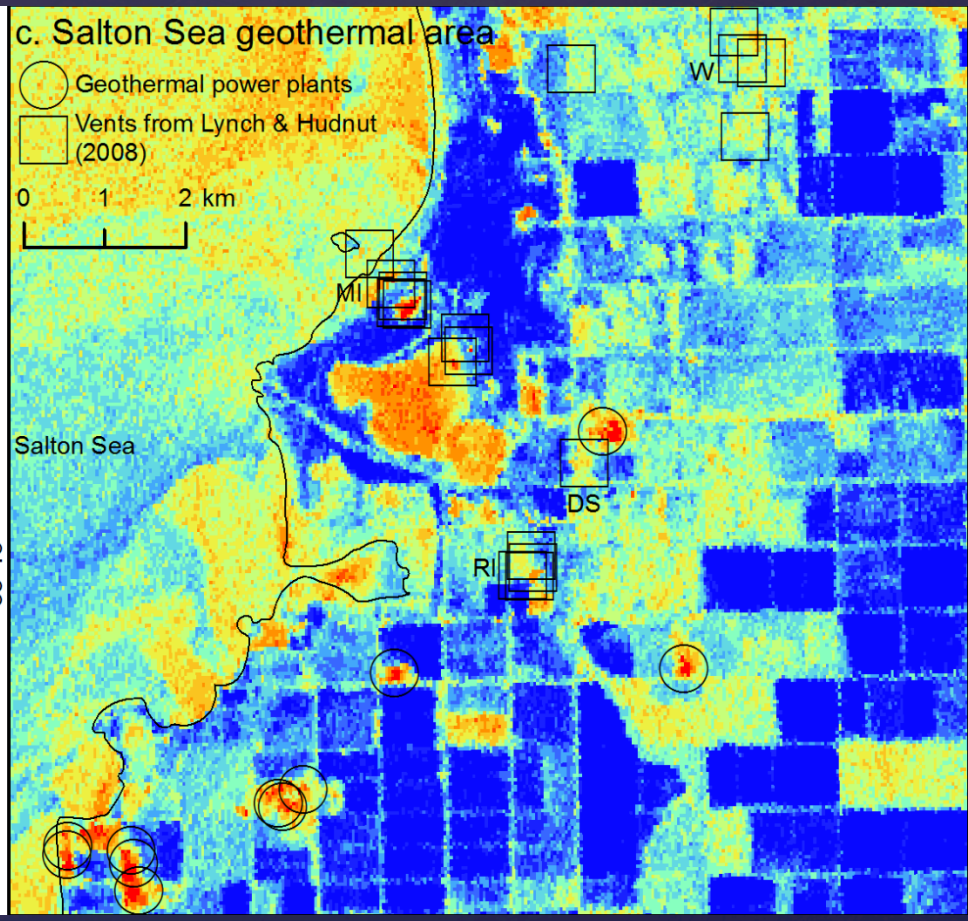
Red highlights quartz-rich materials (dune sand)

Magenta highlights gneisses and schists

Other colors do not show lithology as well

Thermal anomaly mapping





Thermal anomalies correlate with geothermal power plants, fumarole fields, shallow ponds. Temperatures range from 16 to 48C.

Summary

- HyspIRI's planned narrow spectral channels assist in mineral discrimination using simple techniques like DCS around known absorption features.
  - This works for a variety of minerals in diverse geologic settings.
- Alteration associated with past mining activities and geothermal systems is easily mapped.
- Subtle spectral features or those occurring on smaller spatial scales may be missed at larger than 30m ground sample distance.

- Manuscript submitted to RSE but rejected due to "shortcomings"
  - Hard to see real contribution to Remote sensing
  - Work is "hodge podge", lacks purpose
  - Lacked field validation, methods are too "simple"
- Need to revisit to more clearly articulate utility of quick products to precede detailed analysis.
- Need to more clearly show value of narrow spectral channels and reason for HyspIRI (vs WV3)
- Show stability of products over time with similar analysis at different seasons/years.
- Link units in the DCS, mineral map and TIR imagery.

What happens when *not* preaching to the converted…

Future Plans

- Revise and update, resubmit this Case Study work.
- Is another special issue of RSE planned?

- On 1-year no-cost extension, Gwen, Neil to finish soon, will present at AGU.

- With remaining funds and time, look at land surface change in S. Cal box related to renewable energy development.

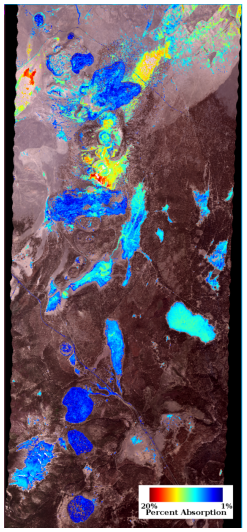
HyspIRI for Energy and Mineral Resources

PI: Wendy Calvin, University of Nevada – Reno

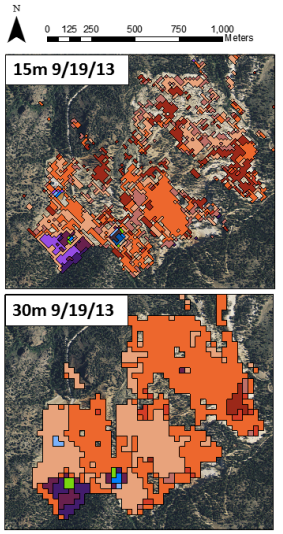
Surface composition mapping that identifies resources and the changes and impacts associated with their development.

Objectives:

- Identify new regions for renewable energy development
- Quantify the impacts of renewable energy development
- Reduce reliance on imports of critical minerals
- Quantify the impacts of resource extraction and their evolution over time
- Demonstrate HsypIRI global impact in energy and mineral applications



Minerals associated with alteration related to surface exposure ages, acid mine drainage, and economic mineral or energy potential are identifiable at 30m resolution in a wide variety of settings.



Approach:

- Pioneer methods of automated image processing for the energy and mineral sectors.
- Detailed spectral mapping for surface compositions relevant to energy and mineral resources.
- Assessment of mapping capabilities at HyspIRI spatial resolution.
- Field and lab analysis to validate remote mapping products.

Results:

- Tested techniques on 18, 30 and 60-m data.
- Identified site specific minerals at diverse locations in 18m and 30m data. Some fidelity lost at 60m.
- Quantified spectral features related to increasing Fe content in solutions.
- Establishing links between spectral properties and site history and evolution, for volcanic, acid mine and renewable energy focused sites.

GREAT BASIN CENTER FOR Geothermal Energy