Remote Sensing of the Mono Basin and the Long Valley Caldera

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Location
Background

Geothermal alteration minerals show diagnostic features at ~2.21μm

Questions to answer:

- What are the limiting factors in detecting these minerals i.e. spectral resolution, spatial resolution, spectral mixing?
- Are there computationally less intensive ways of finding them in a scene?
- Can alteration be used for determining volcanic hazards
Betty Anne Prospect

- Envi spectral hourglass wizard and DCS revealed alteration to the SE of Mono Lake.

- This alteration area had only been identified in 1 other publication a 1958 Bureau of Mines resource report.

- AVIRIS revealed the alteration to cover a much wider extent than was mentioned in the report.
Betty Anne Prospect Continuum Removal Comparison

- A continuum removal from 2.137μm to 2.367μm and band placement at 2.17μm, 2.21, and 2.25 show extent of alteration (Yellows and Oranges) as well as variation within the alteration.

- This alteration is identifiable in both ~15m AVIRIS data and 30m HyspIRI simulated data.

Top: 15m AVIRIS
Bottom: 30m simulated HyspIRI
Northern Alteration

Continuum removal from 2.137μm to 2.367μm is able to highlight subtle changes in the 2.21μm due to the Al-OH bond length, an indicator of metamorphic grade (Duke & Lewis, 2010)

Left: Visible

Right: Continuum removed combination
Long Valley Caldera
Continuum Removed Band Combination Over Long Valley

30m simulated HyspIRI

~15m AVIRIS
Discovery Fault Zone, Comparison with HyMap

Densely vegetated areas appear to hide alteration that had been identified by Martini (2002) using 4m HyMap data.

Top: From Martini 2002 showing mapped alteration mineralogy.

Bottom: Continuum removed band combination showing no alteration.
Mammoth Mountain
Further HyMap Comparison

- Comparison of AVIRIS 15m with identifications made by Martini (2002) using 4m HyMap data.

- Alteration zones were identified in AVIRIS data, with more endmembers chosen.
Mammoth Mt. Examples of Identified Minerals

- White Mica
- Alunite
- Low Grade White Mica
- Halloysite (?)
- Mixture, Halloysite + Alunite
- Kaolinite
Mono-Inyo Craters

- The Mono-Inyo Craters consists of approximately 30 craters and domes that are currently exposed and erupted over the past 40,000 years.

- These craters show general variations in the 2.21μm Si-OH stretch absorption band.
2.21μm Band Depth Map of Geologic Materials

- The Mono-Inyo Craters consists of approximately 30 craters and domes that are currently exposed.
Discussion of 2.21 μm Si-OH band

- Other studies have shown spectral variation with age of volcanic materials.
- These variations are attributed to a hydration layer that forms on rocks as they are exposed to the atmosphere.

Top: From Abbot et al., 2013
Bottom: From Swayze, 2001
Right: From Friedman, 1980
Conclusions

- Multiple alteration mineral types, including argillic and QSP that cover small areas are identifiable using ~15m AVIRIS spectra and to a slightly lesser extent in 30m.

- A Continuum Removal from 2.137μm to 2.357μm with proper channel placement highlight alteration minerals in 15m data and to a lesser extent 30m data, and can show subtleties mineral transitions.

- Volcanic materials in the area show an increase in band depth in the 2.21μm Si-OH stretch, as age increases similar changes were shown by Abbot et al. (2013) and Swayze (2001). This could be used as a way to date young volcanic occurrences in remote areas such as the Aleutian Islands or Kamchatka Region.