STRAIGHTFORWARD RESULTS FROM A MARS ANALOG SITE (ALUNITE, NEVADA): LEARNING TO COMBINE NEAR- AND THERMAL-INFRARED SPECTRAL INTERPRETATIONS FOR MARS.

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Introduction: A common question in Mars remote sensing is why interpretations of data sets that are measured of reflective vs. emissive spectral regions sometimes differ, for example, for CRISM or OMEGA vs. TES. Part of that uncertainty is because of the dearth of similar hyperspectral imagery measured of terrestrial targets that cover both the terrestrial reflective range (~0.4–2.5 µm) and the emissive range (~7.5–13 µm). Such data sets would provide field testing to determine what we should expect in similar interpretations for Mars. Here we present results to build that foundation via airborne hyperspectral imagery measured of 0.4–2.5 µm and 7.5–13 µm.

This abstract presents data imaged of a site ("Alunite") that shows good agreement between the different spectral ranges; in contrast, our second LPSC abstract shows a site ("Mineral Park") that shows poor agreement. The results of the Alunite study are (1) the alunite, quartz, and gypsum materials exhibit bands in the airborne data as laboratory data would suggest; (2) interpretations of the different wavelength ranges compare well; and (3) interpretations of the remotely sensed data sets agree with ground observations. Conversely, results presented in the Mineral Park LPSC study are (1) standard laboratory spectra of jarosite do not match the airborne spectra; (2) interpretations of the different wavelength ranges are inconsistent; and (3) information from ground samples is necessary in order to understand the data.

Data sets: The Aerospace Corporation is a Federally Funded Research and Development center tasked with developing advanced technology. Aerospace funded flights of two hyperspectral instruments in May 2006 at a variety of geologic sites in Arizona, California, Nevada, and Utah. The spectral imagers are SpecTIR (~0.4–2.5 µm, 227 bands) and SEBASS (~3–5 µm and ~7.5–13 µm, 256 bands). We imaged the sites discussed here on 1 May 2006 at 2 m spatial resolution.

The overall project goal is to investigate data sets that cover the full optical range of the Earth's atmospheric windows. Table 1 in our LPSC "Mineral Park" abstract lists the different spectral ranges, and illustrates that the physics differ in both the cause of the spectral bands and the signal source. Those differences can cause the spectral behavior to differ at different wavelengths even for the same mineral target.

Results: Alunite (Fig.1) is near Las Vegas, Nevada (35° 58' 9.0"N/114° 54' 22.3"W, [1]). Figures 2 and 3 compare representative SEBASS and SpecTIR signatures with laboratory signatures. In order to replicate mapping approaches for Mars, we used standard laboratory signatures from the USGS and ASTER spectral libraries for the SEBASS and SpecTIR mapping. Some good references for alunite spectral features are [2,3,4].

SEBASS and SpecTIR map alunite signatures at the same outcrop locations (Figs. 4 to 6). On-site inspection is consistent with the airborne mapping. However, at the 2 m spatial resolution mapped, some differences between the shortwave and longwave maps are apparent for alunite and gypsum (Figures 5 and 6).

The observed SEBASS signatures show contribution from both alunite and quartz. Quartz does not have a distinct spectral band at SpecTIR wavelengths, making the presence of quartz undetectable using SpecTIR data alone. That difference means that the alunite is easier to identify in the short wavelength (SpecTIR) data because a single signature is less complex than a mixture; but that difference also means that the short wavelengths contain less information on the composition of the Alunite site.

Fig. 1: Alunite site, Aug 2004.

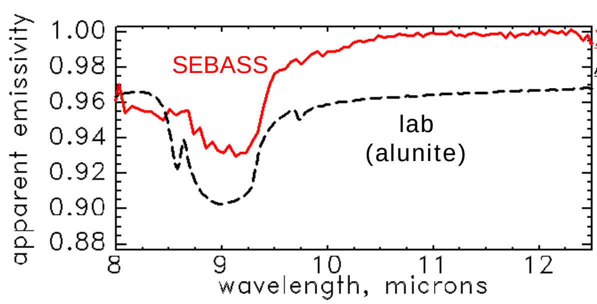

Fig. 2: SEBASS vs. lab spectrum. Laboratory sample is ASTER so04ac (150–500 µm particles), scaled to plot with similar spectral contrast as SEBASS for comparison of the band shapes. SEBASS is pixel x1181/y26, shot 060501_165938_aln2.

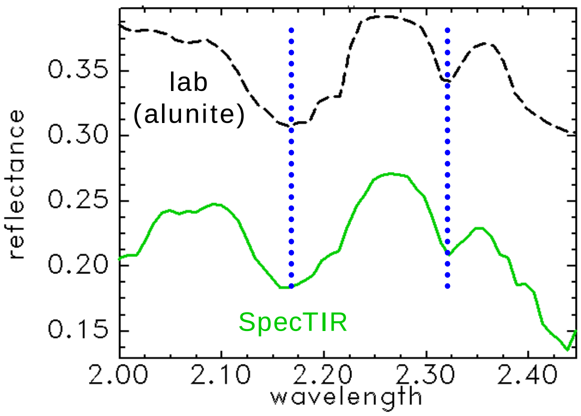

Fig. 3: Example SpecTIR signature from Alunite (shot 12-4, x151/y397). Lab = USGS Speclab “alunite1”.

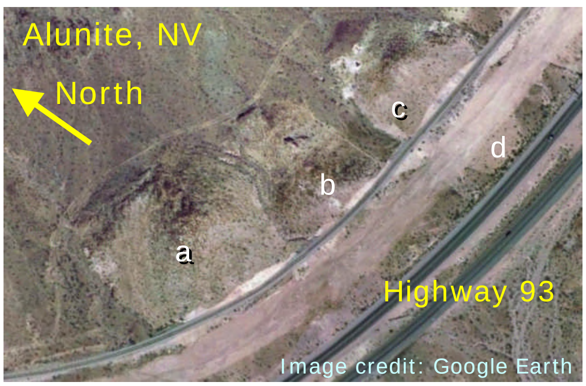

Fig. 4: Overhead view of the Alunite site. Letters mark the same locations in SpecTIR and SEBASS images.

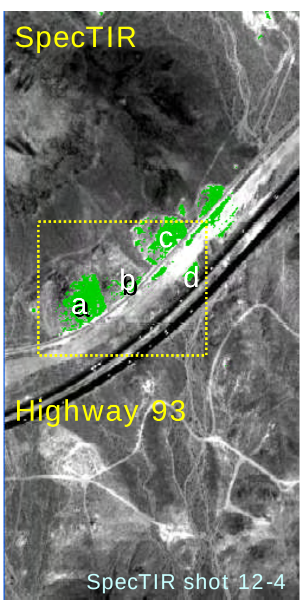

Fig. 5: Mapping of an alunite signature (green) in SpecTIR hyperspectral imagery. Gray image shows the 0.554 µm channel. Both SEBASS and SpecTIR map signatures in this region that match alunite. The dotted box marks the location shown in Fig. 6. Signature mapped is from the USGS Speclab library, “alunite1” (Fig.3). The Fig. 1 picture is at location “c” in this figure.

Conclusions: (1) The emissive and reflective wavelength regions show spectral features that match alunite spectra from on-line libraries. (2) The emissive and reflective wavelength regions show on the whole a one-to-one correlation in the location mapping. However, the details differ slightly at high spatial resolution. (3) For this site, the emissivity spectra contain more compositional information than the reflectance data, but as a consequence, the reflectance spectra provide a simpler identification for the material that does show a spectral feature. (4) For alunite, inclusion of both wavelength regions makes the identification of higher confidence than either wavelength range alone.

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References: [1] Tingley and Smith (1983) *NV B. Mines & Geol.* OFR 83-11. [2] Breitlinger et al. (1997) *J. Mol. Structure 408*, 287–290. [3] Breitlinger et al. (1999) *J. Mol. Structure 480*, 677–682. [4] Frost et al. (2006) *J. Mol. Struct. 785*, 123-132.

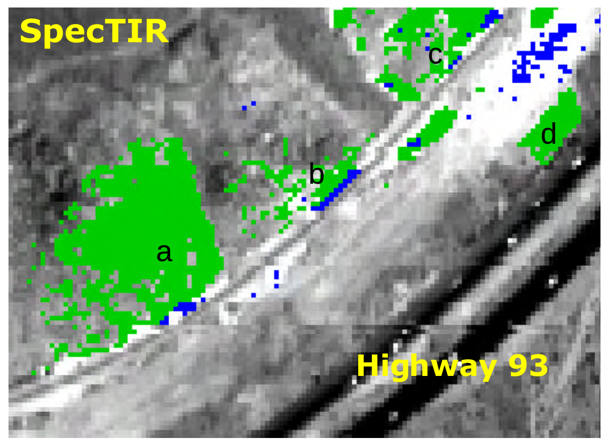

Fig. 6: Zoom of Fig. 5, SpecTIR mapping of alunite (green) and gypsum (blue) signatures.

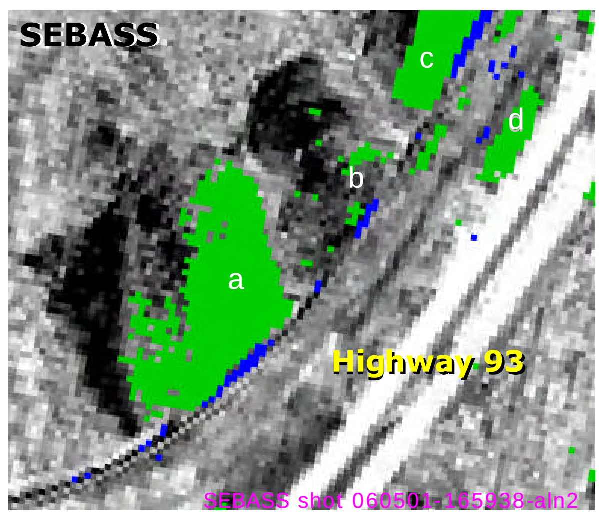

Fig. 7: SEBASS mapping of alunite (green) and gypsum (blue) signatures. Signatures mapped are from the ASTER on-line library, of alunite sample “so04ac” and gypsum sample “so02bc”, both particle size 125 to 500 µm. Gray image is the 9.44 µm SEBASS band.