

FIRST AIRBORNE THERMAL INFRARED HYPERSPECTRAL IMAGING OF A DRY LAKE: SITE GEOLOGY AND TES/THEMIS INTERPRETATIONS OF MARS. Don Burt¹; Paul Adams²; Laurel Kirkland^{2,3}, Ken Herr², ¹Arizona State U., dmburt@asu.edu; ²The Aerospace Corp., Paul.M.Adams@aero.org; Kenneth.C.Herr@aero.org; ³Lunar and Planetary Institute, kirkland@lpi.usra.edu.

Summary: Researchers seek to identify dry lake bed deposits on Mars, if present. Primary tools in this search include the 1996 Mars Global Surveyor Thermal Emission Spectrometer (TES) and the 2001 Mars Odyssey multi-channel radiometer THEMIS. Interpretations are based on a comparison of the recorded signatures to laboratory spectra.

Texture affects both the shape and contrast of the spectral signatures [1]. Materials in the field have a diverse range of textures over multiple scales. In contrast, TES/THEMIS interpretations use laboratory spectra measured of a very narrow range of textures. This leaves a critical gap in the search for evaporites on Mars: the TES laboratory data have never been compared to hyperspectral (spectrometer) airborne spectra of dry lake deposits. We present the first such study, and here focus on the impact of texture.

Background: Kirkland *et al.* published the first geologic study that used an airborne thermal infrared hyperspectral imager [1]. It uncovered key variations in spectral signatures of real-world carbonate deposits that alter TES/THEMIS interpretations. Here we extend this approach to cover some dry lake deposits, using spectra described in a companion abstract [2].

Site: Bristol Lake is in the California Mojave desert, near Amboy. Two interesting materials present are sulfates and halite. Fig. 1 shows a geologic map. The labeled geologic units are [3]:

- Qpsh: Silt, clay, and halite salt (Holocene).
- Qpsg: Silt, clay, gypsum, and celestite (Holocene)
Gypsum caps some wind eroded pedestals.
- Qps: Silt and clay (Holocene).
- Qya: Alluvium (Holocene and Pleistocene?). Sand and poorly sorted sandy gravel of angular and subangular clasts derived from adjacent mountains.

Spectral data: TES hyperspectral (spectrometer) data covers ~6.5–50 μm in 143 channels. However, TES terrestrial airborne foundation studies use low spectral resolution radiometers (multi-spectral), mainly TIMS (6 bands) or MASTER (10 bands). THEMIS is also a multi-channel radiometer (9 bands).

In contrast, we analyze unique hyperspectral (spectrometer) data from SEBASS (7.6–13.5 μm , 128 channels) [2]. Our studies bridge the looming gap between the very restricted laboratory spectra used to interpret TES, and spectra measured in the real-world.

Geology: Uncovering textural spectral effects present field materials requires a correlation of airborne or satellite spectrometer data with the surface texture.

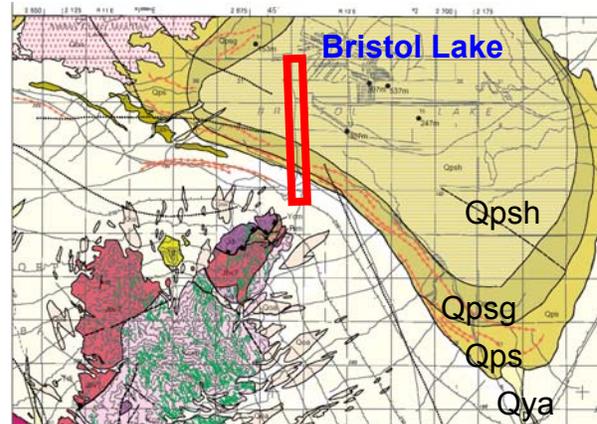


Fig. 1: Geologic overview [3]. The Bristol dry lake is toward the upper right. The compositional “bathtub” rings formed as different materials saturated and precipitated as the lake dried and shrank toward the central region. Amboy Crater is in the upper left. The red box marks the approximate SEBASS study area.

In order to link textural and spectral variations, we must study the surface textures on a range of scales. Here we discuss the dry lake bed deposits as observed in the field, with a preliminary focus on the Qpsh and Qpsg units. The next steps will be to link field observations, SEBASS data, and laboratory characterization of the field materials, including texture, composition, and additional laboratory spectra. We will also take the airborne spectrometer data into the field and examine the relationships on-site.

Qpsh unit: Fig. 2 shows a typical Qpsh location, which has large exposures of halite. The regions are flat and appear to have little coverage by other material. The surface texture varied widely. Some surfaces are smooth and shiny, while others are matte. Those effects are mainly tied to grain-scale texture. Roughness at other scales also occurs, e.g., the difference between upper and lower Fig. 2.

Qpsg unit: The gypsum deposits may be partially altered to anhydrite. We found sulfates in three broad types of exposures, mixed with silt and clay:

- (1) Gypsum/anhydrite crystals exposed on slight rises on the flat, open playa (Figs. 3, 4).
- (2) Celestite nodules on the open playa (Fig. 5).
- (3) Indurated gypsum/anhydrite, which here we will call “gypcrete” (Fig. 6). Preliminary results indicate these exposures caused the strongest sulfate signature in SEBASS data [2].

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Fig. 2: Qpsh (silt, clay, halite) unit [3]. This unit has extensive exposures of halite. Minor amounts of silt and clay probably cause the off-white color. These polygons are ~2 m across. Note the varying textures, including at multiple scales.



Fig. 3: Gypsum/anhydrite exposed on Qpsg unit. These exposures are visible as slightly brighter regions in areas with silt and clay.



Fig. 4: Qpsg unit gypsum/anhydrite, close-up. Boot tip for scale. This type of texture is difficult to preserve for laboratory characterization. We collected samples with a putty knife and gingerly packed them in Tupperware containers.



Fig. 5: Qpsg unit celestite nodules. These are roughly 5 cm across.



Fig. 6: Gypcrete in the Qpsg unit.

Discussion. Field materials exhibit a diverse range of textures, and texture affects the spectral signature [1]. The TES laboratory spectra are measured of smooth surfaces of pure minerals sieved to 710–1000 μ [4]. This is a very restricted texture and purity when compared to real-world variation (e.g., Figs. 2–6), including what may reasonably be expected on Mars. Experience in the field with spectrometers such as SEBASS is the only way to appreciate the enormous gap between the laboratory and field spectral worlds.

We laid the SEBASS lines to include the range of textures evident in Figs. 2–6. Further examination of texture vs. the signatures will constrain whether the TES foundation library would correctly identify mineral deposits with the textures at Bristol Lake.

References: [1] Kirkland L. E. et al. (2002), First Use of an Airborne Thermal Infrared Hyperspectral Scanner for Compositional Mapping, *Remote Sens. Environ.* 80, 447–459, www.lpi.usra.edu/science/kirkland. [2] Kirkland L. E. et al. (2003), submitted *LPSC XXXIV*. [3] Howard K. A. (2002), Geologic Map- Sheep Hole Mtns, *USGS MF-2344*. [4] Christensen P. R. et al. (2000) *JGR* 105, 9735.