LEARNING ABOUT MARS GEOLOGY USING THERMAL INFRARED SPECTRAL IMAGING: ORBITER AND ROVER PERSPECTIVES. L. W. Probst[1], L. E. Kirkland[2]; D. M. Burt[3]; [1]Rice University, lwprobst@rice.edu; [2]Lunar and Planetary Institute, kirkland@lpi.usra.edu; [3]Arizona State University, dmburt@asu.edu. On-line information and data: www.lpi.usra.edu/science/kirkland

Introduction: Much can be learned about a planet's mineralogy with spectral data from both a rover and an orbiter. Amboy Crater [1] is a recent cinder cone volcano surrounded by a basalt lava field 70 square kilometers in area and located in southern California's Mojave Desert [2]. Amboy Crater and its lava field are shown in Figs. 1 and 2. Parts of the landscape included in the Amboy lava field resemble pictures of the Martian surface taken from the Viking and Pathfinder spacecraft. In this work we study the Amboy Crater site with Thermal Infrared (TIR) spectral imaging in order to learn how to better interpret the geology of a site from TIR data. We will then apply this type of study to understanding TIR data from Mars.

Fig. 1: Amboy Crater, a recent cinder cone volcano.

Fig. 2: Amboy Crater's lava field.

We intend to correlate TIR spectral signatures with true mineralogy, viewing geometry, and texture. Properties that can be analyzed to determine the degree of correlation include the ratio of target size to pixel size, surface dip angles, surface textures, the degree of rock vesicularity, the percentage of the rock surface that is exposed, and a description of material covering the rock (such as a rock coating or dust).

Background: A steep sided narrow rock and a shallow sloping broad rock outcrop would provide very different views and surfaces to an orbiter as compared to a rover. Combining both rover and orbiter perspectives can help determine whether anything is present on the side of the outcrop but not on the top, or vice versa. Samples taken from the top and sides of the rock can then support what is seen from both instruments.

The size of a target versus the pixel size of the TIR spectrometer will determine how clearly the target will be detected. If target to pixel size ratio is small, the target will not be clearly seen, if at all, in the image. A larger target to pixel size ratio will allow higher resolution and more detailed information about the target.

Methods: Each of the Mars Exploration Rovers is equipped with a Miniature Thermal Emission Spectrometer (Mini-TES), an instrument which characterizes the surface of Mars using TIR spectroscopy. We simulate Mini-TES with a ground-based hyperspectral imager called Tonka, a TIR spectrometer atop a van platform. Tonka is the field hyperspectral instrument most similar to Mini-TES in that it raster scans two dimensionally, it is about the same height above the ground, and it has a similar spectral resolution and field of view. We simulate Mars orbital TIR spectrometer data on Earth using the Spatially Enhanced Broadband Array Spectrograph System (SEBASS), an airborne hyperspectral imager. Tonka and SEBASS both measure spectra that cover the range of 7.5-13.5 µm in 128 bands, whereas Mini-TES covers the range of 5-29 µm. The spectral range of Mini-TES is limited only by interference effects in its KBr beamsplitter and signal transmission losses [3], whereas the spectral range of SEBASS and Tonka are limited by high atmospheric absorption on Earth. The more limited spectral range available to us on Earth forces us to work with a smaller amount of information.

To determine how SEBASS and Tonka signatures compare to the true mineralogy, we collected samples of the bulk material, dust, and coatings. We will spectrally analyze the samples in the laboratory and compare the lab spectra to field measurements. To determine the correlation between spectral signature and the viewing geometry, we measured the surface dip angle at different rock exposures.

Observations: The lavas at Amboy Crater are basaltic and mildly to highly vesicular. The tops and the sides of rocks commonly show differing degrees of vesicularity, and vesicles on different faces of the rocks are filled with varying amounts of sand. The distribution of vesicle fillage appears random, however. Three types of coating, caliche, varnish, and a brown rind, cover some of the rock surfaces. These factors will each affect the TIR spectral shape. Caliche and brown rind coatings are shown in Fig. 3. Packed and loose textures in sand surfaces also produce differing spectral shapes. A field spectrometer test site for varying sand surface textures is shown in Fig. 4.

Fig. 3: Caliche and a brown rind coat numerous surfaces of this rock outcrop.

Conclusions: Many factors affect TIR spectral shape, and we need to understand each of these factors and their effects well in order to properly diagnose true mineralogy from a spectrometer. Laboratory characterization is a valuable tool to allow more accurate field identification of minerals. This is a work in progress, and many studies remain in order to gain confidence in characterizing minerals in the field. With accurate field mineral identification and similar instruments on Mars, we can begin to use TIR spectroscopy to interpret Mars geology more confidently.

Fig. 4: Test site for the field spectrometer. Each rectangle in the sand has a different texture.

References: [1] Parker, R.B., Recent volcanism at Amboy Crater, San Bernardino County, California, Calif. Div. Mines and Geol. Special Report 76, 21 pp (1963). [2] USGS Reference Site, available at http://vulcan.wr.usgs.gov/Volcanoes/California/Amboy/description_amboy.html. [3] Wiens R. C. et al. (2002) *JGR- Planets*, 107, DOI 10.1029/2000JE001439.