IDENTIFICATION OF A QUARTZ AND NA-FELDSPAR SURFACE MINERALOGY IN SYRTIS MAJOR. J. L. Bandfield[1], P. R. Christensen[1], V. E. Hamilton[2], H. Y. McSween Jr.[3], [1]Department of Geological Sciences, Arizona State University (joshband@asu.edu), [2]Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, Honolulu, Hawai'I, [3]Department of Earth and Planetary Sciences, University of Tennessee.

Introduction: Visible through thermal infrared spectroscopy has been used to identify a number of mineralogically unique surfaces on Mars. Crystalline and nanocrystalline iron oxides [e.g. 1-2], pyroxene [e.g. 3-5], olivine [6-7], plagioclase [4,5,8], water bearing phases such as zeolites [8,9], carbonate [10], and high silica glass [4] are amongst the identified phases. Unique vibrational and electronic absorptions in a wide variety of materials throughout these wavelengths allow for remote identification of these materials.

The Thermal Emission Imaging System (THEMIS) on the Mars Odyssey spacecraft provides measurements of the Martian surface at 100 m/pixel in 9 spectral channels from ~6 to 15 µm. THEMIS images are highly complimentary to data returned from the Thermal Emission Spectrometer (TES) that has high spectral resolution (10 cm^{-1}) but relatively low spatial sampling (3 km).

Methods and Datasets: A variety of datasets were used for this study, including THEMIS visible and near infrared multispectral imagery, THEMIS multispectral thermal infrared imagery, TES surface emissivity [10-11], and MOLA elevation data.

Several new techniques have been developed for analysis of surface composition using THEMIS data. The radiative contribution of atmospheric emission and multiple scattering is computed using a variable temperature and constant surface emissivity surface located within the image. After subtraction of this constant radiance contribution, relative equivalent emissivities between surfaces of different temperatures are valid.

Atmospheric correction is also greatly simplified to a single multiplicative factor for each spectral band. This factor is determined using surface emissivity determined from TES data for a large area of the THEMIS image. The atmospheric opacity determined at TES scales can be used to retrieve surface emissivity from individual THEMIS pixels.

A spectral unit mapping algorithm has been developed for use with THEMIS data similar to methods that have been applied to both Earth and Mars using a variety of spectral regions [e.g. 12-14]. This algorithm is a linear least-squares fit of THEMIS surface emissivity with a set of selected endmembers. The resulting concentrations and RMS error of the spectral fit can be displayed in image format and can provide quantitative information about the coverage of the spectral components present in the THEMIS scene.

Results: Two unnamed craters about 100 km apart near 20N, 65E in North Syrtis Major have been identified with a unique spectral component located within the central peaks (Figure 1). Both craters are ~30 km in diameter and have low albedo deposits in their floors, which are ~1000 m lower than the surrounding terrain. Thermal inertia is moderate within the region and the areas that contain the unique spectral component are not thermophysically discernable from the surrounding terrain. THEMIS visible imagery indicates that the unique spectral component has a higher albedo than the surrounding low albedo crater floor deposits.

A number of THEMIS images were processed using the methods described above. Surface emissivities of the crater floors and the central peak unit are similar for all images (Figure 2). The central peak unit has deeper absorptions from ~8-9 µm and weaker absorptions from ~10-13 µm than the low albedo intracrater material, which has a spectral signature similar to basalt [4-5].

Two warm, daytime TES spectra cover the central peak spectral unit within the northern crater of the pair. The surface emissivity is consistent with the THEMIS measurements. The unique spectral component was isolated and its mineralogy determined by direct comparison as well as deconvolution [11,15]. The unique spectral component closely matches laboratory spectra of quartz and feldspar rich rocks such as quartz monzonites and granite/granodiorites. Deconvolution results indicate high concentrations of quartz and high Na feldspars (dominated by oligoclase). Other components may be present, but could not be identified with confidence.

Spectral unit concentrations were retrieved using a basaltic spectrum derived from TES data in the region and a laboratory spectrum of a granitic sample convolved to the THEMIS spectral bandpasses. RMS errors are low and the THEMIS spectra can be well modeled using the two surface spectral units.

Discussion and Conclusions: Both TES and THEMIS data are consistent with the presence of a quartz and Na-feldspar surface mineralogy. These surface units appear to be part of the base of the central peaks of the two craters, which may indicate that they may have been brought up from ~3-4 km depth [16].

Spectral measurements of these central peaks may be probing compositions that formed at depth in a manner similar to near-infrared spectral measurements of lunar crater central peak structures [17-18].

This composition appears to be unique to the two craters discussed here despite the presence of a number of similar sized craters regionally and planetwide. This may indicate that a unique composition was present before the impact event and the present surface mineralogy may be unrelated to the cratering process.

A number of formation mechanisms are currently being explored. The exposure is consistent with a felsic plutonic rock such as a granodiorite. A hydrothermal origin that may be related to or independent of the cratering process is also possible.

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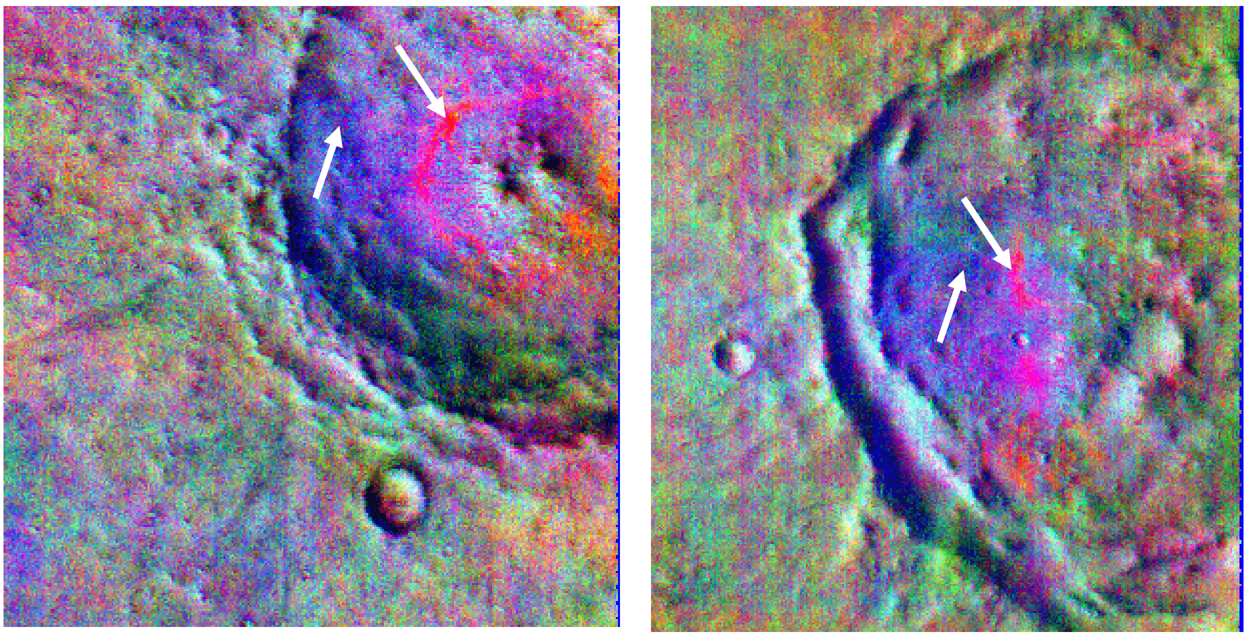

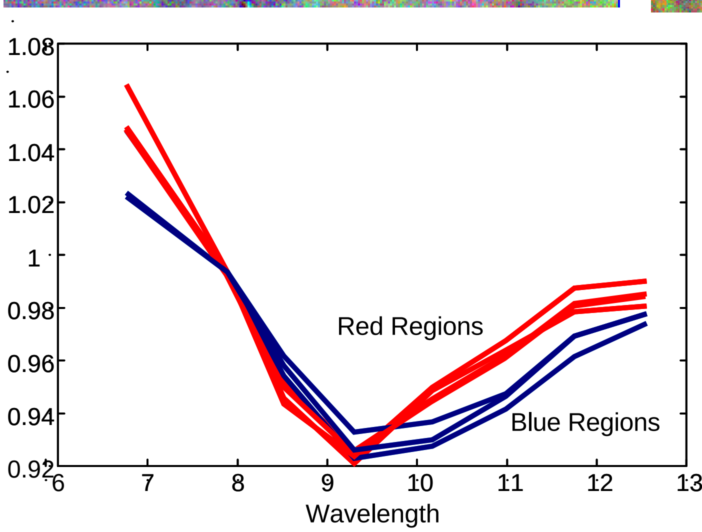

Figure 1. THEMIS images of the two craters containing the unique spectral signature in Syrtis Major. Arrows denote the locations of the spectral unit emissivities plotted in Figure 2. Both images are approximately 30 km across.

Figure 2. Surface emissivity retrieved from multiple THEMIS images over both craters. Red and Blue regions are designated by the arrows in Figure 1 above. Emissivities exceed unity for THEMIS bands 1-2 because band 3 was used for an estimation of surface kinetic temperature. The spectral shapes remain accurate, though offset.