THE STRATIGRAPHY, COMPOSITION AND THERMOPHYSICAL PROPERTIES OF ENDEAVOUR CRATER, MERIDIANI PLANUM, MARS, FROM ORBITAL REMOTE SENSING.

M. Chojnacki[1], J. Moersch[1], J. J. Wray[2] and D. M. Burr[1], [1]Planetary Geosciences Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996 (chojan1@utk.edu), [2]Department of Astronomy, Cornell University, Ithaca, NY 14853.

Introduction and Motivation: In the last decade, Meridiani Planum has become one of the most intensely studied regions on Mars. It is composed of regional-scale layered deposits associated with aqueously altered minerals that have been detected both from orbit and in situ by the ongoing investigations of the Mars Exploration Rover Opportunity [1, 2, 3]. Opportunity (MER B) is currently en route to investigate the ~20 km diameter Endeavour crater (Figure 1), which reaches deeper into the stratigraphy and geologic history of this interesting region than the other craters previously visited by the rover.

We are performing geomorphic, compositional and thermophysical mapping of Endeavour crater and its surroundings (2.1°-2.5°S, 5.4-5.0°W) to support future in situ exploration by MER B.

Methods: To examine crater morphology we used visible image data from the MRO instruments CTX [4] and HiRISE [5]. To determine surface composition, we used thermal infrared emissivity spectra from the TES instrument on MGS [6] and near-infrared reflectance spectra from CRISM on MRO [7]. Thermal inertia (TI) data from the THEMIS multispectral thermal infrared imager [8], on board MO, were derived using the method described by [9] and used to create thermophysical unit maps and infer particle sizes [10].

Crater Stratigraphy and Thermophysical Properties: Endeavour crater exposes ~500 m of the regional stratigraphy with raised rim segments in the north, east and southwest. The rounded and degraded rim shows morphologic and thermophysical evidence of aeolian modification and infilling of plains material, similar to Victoria crater [11], although at a much larger scale. CTX images of moderate slopes, primarily on the west and east inner rim, show radial patterns consistent with backwasting by mass wasting of crater walls.

At least four photogeologic units are found on the floor of Endeavour crater (Figure 2). Intracrater regions can be broadly divided into the following units, listed in order of stratigraphic superposition: light-toned basement unit (B), mid-toned mantling unit (M), transverse aeolian ridges (T), dunes and other minor bedforms (D). The basement unit has an erosional expression and relatively high TI, similar to the plains unit previously termed "etched terrain" [1]. Likewise, the mantling unit is similar in morphology to the hematite-bearing plains that lie atop the etched unit [2, 3]. Two groups of dune fields exhibit morphologies that are different from the ubiquitous aeolian ripples already traversed by the rover. The western group consists of ~200-m-wide barchan dunes (Figure 2), whereas bedforms in the eastern group appear to be more degraded and lack distinct slipfaces. Orbit-based evidence for surface changes in the appearance of the bedforms over the past decade [12] strongly suggests that the eastern group is currently undergoing aeolian erosion.

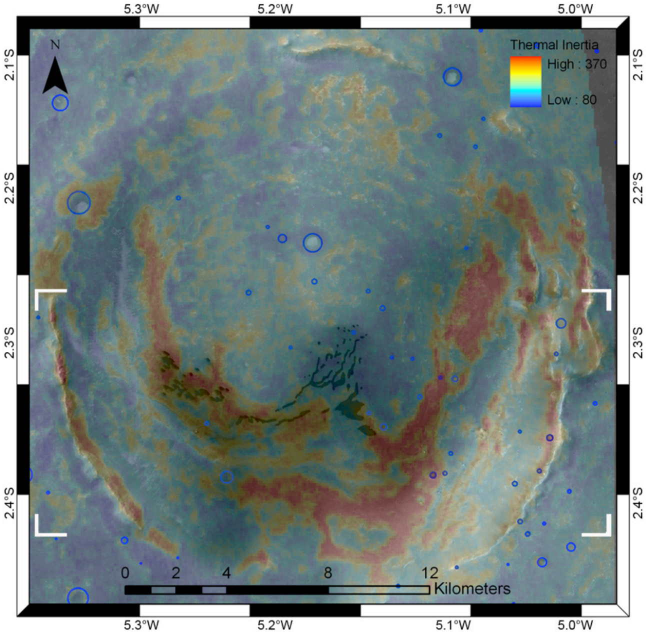

Figure 1. A CTX image mosaic of Endeavour crater, colorized with THEMIS thermal inertia data. Blue circles denote craters and the features outlined in black polygons are locations of dunes. The white box shows the extent of figure 3.

The THEMIS thermal inertia map of Endeavour crater (Figure 1) exhibits values from 80-370 $Jm^{-2}K^{-1}s^{-1/2}$ (units hereafter assumed). The highest of these values are greater than the THEMIS TI values for terrain previously explored by Opportunity [13], although this is likely a resolution effect (*e.g.,* Victoria crater bedrock is possibly over ~1500 [14]). The highest values (>340) are found on crater rim and the light-toned basement unit (B), where sand coverage is minimal at the 100-m scale. The mantling unit (M) has moderate TI values (~200), suggestive of medium sand. Western sand dunes in the dune unit (D) show TI values consistent with medium to coarse sand-sizes

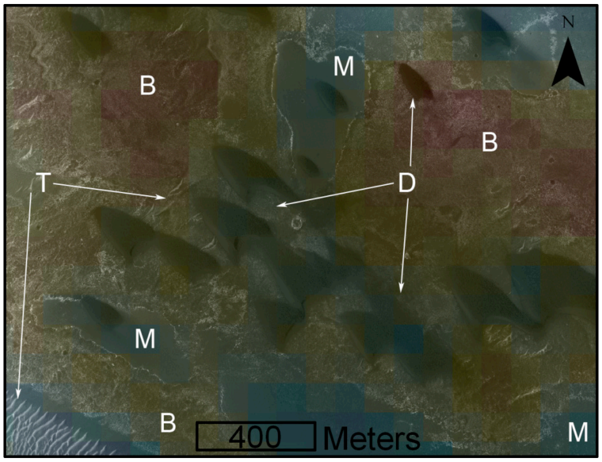

Figure 2. The major crater floor units in HiRISE PSP_005779_1775 with color overlay from THEMIS TI data. The light-toned basement unit (B) is overridden by the mid-toned mantling unit (M), dune bedforms (D) and transverse aeolian ridges (T). See Figure 3 for location.

(250-1000 μm). Eastern dunes have a TI of ~160, consistent with particle diameters of ~65 μm (fine sand).

Composition: The Endeavour crater raised rim units appear different, visibly and spectrally, from the majority of surrounding terrain and have been interpreted as ancient strata [15]. CRISM spectra reveal phyllosilicate (Fe/Mg-smectite clay) in the rim units, while polyhydrated sulfate is detected in the plains surrounding the rim [15]. Hydration (consistent with sulfate) is also detected in the unit B materials on the crater floor. Hydration has not been detected from orbit in the plains traversed by MER B to date [3], so its detection in unit B may indicate that the intracrater exposures are less obscured by surficial fines, consistent with the higher TI surfaces.

Our work with TES data also reveals compositional differences between Endeavour and the surrounding plains (Figure 3). Spectral signatures of basalt and hematite are more enhanced on the crater floor than the plains. This enhancement may be due to the intracrater TES dust coverage being lower than outside the crater. The greatest basalt abundances are found in the low TES albedo (0.11-0.13) southern crater floor and adjacent rim. These locations correlate with the exposures of the mid-toned mantling unit (M) and the dune unit (D). Spectral unmixing of the basalt-rich TES spectra in these areas suggests a combination of intermediate plagioclase (45%), hematite (30%) and intermediate pyroxene (25%), once the blackbody component has been removed. Intracrater hematite could indicate "in place" deposits, as observed in previous craters studied by MER B [2, 14], or transport of hematite concretions into the crater by gravity- and/or aeolian-driven processes. The highest hematite percentages (~30%) are correlated with the locations of several dune fields (Figure 2 and 3). If concretions are part of dune bedforms in Endeavour, that would contrast with MER B findings to date, which suggest only basaltic sand is mobile, whereas concretions are stabilized [16].

Summary & Future Direction: Endeavour crater shows morphologic and spectral differences from locations previously visited by MER B. Further investigation of existing and yet-to-be-acquired orbital remote sensing data will be needed to fully maximize the scientific yield from Opportunity's upcoming exploration of Endeavour crater.

References: [1] Hynek B. M. et al. (2002) JGR, 107, 5088. [2] Squyres S. W. et al. (2004) Science, 306, 1709–1714. [3] Arvidson R. E. et al. (2006) JGR, 111, E12S08. [4] Malin M. C. et al. (2007) JGR, 112, E05S04. [5] McEwen A. S. et al. (2007) JGR, 112, E05S02. [6] Christensen P. R. et al. (2001) JGR, 106, 23,823-23,871. [7] Murchie S. et al. (2007) JGR, 112, E05S03. [8] Christensen P. R. et al. (2004) Space Sci. Rev., 110, 85–130. [9] Putzig N. E. and M. T. Mellon (2007) Icarus, 191, 68-94. [10] Presley M. A. and P. R. Christensen (1997) JGR, 102, 6551–6566. [11] Grant J. A. et al. (2008) JGR, 113, E11010. [12] Chojnacki M. et al. (2010) LPSC, *this conference.* [13] Fergason R. L. et al. (2006) JGR, 111, E12004. [14] Squyres S. W. et al. (2009) Science, 324, 1058–1061. [15] Wray J. J. et al. (2009) GRL, 36, L21201. [16] Geissler P. E. et al. (2008) JGR, 113, E12S31.

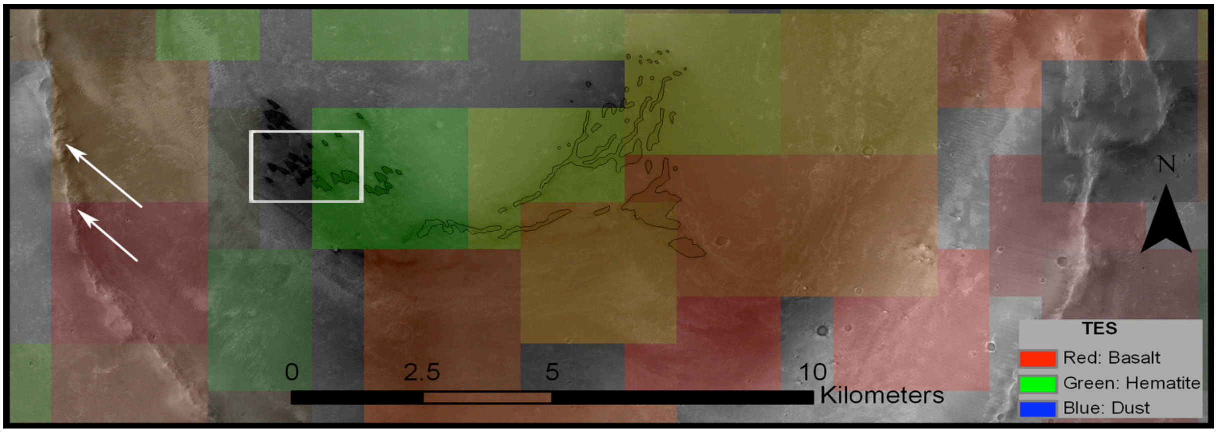

Figure 3. CTX image of the southern portion of Endeavour crater, with color overlay from TES compositional data. The three TES-end members correspond with the RGB channels. The white arrows indicate CRISM-detected phyllosilicates [15], and the white box shows the location of Figure 2.