GEOLOGIC MAPPING OF THE MERIDIANI REGION, MARS.

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Introduction: The light toned bedrock that has been observed at the Mars Exploration Rover Opportunity landing site is an upper layer in a sequence >600 m thick in places. These outcrops contain mineral and textural signatures that require interaction of, and possibly formation from, water. Many distinct layers are visible in the remote sensing data (e.g. Figure 1) and no work has ever characterized the full set of these materials that cover an area $>3 \times 10^5$ km^2 spanning 20º of longitude. Thus, whatever water-related process(es?) altered, and possibly formed, the rocks at the Opportunity landing site extended over a vast region of Mars. Yet many questions remain to be answered, such as: (1) in what capacity did water form and alter the deposits?, (2) what are the temporal and spatial relations with other major events known from ancient Mars?, and (3) would this type of environment have been conducive to the development of life?

To address these questions we are completing a detailed geologic, stratigraphic, and thermophysical properties study of this widespread terrain. Specifically, we are drafting a 1:2M-scale geological map covering the full extent of these water-related deposits. In tandem with the mapping, Hynek and Phillips [1] have conducted a preliminary stratigraphic analysis of the stack of materials. After mapping is complete, we will study the thermophysical properties of the varied layers to derive possible compositional information of the materials. These tasks serve several purposes including gaining an understanding of the complex nature of these materials, their potential source region(s), and their timing of emplacement. All of these efforts are necessary to place the observations by the Opportunity Rover in a broader context and prepare for potential future landed missions to the region. Understanding the large-scale paleohydrology of Mars is central to NASA's goals and vital for determining if life ever arose on the planet.

Geologic Mapping: PI Hynek and Collaborators Roger Phillips (SwRI), Ken Tanaka (USGS) and Bruce Jakosky (CU/LASP) are currently funded to complete detailed geologic mapping at 1:2,000,000-scale in the Meridiani region, defined here as 5°S-15°N, 15°W eastward across the prime meridian to 15°E. This covers portions of the quadrangles MC-11 (Oxia Palus), MC-12 (Arabia), MC-19 (Margaritifer Sinus), and MC-20 (Sinus Sabaeus). The area encompasses the entire suite of light toned outcrops within the Meridiani region, which will be the primary focus of this map. In places of particular interest with sufficient data coverage, we will map the terrain at a larger scale to truly detail the local geology. The numerous units in the study area will be refined from recent works [2-6].

Formal geological mapping has not yet begun. The large geographic area has resulted in delays in the production of a 100-m-resolution THEMIS base map, which was just completed by the USGS Flagstaff. We have acquired many other data sets, formatted them for GIS, and coregistered them (Figure 1). This includes MOC WA images, THEMIS daytime and nighttime IR data, some THEMIS visible data, MOLA topography, some MOC NA images, TES and THEMIS thermal inertia, and mineral abundance maps from TES and OMEGA. We have completed mapping of regional valley networks to understand their potential link to the layers. We have produced generalized sketch maps of key units within the region (Figure 1) but are just beginning formal mapping with the newly-acquired high resolution THEMIS base map.

Stratigraphic and Thermophysical Analyses: PI Hynek has been working with Collaborator Roger Phillips to map out the largest stratigraphic markers across the Meridiani region. We extracted the individual MOLA elevation data points along their exposures, tried to fit planes to the data, and then analyzed their orientations relative to the regional tilt. Our results show that most of these benchmark horizons: (1) are planar and coherent over at least a 100-km scale, and (2) have dip azimuth and magnitudes that are similar to the underlying regional slope, which was emplaced by 3.7 Ga. Mapping relations with nearby ancient river valleys suggest that these deposits also formed near this time and without significant contributions from precipitation-fed surface runoff. THEMIS thermal inertia data and erosional expressions imply that significant physical compositional differences exist within the stratigraphy, and these likely reflect a changing paleodepositional environment and/or chemical alteration histories. Any hypothesis for the origin of these regional-scale materials must be consistent with all these observations. This work is helping to elucidate the timing, origin, and nature of the Meridiani region layered deposits and we have placed significantly greater constraints on the layers' characteristics and history. A manuscript detailing this work has been written and is in review for publication [1].

Summary: In our first six months of funding, significant progress has been made on acquiring data for geologic mapping and initial delineation of major units. With the newly-produced base map we plan to begin formal mapping. A large stratigraphic analysis of the region has already been completed and we have found that most of the benchmark horizons identified are coherent over the 100-km-scale and are similar in dip azimuth and direction to the underlying long wavelength topography [1]. This work has helped test hypotheses regarding the origin of the layered materials and their timing relative to other events that shaped ancient Mars.

References: [1] B. M. Hynek and R. J. Phillips, *Earth and Plan. Sci. Lett*., 2008 (submitted). [2] B. M. Hynek et al., *J. Geophys. Res.*, doi:10.1029/2002JE001891, 2002. [3] Edgett, K. S., and M. C. Malin, *Geophys. Res. Lett.*, doi:10.1029/2002GL016515, 2002. [4] Hynek, B. M., *Nature*, doi:10.1038/nature02902, 2004. [5] Edgett, K. S., *Mars*, doi:10.1555/mars.2005.0002, 2005. [6] R. E. Arvidson et al., *Science*, doi:10.1126/science.1109509, 2005.

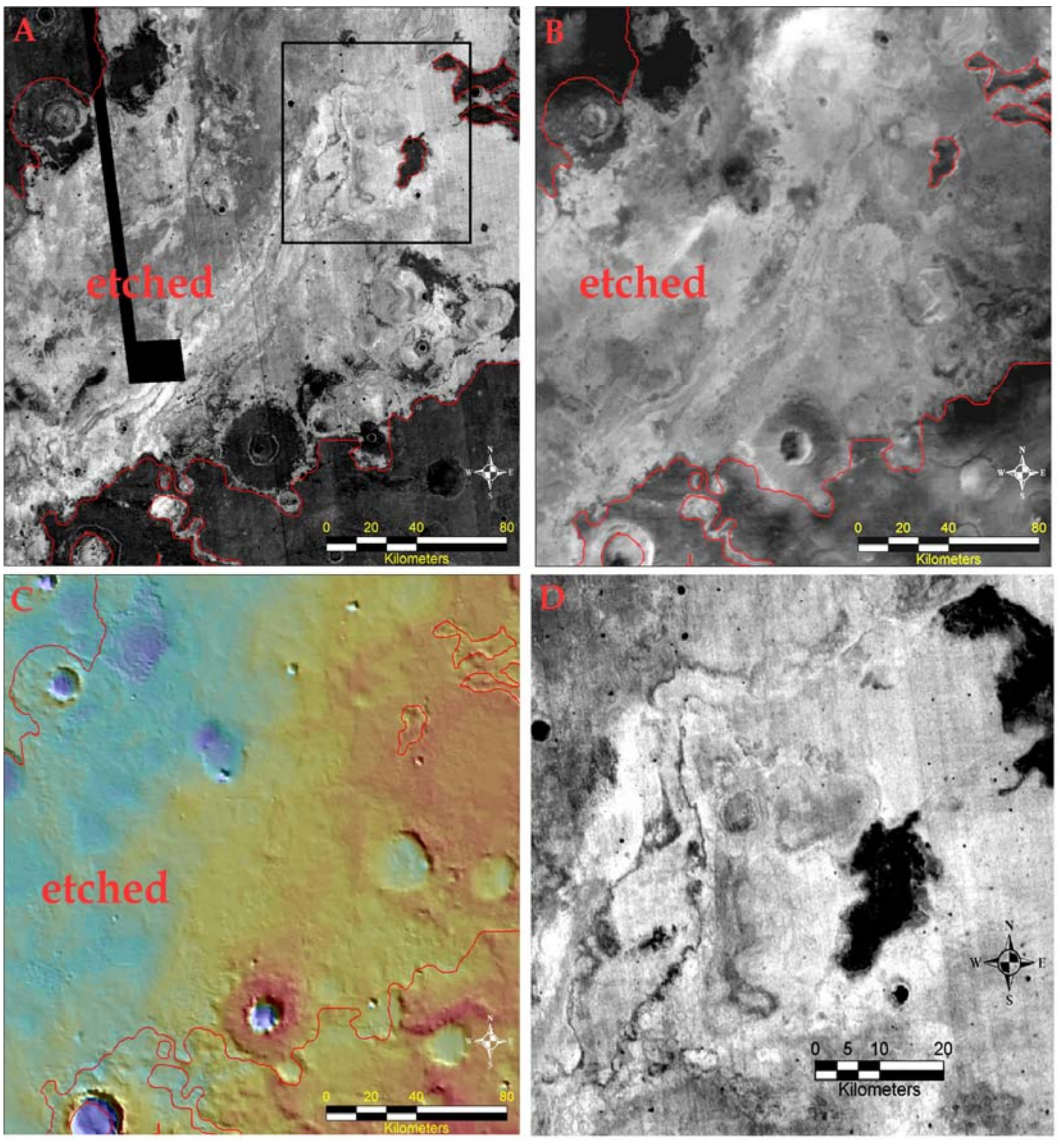

Figure 1. Examples of the data sets being used in the analyses. Figures 1A and 1D are THEMIS-derived thermal inertia (dark = low values); Figure 1B is a MOC WA mosaic (credit: MSSS); Figure 1C is MOLA elevation colors on MOLA shaded relief (blue = low, red = high, ~1 km relief). Red lines denote the generalized extent of a prominent light toned etched unit and Figure 1D is a zoomed in view of the black box in Figure 1A. To date, we have mapped out the major "etched" unit but diverse subunits are clearly visible in all the data sets. Figures 1A-1C cover the same geographic extent and are centered near 2ºN, 5ºE.