TERRA MERIDIANI HEMATITE DEPOSIT LANDING SITE RATIONALE. B. M. Hynek, R. E. Arvidson, R. J. Phillips and F. P. Seelos, Department of Earth and Planetary Sciences, Washington University, One Brookings Drive, St. Louis MO 63130 (hynek@levee.wustl.edu).

Introduction: The primary hematite deposit in Terra Meridiani lies in a unique region of Mars that has undergone regional-scale tilting toward the Chryse Trough due to tectonic activity associated with formation of the Tharsis rise. This tilting and perhaps accompanying climate change led to large-scale denudation of the Martian highlands, followed by widespread deposition. Stripping of the deposits has exposed a number of layered systems, including the hematite unit. Landing a rover on the hematite deposit would enable the testing of multiple working hypotheses regarding the deposition of these layered materials. Most of these hypotheses require surface or near-surface water at the time of formation (Late Noachian-Early Hesperian), raising the possibility of finding prebiotic or biotic materials.

Regional Setting: The formation of the Tharsis rise has profoundly affected the global shape of the planet. Recent modeling of Mars Global Surveyor data indicate that the long-wavelength topography and gravity field of Mars are explained by the oblateness and the Tharsis load. Global deformation of the lithosphere (elastic outer spherical shell) resulted from the Tharsis loading [1]. The majority of the Tharsis igneous complex was emplaced by the end of the Noachian [2], and resulted in both topography and gravity lows circumferential to the Tharsis rise (Chryse Trough), and topography and gravity highs nearly antipodal to Tharsis (the "Arabia Dome") [1].

The entire western flank of the Arabia Dome has likely undergone extensive fluvial denudation [3] in response to the emplacement of Tharsis. This loading created a regional tilting, resulting in erosion and incision of the martian uplands, and transport to and deposition of sediment in the Chryse Trough. The system was likely governed by the overall potential energy associated with the gradient across the aeropotential and the ability of the system to erode and transport. Using fine-scale topographic grids we estimated that ~4.5×10^6 km^3 of material has been eroded from the cratered uplands and transported to local and distal sinks [3]. The morphology, rate of denudation and extensive nature of upland degradation indicate that precipitation-fed surface runoff is the most likely geomorphic agent capable of such a process, indicative of a warmer and wetter Mars during the Late Noachian interval.

The primary hematite deposit lies within the denuded zone between the Chryse Trough and the uplifted Arabia Dome. Superposition relations and crater counts reveal that the hematite deposit formed coeval or immediately after the denudation event [3], indicating that surface and/or near-surface water may still have existed at the time of formation.

Characterization and Formation Mechanisms of Martian Hematite: The 350 by 350-750 km-sized deposit located in Terra Meridiani is interpreted to be composed of coarse-grained, gray crystalline hematite [4]. Data from the Mars Orbiter Laser Altimeter (MOLA) and the Mars Orbiter Camera (MOC) indicate that the deposit is smooth, superposed on surrounding materials, and buries valley networks (Figure 1). MOC images show that the hematite deposit has been stripped by wind erosion to reveal layering and underlying cratered surfaces in places. The images also reveal an abundance of layered materials in and around the Terra Meridiani region, which Malin and Edgett [5] interpret as sedimentary deposits.

A number of formation mechanisms have been proposed for the martian hematite deposit, many of which require liquid water. Christensen et al. [4] advocated precipitation from a standing body of Fe-rich water based on the association with nearby layered deposits, large areographic extent, and distance from a regional heat source. Lane et al. [6] proposed subaqeous deposition, burial, and metamorphism, with subsequent exhumation. Alternatively, the hematite may be a result of an igneous intrusion or an altered ignimbrite deposit without aqueous activity [7].

Ability to Test Multiple Working Hypotheses: The Athena payload on MER is well suited to test mechanisms of hematite formation. The Pancam and Mini-TES have the ability to determine both geologic setting and mineralogical compositions [8]. Thus mineralogy within nearby layering (or at minimum the surface layer) could be determined before a traverse is even attempted. In-situ analysis of the nearby terrain, including detailed compositional information provided by the Alpha Particle-X-Ray-Spectrometer, iron-bearing mineralogy determined by the Mossbauer Spectrometer, as well as fine-scale textural properties using the Microscope Imager, would allow the deciphering of the complex geologic history in this unique region of Mars [8]. A lacustrine origin of the hematite could be confirmed by finding features such as wave-cut terraces, shoreline deposits, cross-bedding within layers, fluvio-lacustrine sequences and imbricated pebbles, most of which should be evident if this hypothesis is correct. Conversely, an igneous origin could be confirmed by detection of welded tuffs. Spectral information provided by Pancam and Mini-TES could distinguish volcanic from aqueous cementation, including mineralogic differences and temperature of formation. Results from field tests of the Athena payload indicate that most, if not all, of these geologic, mineralogic, and compositional indicators are easily detectable [9].

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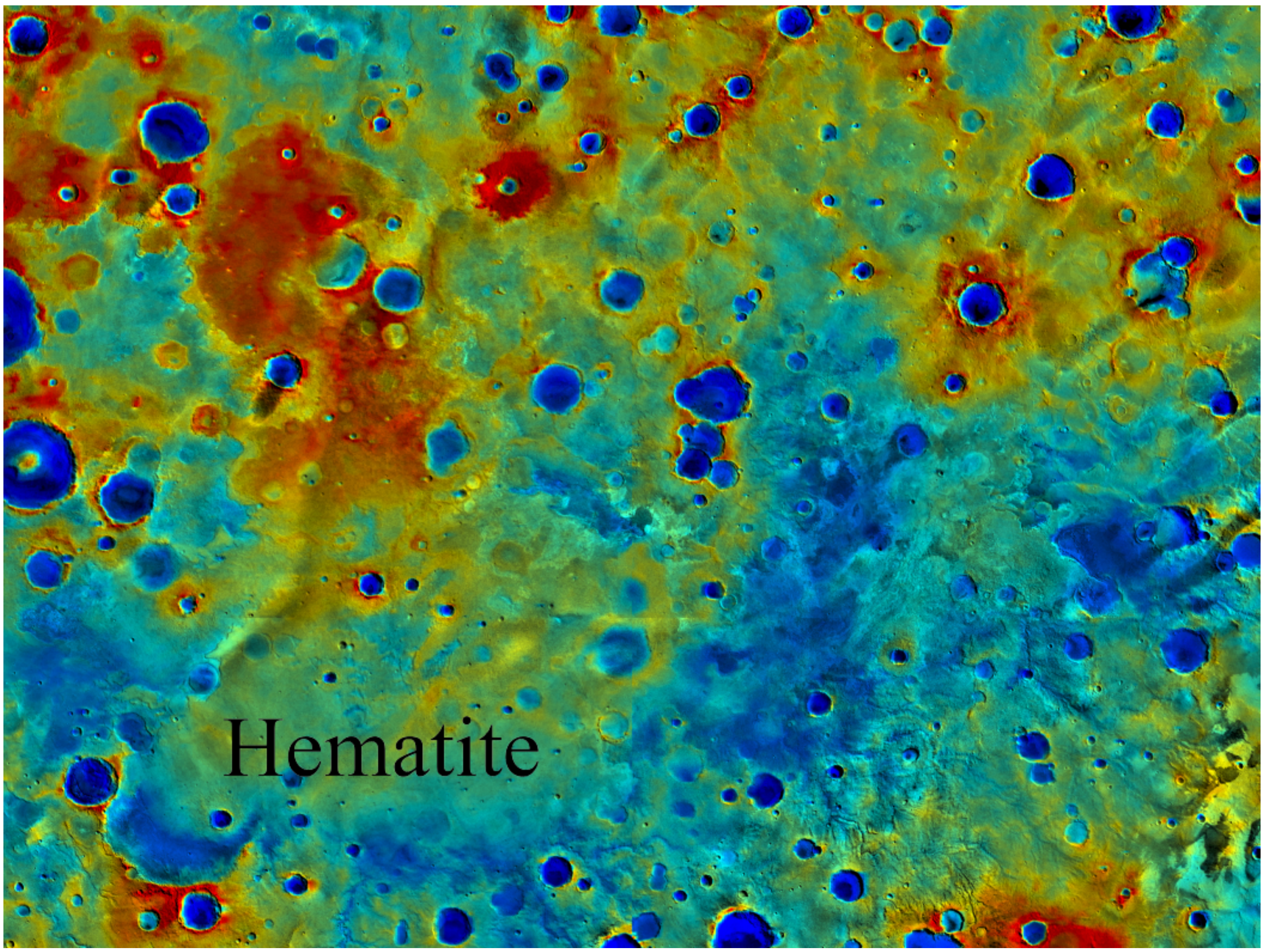

Figure 1. MDIM overlain with MOLA elevations coded in color. Blues = low, reds = high, with relief of 2.7 km. Regional tilt has been removed. Covers 5°S to 10°N and ± 10° about prime meridian. Hematite deposit is labeled. High areas correspond to erosional inliers that preserve layered stratigraphy.