SPATIAL DISTRIBUTION OF HEMATITE AROUND THE BASE OF AEOLIS MONS, GALE CRATER, MARS.

K. D. Seelos[1] , D. L. Buczkowski[1], A. A. Fraeman[2], B. J. Thomson[3], and L. S. Crumpler[4], [1]JHU Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 21043, (kim.seelos@jhuapl.edu), [2]Jet Propulsion Laboratory, [3]University of Tennessee, Knoxville, [4]New Mexico Museum of Natural History & Science.

Introduction: Aeolis Mons, also known as Mt. Sharp, is a ~5 km-high stack of layered materials superposed on the floor and central peak of Gale crater located along the crustal dichotomy boundary of Mars (-5.3°N, 137.8°E). The floor of Gale and the lower units of Mt. Sharp are being investigated by the Mars Science Laboratory (MSL) Curiosity rover, largely as a result of orbital identification of minerals such as hematite, mono- and polyhydrated sulfates, Fe/Mg phyllosilicates, and hydrated silica that indicate significant past aqueous activity under variable geochemical conditions [e.g., 1, 2]. In this contribution, we provide an expanded view of hematite-bearing materials around Mt. Sharp to contextualize Curiosity's observations and provide more information about the spatial extent and likely processes that produced this particular phase.

Background: Strong orbital hematite spectral signatures have been reported at multiple elevations in the well-exposed northwest quadrant of Mt. Sharp [1, 3, 4]. Curiosity CheMin data have recently validated one of these detections at Vera Rubin Ridge (VRR) [5, 6], a high standing feature that parallels the lower units of Mt. Sharp. Based on orbital mapping, the hematite at VRR was initially proposed to have originated at a redox interface, either when Fe^{2+} that had been carried by anoxic waters encountered an oxidizing environment, or via in-place alteration of Fe^{2+} to Fe^{3+} phases by oxidizing, neutral to low pH fluids. Both of these scenarios could provide favorable environments and energy sources for chemolithotrophic bacteria; thus, characterization of hematite plays a key role in understanding overall habitability potential.

Methods: We utilize hyperspectral visible-near infrared (0.4-4 micron) targeted images (18 or 36 m/pix) acquired by the Mars Reconnaissance Orbiter (MRO) Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) [7] to characterize the spatial distribution of hematite. Data are processed through either the Map-Projected Targeted Reduced Data Record (MTRDR) pipeline [8] or equivalent procedures available in the CRISM Analysis Toolkit (CAT) [9]. In both cases, radiometrically calibrated CRISM data are photometrically and atmospherically corrected, noise filtered, and map projected. Summary parameters that encode spectral features [10] are also generated. Each image is georeferenced to align with a Context Camera (CTX) basemap [after 11] to facilitate improved correlation to surface morphology. We then render, qualitatively balance, and mosaic red-green-blue (RGB) browse images composed of the summary parameters BD530, BD860, and BDI1000VIS [10], respectively, for 24 CRISM scenes (Figure 1). In this color composite, hematite appears yellow-green, ferrous-bearing mafic minerals like olivine and pyroxene appear blue, and nanophase iron oxides (e.g., in dust) appears red.

Observations: An overview of Mt. Sharp and targeted CRISM data is shown in Figure 1, with key hematite occurrences emphasized in Figures 1A-H. Areas A and B are closest to Curiosity's traverse, with VRR evident in B and standing in high relief compared to its surroundings. Northeast of the ridge in A, the hematite-bearing ridge tapers in relief but broadens to a few kilometers. To the north and west of VRR in B and C, hematite is located in a nearly flat-lying deposit with dunes and other units superposed. Moving west and south counter-clockwise from Curiosity's location, a hematite signature becomes associated with an erosional trough, narrowly outcropping along the Mt. Sharp side (D-G). In areas F and G, a second, higher elevation hematite-bearing layer is apparent. These two layers are particularly distinct in H on the far southeastern lobe of Mt. Sharp. The upper of these two layers is again expressed as a more erosionally resistant ridge.

Implications: The extended distribution of hematite-bearing outcrops around Mt. Sharp indicates the process(s) responsible for hematite formation were active throughout the lower mound. Understanding additional stratigraphic and mineralogic associations will further inform potential formation scenarios. In addition, in situ measurements along Curiosity's traverse reveal that hematite is present in strata even where orbital data does not show a strong signature [5]; this allows testing of the relationships and dependencies between orbital and ground observations that is essential for improving the science return of both missions.

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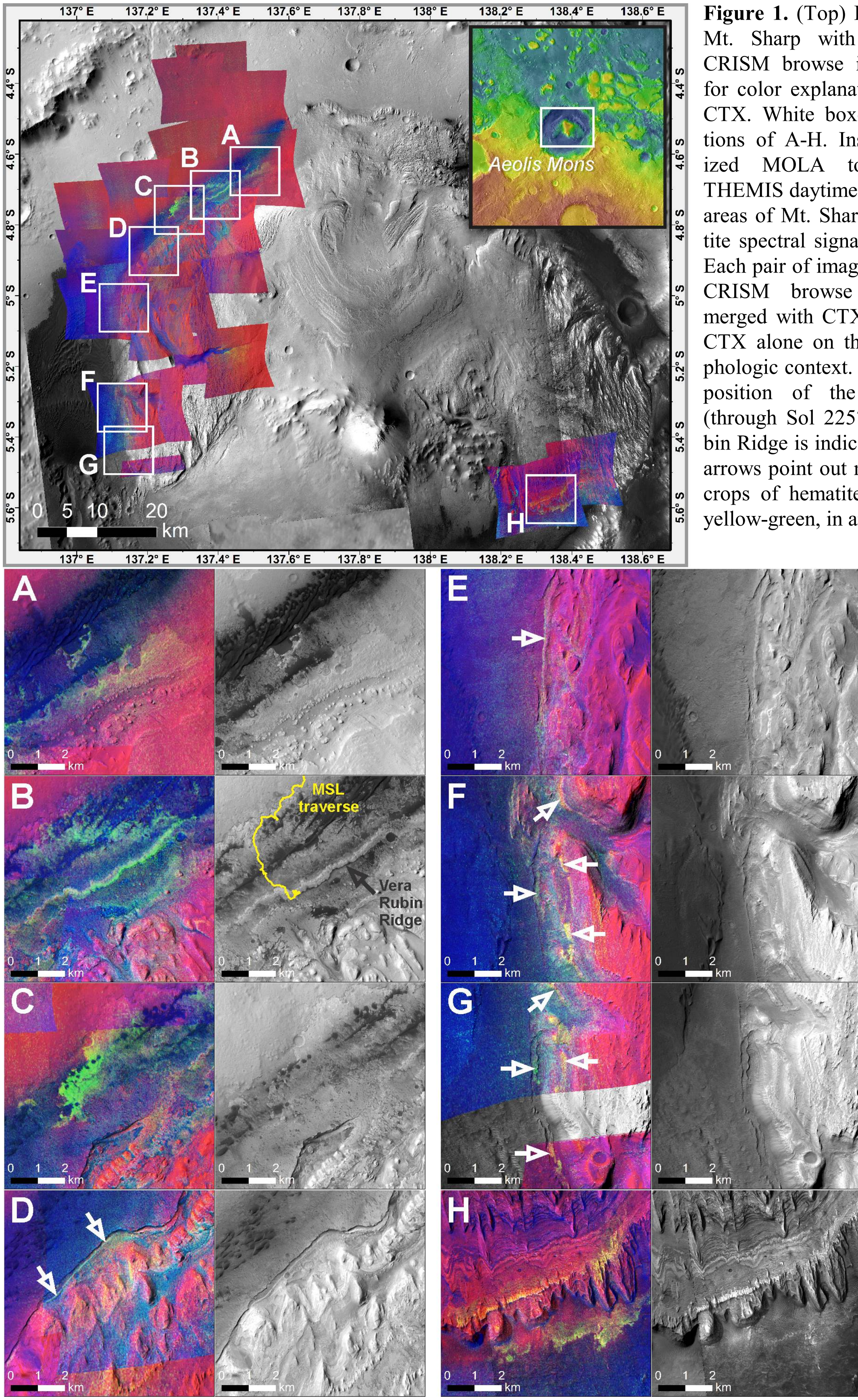

Figure 1. (Top) Regional view of Mt. Sharp with mosaic of 24 CRISM browse images (see text for color explanation) overlain on CTX. White boxes indicate locations of A-H. Inset shows colorized MOLA topography over THEMIS daytime IR. (A-H) Select areas of Mt. Sharp where a hematite spectral signature is observed. Each pair of images consists of the CRISM browse image mosaic merged with CTX on the left and CTX alone on the right for morphologic context. The approximate position of the MSL traverse (through Sol 2257) and Vera Rubin Ridge is indicated in B. White arrows point out more narrow outcrops of hematite, which appears yellow-green, in areas D-G.