UPDATE ON STUDIES OF THE MARTIAN HEMATITE-RICH AREAS. Melissa D. Lane, William K. Hartmann, and Daniel C. Berman, Planetary Science Institute, 620 N. 6th Avenue, Tucson, AZ 85705 (lane@psi.edu).

The best evidence for regions with unusual mineral concentrations on Mars comes not from carbonate areas, as had been expected before Mars Global Surveyor (MGS), but from coarse-grained, gray hematite areas found by the MGS Thermal Emission Spectrometer (TES) team [1, 2]. The largest and first area to be identified is near zero latitude and zero longitude in Sinus Meridiani (SM), and has received the most attention. We will focus on the SM area for this work. A second area is associated with Aram crater [2], which clearly was filled with sediments, and in which the sediments have broken into chaotic terrain, causing release of water that eroded through the eastern rim and flowed out along Ares Vallis.

Lane *et al.* [3,4] showed that the hematite emissivity spectra of Sinus Meridiani lack a band at 390 cm^{-1},and that the absence of this band is characteristic of preferentially oriented crystals of hematite (i.e., grains measured along their optic axis) (Figs. 1 and 2). They concluded that the hematite in that area is a discontinuous exposure of oriented, platy grains, and that the hematite-rich layer probably was a water-deposited sediment, deposited initially as a red, fine-grained chemical precipitate, but subsequently buried, causing recrystallization into a coarser-grained, gray hematite. The preferential orientation of the crystals and the gray color appear to be good evidence that the hematite in that area was once buried, and has been exhumed. Burial could have been as deep as a few kilometers. Recent work by Malin and Edgett [5] on freshly exhumed sediments demonstrates that formation and exhumation of such thick layers can occur. Similarly, there is some evidence that the hematite-bearing layer in Aram crater is a stratum within the sediments that fill the crater [2].

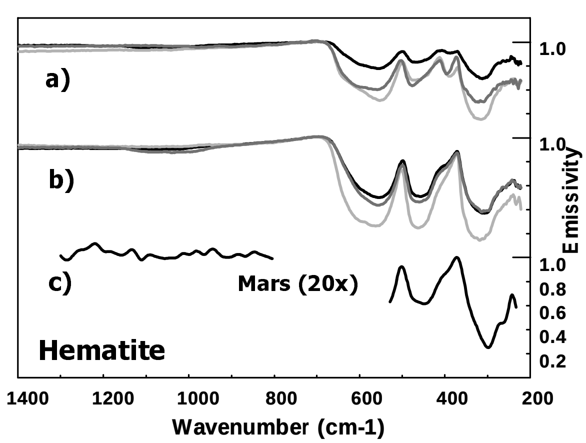

Figure 1. Laboratory spectra of various hematite samples showing the two classes of spectra: (a) those with a 390 cm-1 band and (b) those without the 390 cm-1 band. In addition (c) shows a Sinus Meridiani spectrum showing that the SM region does not exhibit the 390 cm^{-1} band.

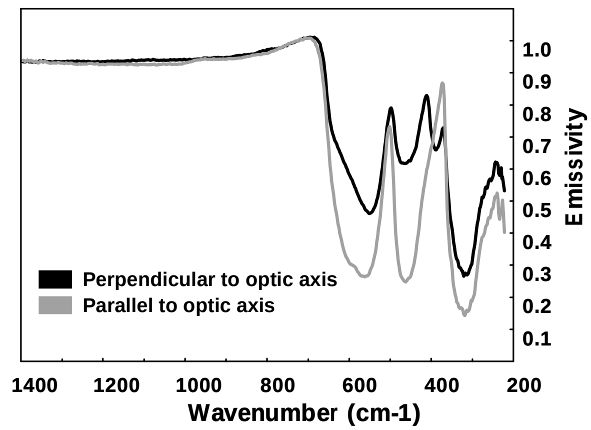

Figure 2. Emissivity spectra of a single, large hematite crystal showing the effect of crystal orientation. Comparison of the gray spectrum (parallel to the optic, or *c*, axis) to that of SM shown in Figure 1c shows that the SM spectrum is indicative of hematite grain orientation.

Kelsey et al. [6] also pointed to evidence that the Sinus Meridiani hematite area has been recently exposed by exhumation. This evidence centered on the discovery of a population of old 200-m-scale craters, unique in four ways (Fig. 3). First, these craters have unusual morphology, being extremely shallow and defined primarily by rims of contrasting albedo material that appear possibly to have resisted erosion. Second, as seen in Fig. 4, their crater population densities (craters/km^2) fall virtually on the saturation equilibrium line, which is nearly unprecedented in this size range. Elsewhere on Mars, such craters have reached a lower density steady state, due to erosive loss. The high density suggests that this is a very ancient surface, formed during the intense early bombardment of Mars (before 3.8 GY ago, during the Noachian). Third, an overlapping population of small, sparse, sharp-rimmed, fresh craters falls on an isochron with an age of the order only 10 My, implying very recent exposure of this surface by exhumation. Fourth, all these features appear to be concentrated in the hematite-rich area, although we are still investigating the exact relation of the hematite concentration and crater features.

These observations are consistent with a model in which the Sinus Meridiana hematite deposit may mark a paleolake floor or other layer of water-associated hematite enrichment, which was covered and preserved by sediments, and recently exhumed.

Further studies are needed to relate the exact hematite distribution to the geological features shown in MOC images, and to compare these diagnostics to the situation in the other hematite areas of Aram Crater and diverse exposures in Valles Marineris.

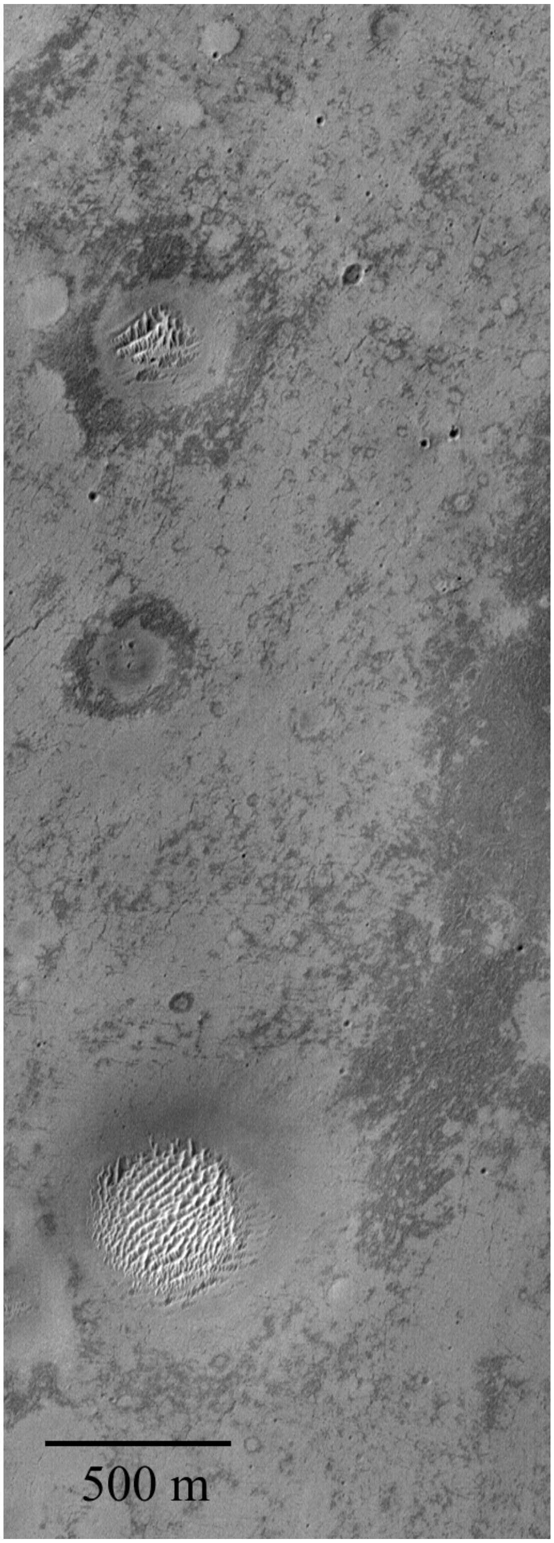

Figure 3. A portion of the Terra Meridiani hematite-rich area shown in MGS/MOC image M00-01661. The area is nearly saturation with ancient "fossil craters" expressed as shallow rings. A sparse population of small, sharp craters also exists.

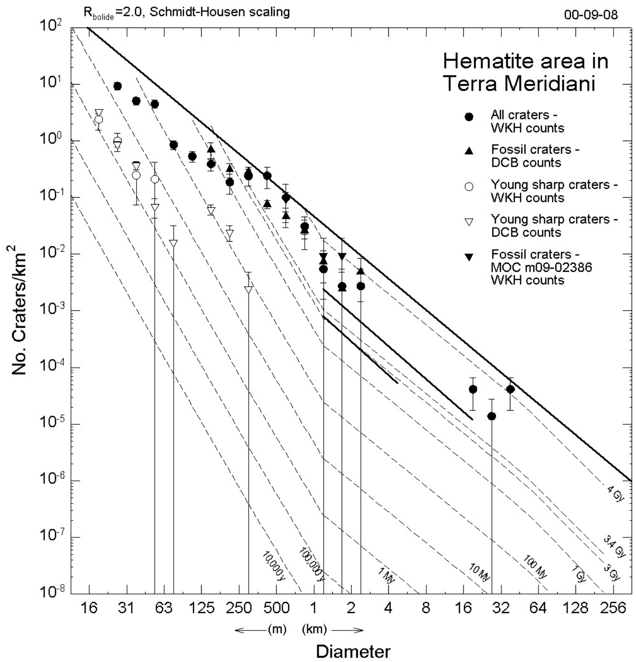

Figure 4. Crater count diagram and isochrons for the Terra Meridiani hematite-rich area. Filled symbols show the population of "fossil craters" lying near the saturation equilibrium limit (upper straight line), indicating a very ancient surface. Open symbols show the fresh, recent craters created since the modern surface formed, indicating that the area has been exposed for as little as a few million years. Our interpretation is that an ancient (paleolake bed?) was covered by sediments and exhumed only a few million years ago.

References: [1] Christensen P. R. et al. (2000) *J. Geophys. Res. 105*, 9623-9642. [2] Christensen P. R. et al. (2001) *J. Geophys. Res.*, in press. [3] Lane M. D. et al. (2000) in *Geology and Ore Deposits 2000: The Great Basin and Beyond*, Geol. Soc. of Nevada Symp. Proc. 849-854. [4] Lane M. D. et al. (2000) *LPS XXXI*, 1140. [5] Malin M. and Edgett K. (2000) *Science 290*, 1927-1937. [6] Kelsey C. M. et al. (2000) *LPS XXIII*, 1524; Hartmann W. K. (2001) *Icarus*, in press.