CHARACTERIZATION OF SURFICIAL UNITS IN THE CENTRAL EQUATORIAL REGION OF MARS. M.A. Presley and R.E. Arvidson, McDonnell Center for the Space Sciences, Dept. of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130; and P.R. Christensen, Dept. of Geology, Arizona State University, Tempe, AZ 85287

A major objective of the Mars Observer Mission is to map the physical, elemental and mineralogical characteristics of the surface, for the purpose of characterizing both the surficial materials and bedrock geology. A detailed study of the surficial units in the central equatorial region (335°W - 15°W, 10°S - 30°N) was conducted [1] to determine whether the surficial units may be used to characterize the bedrock geology or whether they are completely decoupled from the underlying bedrock. This area was selected because it displays a wide variation in color, albedo and thermal properties over a small area of the planet and has good data coverage, relatively free from atmospheric dust and haze.

Three surficial units can be distinguished on the basis of spectral reflectance properties determined from radiometrically calibrated Viking Orbiter color images and thermal properties determined from the Viking Infrared Thermal Mapper. These units are: (1) a bright red unit that has a relatively high reflectance in both red (average reflectance = 0.17) and violet wavelengths (0.06) and a low fine component thermal inertia (modal value = 2.5 x 10^{-3}cal·cm^{-2}·s^{-1/2}·K^{-1}); (2) a dark violet unit that has a relatively low reflectance in both red (0.10) and violet wavelengths (0.05) and a relatively high thermal inertia (6.8); and (3) a brown unit that has a reflectance that is relatively low in the violet wavelengths (0.04), but intermediate in value relative to the other units in the red wavelengths (0.13), and a thermal inertia that is also intermediate in value (4.7). When the reflectance values for the region are plotted on a two-dimensional histogram of the number of pixels as a function of their red and violet reflectances, two nearly linear trends intersect in a V-shape pattern. These trends suggest that a bright red end-member material is mixing with a dark violet end member and with a brown end member. The violet and the brown units, however, do not mix with each other.

These units can be mapped to contiguous, well defined locations by use of simple parallelepiped techniques. Material that produces the brighter reddish trend, at the apex of the two mixing trends, is located in Arabia and in Deucalionus Regio. Dark violet material is located in Sinus Meridiani and Sinus Sabaeus. The dark violet material also exists as dark splotches in large craters within the Oxia Palus quadrangle, as well as dark streaks associated with the splotches. Brown material is located in the north to northwest where it is the dominant unit in the western half of the Oxia Palus quadrangle. In addition to the contiguous units, bright red material can be found as bright crescents on the upwind side of large crater rims in Oxia, and as bright margins surrounding the dark streaks. Consistent with the observed mixing trends, dark violet material and brown material are rarely found in contact with one another. Bright material is always present along the margins separating the two darker units.

Color/albedo boundaries are relatively sharp and distinct in all places. There are, however, no systematic correlations between these boundaries and either topography or morphology, based on comparison with medium and high resolution Viking images. In addition, crater size-frequency distributions,
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derived from high resolution Viking Orbiter images and Mariner 9 A-frames, indicate that the units are indistinguishable in terms of age. Using a lunar-like cratering rate, the size-frequency distributions imply that only a relatively minor amount of crater obliteration (< 0.008 μm/year depositional rate) could have occurred over the past several billion years.

The results of this study are consistent with the bright red unit being composed of dust, probably part of a globally homogenized deposit emplaced during dust storm decay [2]. The dark violet unit is probably composed of sand-sized, less oxidized materials (see e.g., [3] and [4]). The thermal inertia of the brown unit, and the lack of mixing between the brown and the dark violet units, are consistent with significant duricrust formation in the brown unit, as suggested by Kieffer et al. [5], or with the brown unit being a lag deposit composed of a mixture of particles with an effective grain size in the range of fine sand. If the brown unit is composed of duricrusted dust deposits then the bright margins separating the dark violet unit from the brown unit may be due to impedence of duricrust formation at the boundary by saltating sand grains of the dark violet unit. If, on the other hand, the brown unit is a lag deposit, then the bright margins may be caused by dynamic effects during dust deposition due to roughness differences between the brown and dark violet units as determined by their different effective grain sizes. It is impossible to test between these two hypotheses with existing data.

The color/albedo patterns compared with morphology, topography and crater statistics imply that at least two of these units, the bright red and the brown, are relatively thin deposits, decoupled from the underlying bedrock geology. Data utilized in this study are insufficient to determine whether the dark violet unit is locally derived from bedrock, or whether it is also a thin eolian deposit. Earth-based spectra of the dark regions, however, indicate that Fei+ absorptions around 1 μm vary with location on the planet. These variations are believed to be due to differences in the mafic mineralogy, primarily pyroxenes and olivines [6]. Earth-based spectra, thus suggest that the dark material may be derived from local sources. Since the dark violet unit is the most likely to be derived from bedrock, data collection by the Mars Observer Mission should concentrate on these areas, and other dark regions like them. In other places, however, the optical and thermal signatures of the bedrock may be extensively contaminated or obscured by overlying eolian deposits. Interpretation of Mars Observer data will therefore require careful consideration of how extensively the surficial materials may be related to the underlying crustal geology or to laterally homogenized eolian deposits.

REFERENCES