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**GLOBAL COLOR VIEWS OF MARS.** A. S. McEwen, L. A. Soderblom, T. L. Becker, E. M. Lee, and R. M. Batson, U.S. Geological Survey, Flagstaff AZ 86001, USA.

About 1000 Viking Orbiter red- and violet-filter images have been processed to provide global color coverage of Mars at a scale of 1 km/pixel. Individual image frames acquired during a single spacecraft revolution ("rev") were first processed through radiometric calibration, cosmetic cleanup, geometric control, reprojection, and mosaicking [1]. We have produced a total of 57 "single-rev" mosaics. Phase angles range from 13° to 85°. All the mosaics are geometrically tied to the Mars Digital Image Mosaic (MDIM), a black-and-white base map with a scale of 231 m/pixel [2].

The largest challenge in producing a global mosaic from Viking images with useful color and albedo information for the surface was the photometric normalization, including removal of atmospheric effects. First we selected a subset of single-rev mosaics that provide the best global coverage (least atmospheric obscuration and seasonal frost). A Minnaert photometric normalization was applied to normalize the variations in illumination and viewing angles. Image data acquired at illumination or emission angles larger than 77° were trimmed off, as these data are strongly affected by atmospheric scattering. A model image of condensate haze was created from the violet images, consisting of 60% of the violet-filter reflectance greater than 0.05, followed by smoothing over 20-km scales. The haze model was then subtracted from both the violet- and red-filter images. The residual polar caps were excluded from haze removal. This procedure is "conservative" in the sense that it errs on the side of undercorrecting for the haze. Finally, these normalized mosaics were combined with seam removal [3] into global mosaics. Global coverage is about 98% complete in the red-filter mosaic and 95% complete in the violet-filter mosaic. A green-filter image was synthesized from an average of the red- and violet-filter data to complete a three-color set. The Viking Orbiters acquired actual green-filter images covering about 60% of the martian surface.

Two final datasets have been produced: "cosmetic" and "scientific" versions. For the cosmetic version, gaps were filled by interpolation, the violet-filter images were given a divide filter to remove residual atmospheric hazes, and digital airbrushing was applied to the north polar region. The divide filter consists of dividing the value of each pixel by the average value over a 200-km$^2$ area surrounding each pixel. The north polar region contains the largest gaps and poorest color data due to the typical atmospheric conditions and the geometry of the Viking orbits. For large areas near the north pole with red-only coverage, the violet-filter coverage was synthesized using a function fit to actual Mars red- and violet-filter data. For the scientific versions, data gaps are left blank and the divide filtering and digital airbrushing were not applied. About 30% of the violet-filter data is obscured by hazes to an extent that makes the data unreliable for quantitative analyses of the surface color. We plan to mosaic the available green-filter images in the near future.

The final mosaics have been reprojected into several map projections: Sinusoidal Equal-Area (global), Lambertian Equal-Area (east- and west-hemisphere views), Polar Stereographic (one-half planet views of the northern and southern hemispheres), Mercator (equatorial region), and Orthographic views centered on six different positions. The Orthographic views are most like those seen by a distant observer looking through a telescope. All versions exist both with and without latitude-longitude overlays.

The color balance selected for these images was designed to be close to natural color for the bright reddish regions such as Tharsis and Arabia, but the data have been "stretched" such that the relatively dark regions appear darker and less reddish than their natural appearance. This stretching allows us to better see the color and brightness variations on Mars, which are related to the composition or physical structure of the surface materials. Note that these images are also unnatural because atmospheric effects have been (mostly) removed and because we see the summertime appearance of both polar caps simultaneously.

Five major surface units can be mapped from the global mosaics: (1) bright red regions such as Tharsis, Arabia, and Hellas, which have properties consistent with surface deposits of fine-grained dust such as that carried aloft by dust storms [4]; (2) dark regions, which have properties consistent with coarse-grained sand and rock fragments [4]; (3) intermediate brightness regions, which may represent rough, indurated surfaces [5]; (4) the bright north polar residual cap, which consists of water ice mixed with dust [6]; and (5) the very bright south polar residual cap, which probably consists of $CO_2$ ice [7].

The global color mosaics have been merged with the MDIM in a set of 30 quadrangles covering Mars at a scale of 462 m/pixel. These products show both the surface morphology as seen from imaging at low Sun elevation angles and the color and albedo information best seen at high Sun elevations. The datasets were merged by the following steps: (1) extract red and violet color data (cosmetic versions) for a quadrangle and make red/violet ratio; (2) reproject red and red/violet ratio to the same map projection and scale as the MDIM quadrangle; (3) choose match points and warp the color images to improve the geometric registration; (4) add the red and MDIM files to create a merged red; (5) divide the merged red by the red/violet ratio to make a merged violet; and (6) average the merged red and violet files to create a synthetic merged green image.

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**THE DISTRIBUTION OF MARTIAN GROUND ICE AT OTHER EPOCHS.** M. T. Mellon[1] and B. M. Jakosky[2], [1]Laboratory for Atmospheric and Space Physics, Department of Astrophysical, Planetary, and Atmospheric Sciences, [2]Department of Geological Sciences, University of Colorado, Boulder CO 80309-0392, USA.

The theoretical study of ground-ice stability for the present epoch has shown that ice within the martian regolith is stable poleward of about ±40° latitude with about 20°–30° of variation from one longitude to the next in the northern hemisphere (due to variations in the surface thermal properties). The depth of stability in this region was found to range from a couple of tens of centimeters to about a meter, being closer to the surface nearer to the pole. It was also found that atmospheric water vapor (at Viking-measured abundances) was capable to diffusing into the regolith and condensing as pore ice within the top few meters in these regions of stability. The timescale of condensation of ice from atmospheric water was found to be comparable to that of the evolution of the martian orbit, indicating the need to include past orbital changes in the prediction of the present distribution of ground ice. In the present work we include the past orbital evolution of Mars and examine the changes in ice stability as well as the condensation, sublimation, and diffusion of atmospheric water in an exchange with the regolith.

The martian obliquity has undergone significant oscillations in its recent past. During periods of high obliquity the solar energy would have been distributed such that the equatorial and midlatitude regions would have been colder than at present and the polar regions would have been warmer. Warmer polar regions would result in the sublimation of more polar cap water into the atmosphere and thus higher atmospheric water abundances. This combination of effects would have resulted in ground ice being stable globally. During periods of low obliquity the opposite would have occurred, where the equatorial and midlatitude regions were warmer and the polar regions were colder, resulting in less atmospheric water and ground-ice stability only in the polar regions.

The results of our modeling of the regolith thermal behavior and the molecular diffusion of water vapor within the regolith and in exchange with the atmosphere have shown significant quantities of ground ice can form at all latitudes within the top 50 cm to 1 m of the regolith during periods of high obliquity. The amount of ice that forms can be as much as the regolith pores can hold. During low obliquity most or all of this ice sublimes and diffuses away. Below this depth a longer-term stability is observed at some latitudes where ice steadily increases in concentration regardless of the orbital oscillations that occur.

These changes in the pattern of ice stability may affect the surface morphology at all latitudes. Periodic saturation and dessication of the regolith may produce some type of frost-heave-related features such as solifluction or stone sorting. The presence of ice in conjunction with seasonal thermal cycles may produce small-scale (a few meters) ice-wedge polygons or other forms of segregated ice.

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**MINERALOGICAL DIVERSITY (SPECTRAL REFLECTANCE AND MÖSSBAUER DATA) IN COMPOSITIONALLY SIMILAR IMPACT MELT ROCKS FROM MANICOUAGAN CRATER, CANADA.**

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**Introduction:** Meteoritic impacts under oxidizing surface conditions occur on both Earth and Mars. Oxidative alteration of impact melt sheets is reported at several terrestrial impact structures including Manicouagan [1], West Clearwater Lake [2], and the Ries Basin [3,4]. A number of studies [e.g., 5–7] have advocated that a significant fraction of martian soil may consist of erosional products of oxidatively altered impact melt sheets. If so, the signature of the Fe-bearing mineralogies formed by the process may be present in visible and near-IR reflectivity data for the martian surface.

What mineral assemblages form in impact melt sheets produced under oxidizing conditions and what are their spectral signatures? We report here spectral and Mössbauer data for 19 powder samples of impact melt rock from Manicouagan Crater. Experimental procedures are discussed elsewhere [8,9].

**Results and Discussion:** *Previous chemical and petrographic studies.* One of the important conclusions of chemical studies of Manicouagan impact melt rocks [1] is that there is no significant difference in the bulk composition with respect to either vertical or horizontal sampling of the impact melt sheet (230 m thick and 55 km

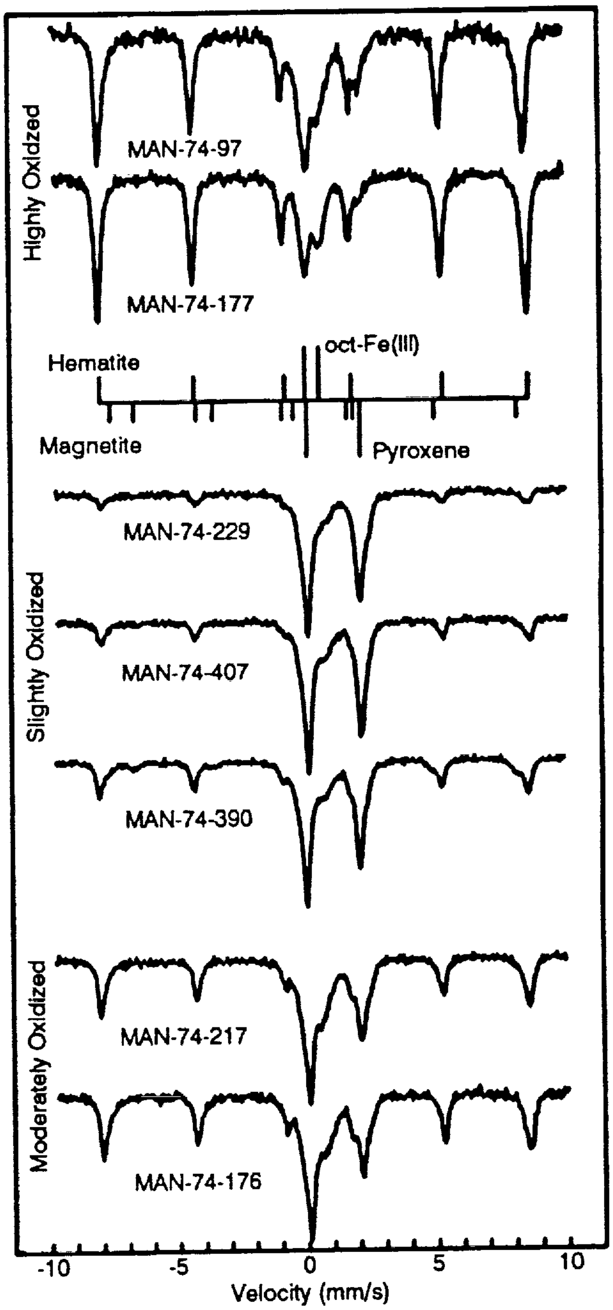


**Fig. 1.**