Constraints on the Origin of the 3.8 μm Mars Absorption Feature; Diana L. Blaney and Thomas B. McCord, Planetary Geosciences Div., Hawaii Institute of Geophysics, U. of Hawaii, 2525 Correa Rd. Honolulu, Hi 96822.

Reflectance spectra of the surface and atmosphere of Mars were obtained in the 2.6 μm to 4.2 μm spectral region using the University of Hawaii 2.2 m telescope at the Mauna Kea Observatory. Observations of four overlapping areas of Mars, designated Syrtis, Hellas, Arabia, and a highlands area northeast of Hellas, were made on the night of September 19, 1986. Figure 1 shows the regions, which are named for well known features in the region and not for exact geological locations. The measurements were reduced using a nearby standard star Tau Sagittarius (see figure 2). The reflectance spectra for two partially overlapping areas show a weak absorption band in the 3.8 μm to 3.9 μm region (1). The feature also appears in data collected by Singer et al. on a different night and at a different telescope (personal communication). This feature (from about 3.76 μm to 3.95 μm) is clearly at a shorter wavelength and is broader than the calcium carbonate band at about 4.0 μm and it is at a slightly shorter wavelength position than the magnesium carbonate (magnesite) band at about 3.88 μm (2). The chemical incorporation of water into carbonates, such as in the formation of a bicarbonate, cannot be used to explain the 3.8 μm absorption feature (3). Positive identification of the feature has not been made at this time, but some inferences about the feature can be made.

The source of this feature has four possibilities: A) Instrumental effects, B) Improper atmospheric extinction correction, C) Mars atmosphere, D) Mars surface.

A) The feature appears limited to the Syrtis and North-East Highlands data. It does not appear in the other Mars data or in the Tau Sagittarius data. Also, the appearance of the same feature in the Singer measurements, which used a different telescope and instrument, tends to eliminate the instrumental response explanation.

B) Examination of the standard star data, taken before and after the Mars measurements, show no unusual changes in the 3.8 μm region. If the 3.8 μm feature was caused by a terrestrial atmospheric effect, then it occurred only when the affected data were being taken and not when the star data were obtained.

C) Attribution of this feature to the Mars atmosphere is also difficult to explain. No CO_2 absorption lines (4) are present in this wavelength region. Other known components in the Martian atmosphere, determined from Viking measurements (5), do not have absorption features in this region. Also, the viewing geometry, topography, and seasonal effects created a longer atmospheric path at the Hellas spot than at the Syrtis and North-East Highlands spots. This rules out any homogeneous atmospheric effect. Spatially inhomogeneous atmospheric effects are also unlikely to cause the feature, for no dust storms were observed, and water or carbon dioxide frost have no spectral features in this wavelength region.

D) By the process of elimination, this leaves the Mars surface as the only viable source of the absorption feature. The overlapping nature of the regions involved limits the location of the material causing the feature to the region formed by the union of the Syrtis and North-East Highlands spots minus areas of the Arabia and Hellas spots that overlap with this region. This region encompasses most of Syrtis Major Planum. Viking images of this dark region reveal a high concentration of bright wind

streaks indicating that a high degree of differential erosion is occurring which may expose material responsible for the absorption.

In conclusion, while the material causing the absorption feature is not yet identified, the material seems to be on the Mars surface and the region where this material exists in sufficient abundance to be detected spectroscopically is of limited extent, specifically at Syrtis Major Planum.

References

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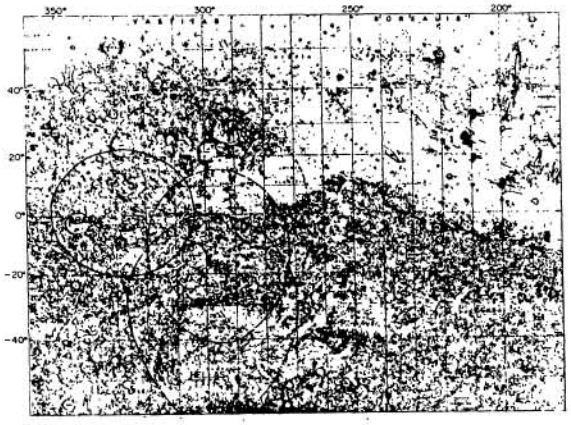

Figure 1. Locations of the four areas observed on Mars on September 19,1986 are shown. (Base map from U.S. Geologic Survey.)

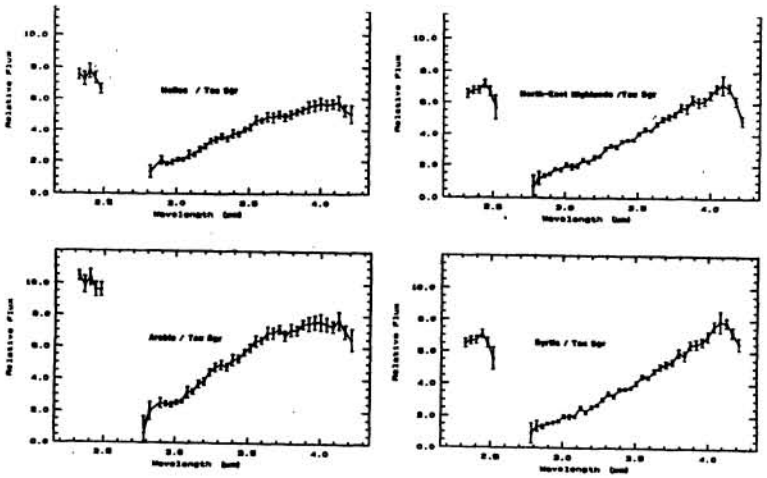

Figure 2. Reflectance Spectra are shown for the four Mars regions shown in Figure 1 and designated Hellas, Arabia, Syrtis and North East Highlands. The spectra were calculated using measurements of the star Tau Sagittarius.