ANALYSIS OF MARINER 7 THERMAL INFRARED SPECTRA OF MARS AND COMPARISON TO RECENT AIRBORNE OBSERVATIONS; T. L. Roush (San Francisco State Univ. & NASA Ames), T. Z. Martin (Jet Propulsion Laboratory), and J. B. Pollack (NASA Ames Research Center)

During their 1969 fly-by encounters with Mars the Mariner 6 and 7 spacecraft obtained about 500 infrared (IR) spectra of the planet. The IR spectrometers (IRS) carried on board were designed to provide moderate spectral resolution (~100) over a broad spectral domain (1.8 to 14.3μm) [1]. Through efforts of the Planetary Data System these data are now available in digital format and can be calibrated in both wavelength and intensity to yield spectra in radiance units or brightness temperature [2]. After calibration, numerous absorption features have been identified in the spectra, many due to Martian atmospheric CO2 (figure 1). Here we focus on analysis of features beyond 6μm. We compare the results of this analysis with airborne thermal infrared observations of Mars obtained during the 1988 opposition [3].

All CO2 absorption features identified in the spectra obtained from the Kuiper Airborne Observatory (KAO) in 1988 are present in the IRS spectra (figure 2). The 8.75- and 9.3μm features, previously attributed to sulfate-bearing [3] and silicate phases [4,5,6], are present in both data sets (figure 2). The strongest carbonate vibrational fundamental occurs near 7μm and although no distinct feature was identified in the KAO spectra (at a spectral resolution of ~60), there was suggestive evidence that such a feature might exist [3]. Thus the presence of a weak feature in the IRS data remains consistent with the KAO data, and offers additional evidence that carbonates are detectable in Martian soils. In both data sets the general location of a radiance or brightness temperature maximum between 7.5- and 8.0μm is consistent with an interpretation of igneous rock having mafic to felsic compositions but is inconsistent with igneous rocks having ultramafic compositions [7]. However, it is possible that secondary minerals, derived by weathering of the primary igneous rocks, are contributing to, or dominating, the fluxes measured from Mars.

Additional analysis of the IRS data consisted of defining several individual band areas by integrating the band depth [8], relative to a straight-line continuum, across the wavelength region containing the band of interest. This method was used, rather than a simple band depth determination, to minimize the effect of wavelength calibration errors. We found that absorptions due to gaseous CO2 were strongly correlated. The 8.75- and 9.3μm absorptions were strongly correlated with the CO2 features (figure 3a), suggesting the material responsible for these two features is located in the atmosphere. An analysis of the weak 7μm feature indicated that this band is poorly correlated with any CO2 feature (figure 3b) or the 8.75- and 9.3μm absorptions, implying that the feature may be due to material located on the surface.

Figure 1. Radiance (dashed line, left axis) and brightness temperature (solid line, right axis) for two wavelength segments of a Mariner 7 IRS spectrum. Several features are labelled for both curves.

Figure 2. Comparison of brightness temperature spectra from Mariner 7 and the 1988 KAO observations. Features common to both spectra are indicated.

Figure 3. Correlation of 9.3μm (R=0.95) (A) and 7.0μm (R=0.29) (B) band areas with the 12.6μm CO₂ atmospheric band area.