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MIDINFRARED SPECTRAL INVESTIGATIONS OF CARBONATES: ANALYSIS OF REMOTELY SENSED DATA

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There are ample theoretical reasons and geomorphic evidence that during the earliest history of Mars liquid water was stable at the surface. The higher temperatures required to maintain water as a liquid are often attributed to higher concentrations (1-10 bars) of the greenhouse gas carbon dioxide (CO_2). The current observed concentration of CO_2 (roughly 7 mbars) leads to an enigma regarding the fate of the remaining original gas. One line of reasoning suggests that CO_2 reacted chemically with igneous silicates to form carbonate (CO_3) rocks, resulting in its permanent removal from the atmosphere. If this scenario is correct, then identification of CO_3 rocks on the current martian surface would provide evidence of an early clement environment where the presence of higher temperatures and liquid water may have been conducive to the evolution of life. Additionally, identification of specific CO_3 species can provide significant insight into the depositional environment in which they formed.

Recent airborne thermal infrared observations of Mars from the Kuiper Airborne Observatory (KAO) have provided evidence for the presence of carbonates, sulfates (SO_4), and hydrates. Analyses of these data have relied upon radiative transfer models which account for thermal emission from the surface, as well as absorption, emission and scattering due to both solids and gases present in the atmosphere. From first principals these models rely upon knowledge of the optical properties of materials, and these are limited for CO_3's and SO_4's. While the optical properties of calcite ($CaCO_3$) and anhydrite ($CaSO_4$) can not explain the details of specific spectral features, values of more appropriate materials are unavailable. Using the optical properties of calcite and anhydrite, it was estimated that CO_3's and SO_4's constituted about 1-3 and 10-15 wt.%, respectively of the materials composing the atmospheric dust. Using the derived value as an estimate of total CO_3 abundance, and making an assumption that the CO_3's were uniformly distributed within the martian regolith, it was estimated that such a CO_3 reservoir could contain roughly 2-5 bars of CO_2.

While the results indicate that several volatile-bearing materials are present on Mars, the observations from the KAO are inherently limited in their ability to determine the spatial distribution of these materials. However, previous space craft observations of Mars provide both the spectral coverage necessary to identify these materials, as well as the potential for investigating their spatial variability. This has prompted us to pursue a reinvestigation of the Mariner 6 and 7 infrared spectrometer and Mariner 9 infrared interferometer spectrometer observations. The former data have been recently made available in digital format and calibration of wavelengths and intensities are almost complete. Additionally, we are pursuing the derivation of optical constants of more appropriate carbonates and sulfates.