DRIFTS on Mineral Additions to Martian Soil Simulants

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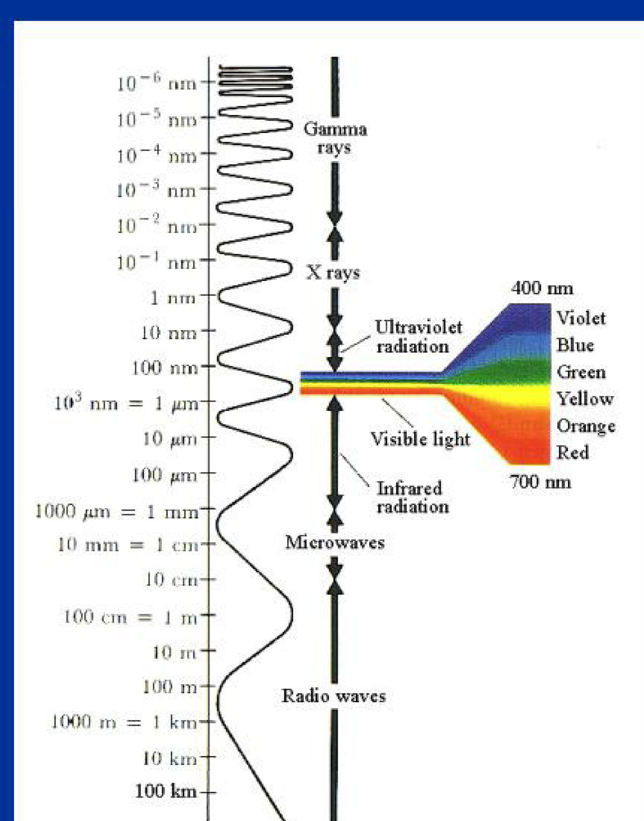
Introduction

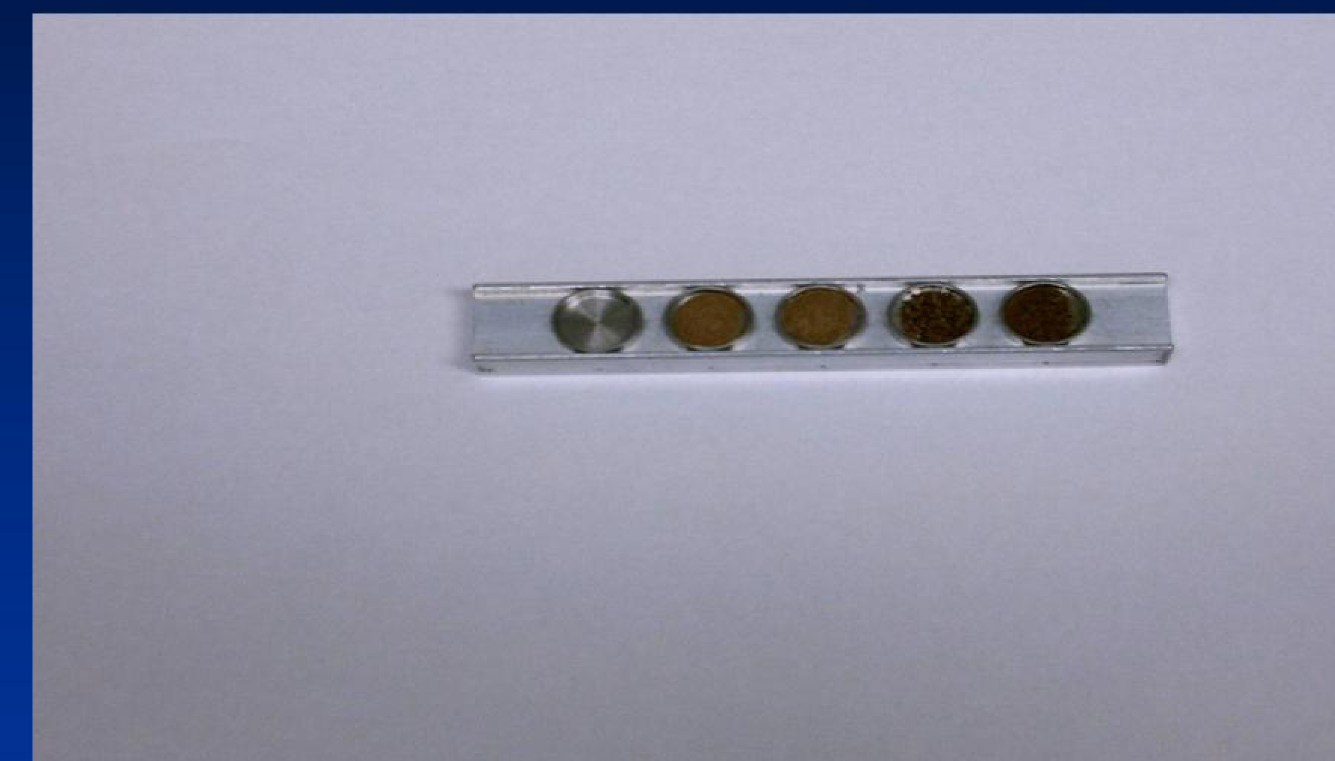
Many substances such as hydrates, sulfates, carbonates, and oxides have been discovered to be on Mars either on the surface or in the atmosphere. Many of these minerals give proof to the fact that Mars may once have had liquid water on its surface. This experiment involves using reflective infrared radiation to discover where the functional groups of these minerals appear in the infrared spectra. The infrared region of the spectrum ranges from the wavenumbers of about 12,800 to 10 cm^{-1} or wavelengths from 0.78 to 1000 μm.



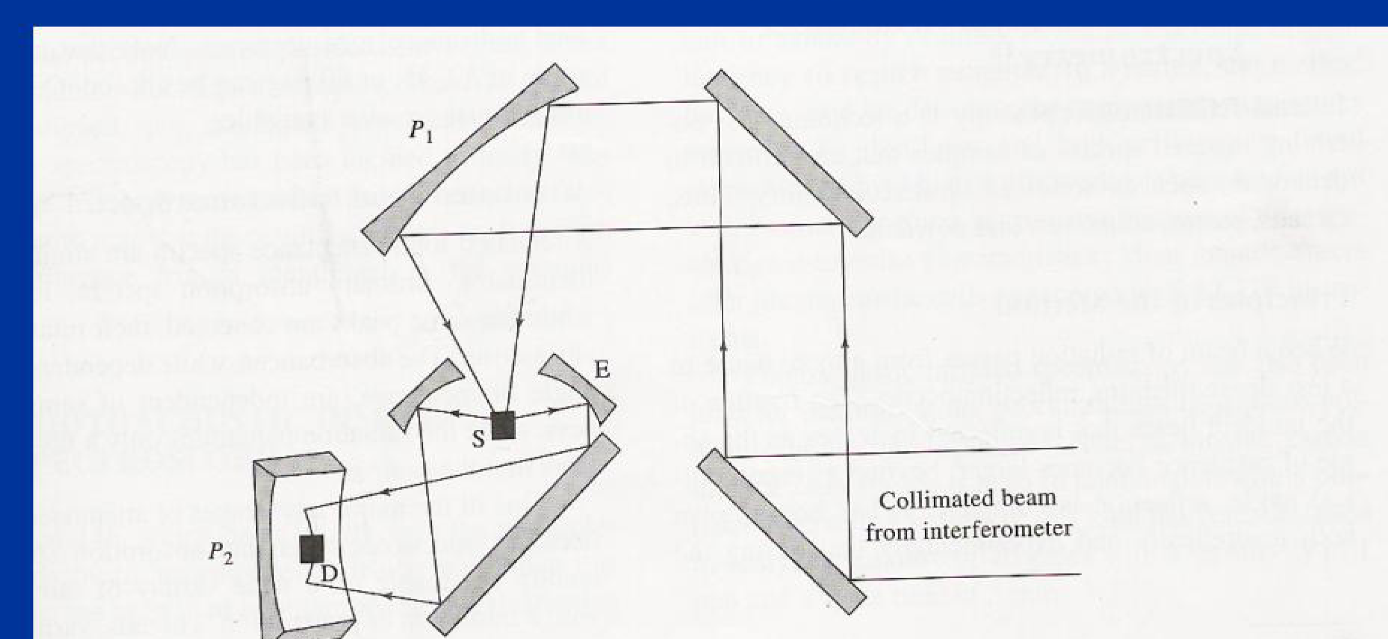
Methods

This experiment involves using small ground samples of mineral additions to Martian soil simulants, and then using DRIFTS to determine where the functional groups of the mineral additions appear in the infrared spectra. The functional groups appear in different regions of the spectra based on the molecules in the functional group, and the vibrational characteristics of the molecule.

Diffuse Reflectance Infrared Fourier Transform Spectrometer



Sample sizes for this experiment are placed in very small sample containers with dimensions of 1 cm in diameter and 1 mm in depth. The sample is spread evenly in a very small layer to ensure that the infrared light will be able to penetrate the sample. Research has proven that the particle sizes for this procedure must be around the order of 40 μm. Sample sizes larger than this lead to band broadening, and a decrease in the intensities of the minerals functional groups in the infrared spectra. These problems arise due to the fact that the particles sizes are too large to reflect the infrared light throughout the sample.

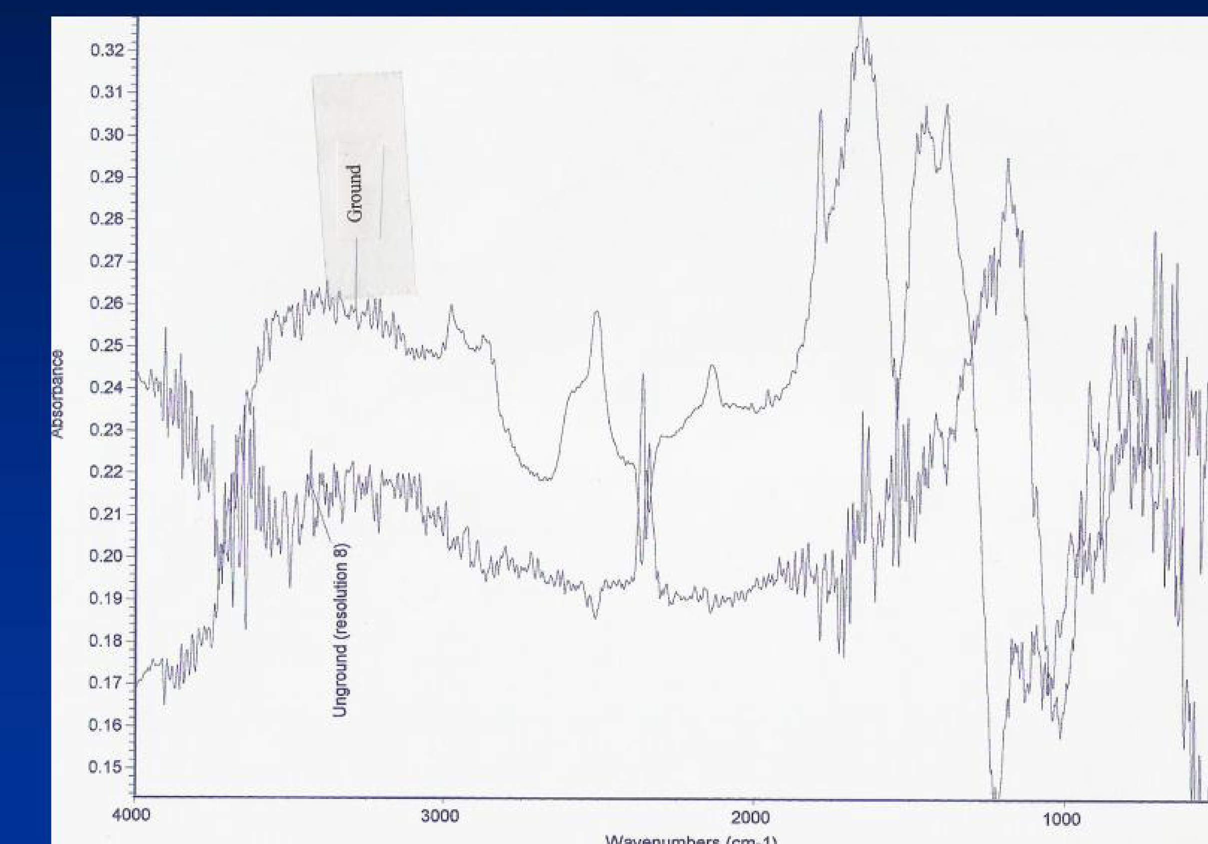


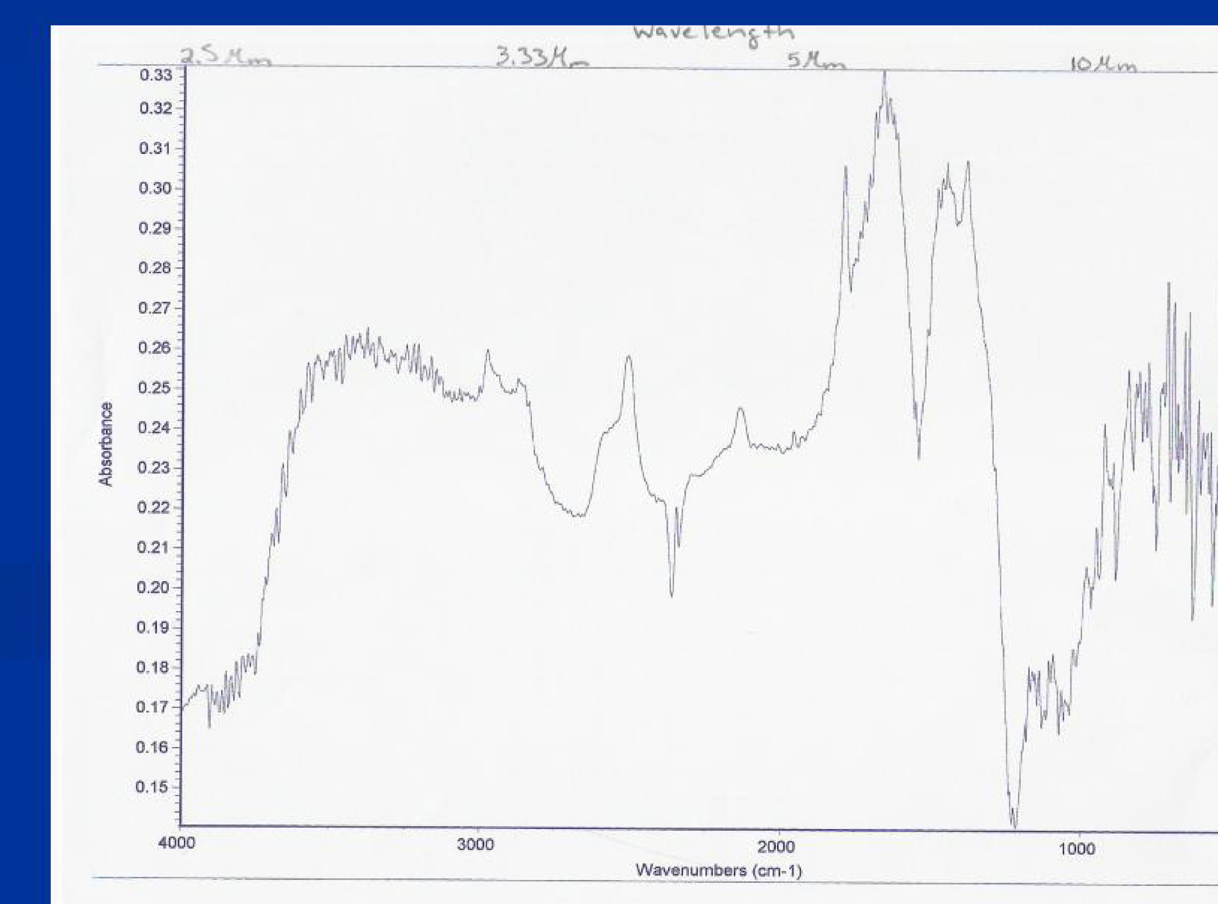
(From F. James Holler, Timothy A. Nieman, and Douglas A. Skoog, *Principals of Instrumental Analysis*, 1998, 419)

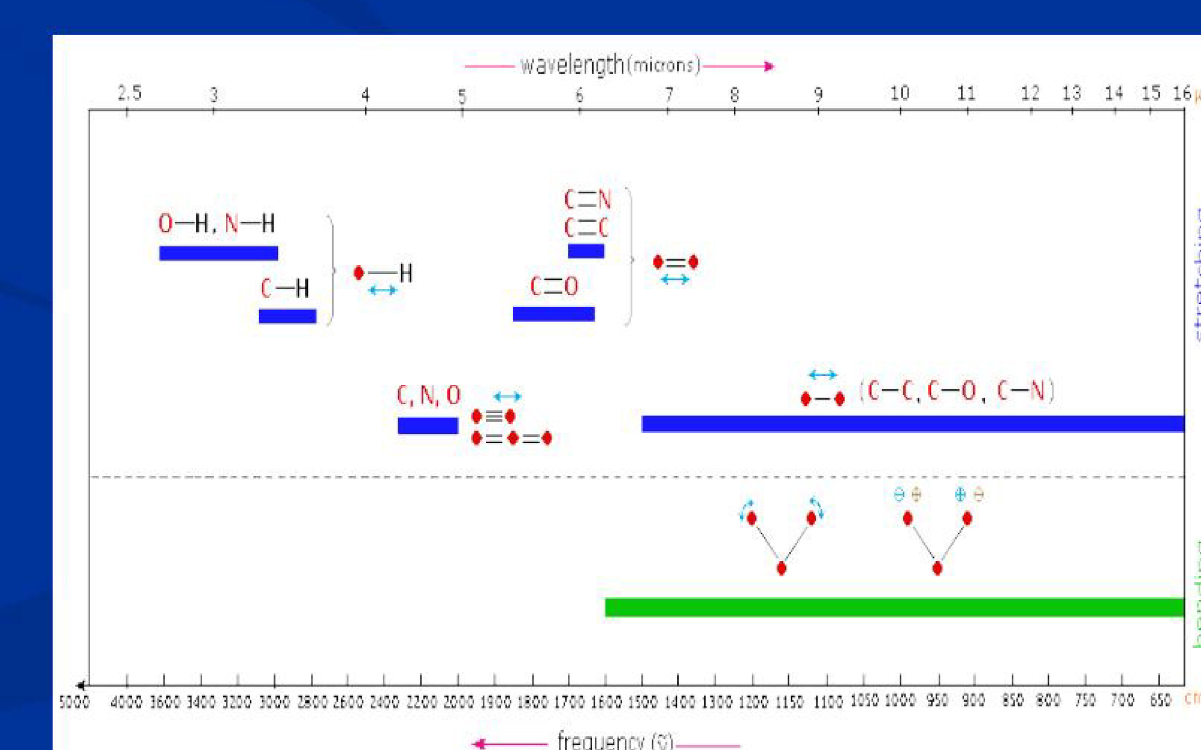
DRIFTS uses a sequence of plane and ellipsoidal mirrors to focus the beams from the spectrometer onto the sample (S) and then to the detector (D). When the radiation hits the finely divided powder, reflection occurs throughout the whole sample. This causes radiation to be reflected in all directions. The mirrors are aligned along the sample to reflect the radiation towards the detector.

Results

The results from this experiment are from the calcite addition to the Mars soil simulants. The first graph shows the difference between a ground sample and a unground sample. The unground sample has no detectable peaks due to band broadening from particle size while the ground sample produces noticeable peaks. The final spectra is for a 10% calcite addition to the Mars soil simulant. A background spectra was obtained using a empty container. Then spectra where obtained for a soil sample with no mineral additions, and a soil sample with a 10% calcite addition. The 10% calcite spectra was then subtracted from the regular Martian soil simulant spectra to produce the detectable peaks shown.







Future Work

The future work of this project is to examine more mineral additions to the Mars soil simulant, and to determine what functional groups are responsible for the peaks observed in the infrared spectra.