DRIFTS ON MINERAL ADDITIONS TO MARTIAN SOIL SIMULANTS. N. Phillips[1] and R. Ulrich[1, 2], [1]Arkansas-Oklahoma Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, AR 72701, [2]Dept. Chemical Engineering, University of Arkansas, Fayetteville, AR 72701.

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. These minerals give proof to the fact that Mars may once have had liquid water on its surface. DRIFTS is a possible way of taking spectra of these minerals and using the information about their functional groups to determine how to identify these minerals in the IR spectra. 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 in sample, reflection occurs throughout the whole sample. This radiation is then reflected off the mirrors and towards the detector.

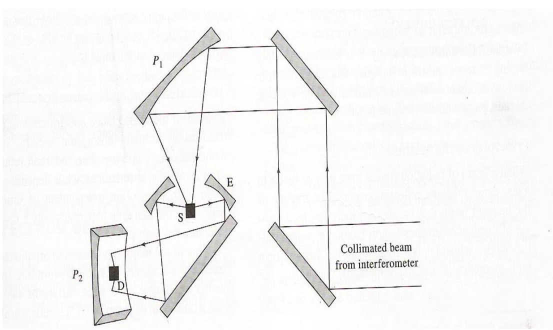

Figure 1: Diffuse Reflectance Infrared Fourier Transform Spectrometer mirror setup showing how the radiation is reflected from the spectrometer [1].

Methods: Percentages of mineral additions are added to the JSC Mars 1 soil, and then DRIFTS is used to determine where the functional groups of the mineral additions appear in the infrared spectra. 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.

Results: Research has proven that the particle sizes for this procedure must be around the order of 40 µm. Sample sizes larger than 40 µm leads to band broadening, and a decrease in the intensities of the minerals functional groups in the infrared spectra. This problem arises due to the fact that the particles sizes are too large to reflect the infrared light throughout the sample.

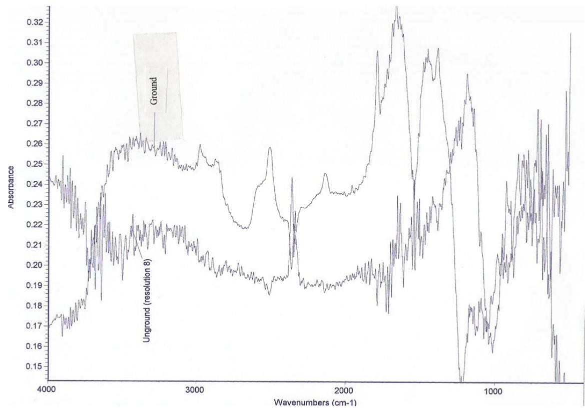

Figure 2: Spectra showing the difference between spectra with various particle sizes. The spectra in this figure are from calcite additions to the JSC Mars 1 soil. The unground sample can be seen to have more noise from band broadening and less intensity in the peaks of the minerals functional groups.

The minerals and samples studied included calcite, magnesium sulfate, hematite, and olivine. The graphs shown in figure 3-6 are plotted as absorbance vs. wavenumber. For all of the samples observable peaks were shown. In the example of calcite shown in figure 3, 4 observable peaks can be recognized along the wavenumbers of 2782.48 cm^{-1}, 2511.30 cm^{-1}, 1794.65 cm^{-1}, and around 1650 cm^{-1}. These peaks are believed to be from the stretching and vibrations of the carbon and oxygen molecules in the calcite. Magnesium sulfate produced observable peaks around the wavenumbers of 3000 cm^{-1} and 1000 cm^{-1}. Olivine and hematite also produced an observable peak. Olivine demonstrated a large peak at around 3500 cm^{-1}, and hematite showed a significant peak at around 1000 cm^{-1}. The results proved that DRIFTS can be a useful method of identifying elements on the Martian surface. Particles used in these samples would be of the same magnitude in size as dust particles on the surface of Mars. Soil samples could also be taken and reduced to particle sizes needed to carry out DRIFTS experiments on Mars soil.

Figure 3: DRIFTS spectra taken for a 20% calcite and 80% JSC Mars 1 soil composition.

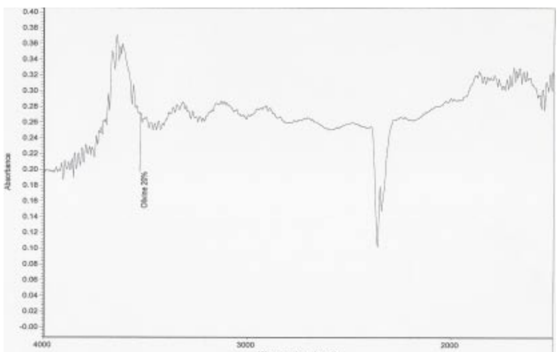

Figure 5: DRIFTS spectra taken for a 20% olivine and 80% JSC Mars 1 soil composition.

Further Study: It would be of great value for this experiment to repeat this procedure several times reducing particle sizes to reduce noise in the spectra even more. More extensive study should also be conducted on determining what vibrations and stretching modes are present in the different functional groups studied in this experiment. The last possible approach to improving this experiment would be to increase the range of the spectra we are measuring. The current instrumentation being used for the DRIFTS experiment only provides a range from about 4000 cm^{-1} to about 700 cm^{-1}. For more suitable experimentation it would be useful to cover the whole range of the mid-infrared region from 4000 cm^{-1} to about 200 cm^{-1}. These changes would allow for less noise due to band broadening, a wider range to detect more peaks that may be present, and they would lead to a greater understanding of the functional groups responsible for the observable peaks shown.

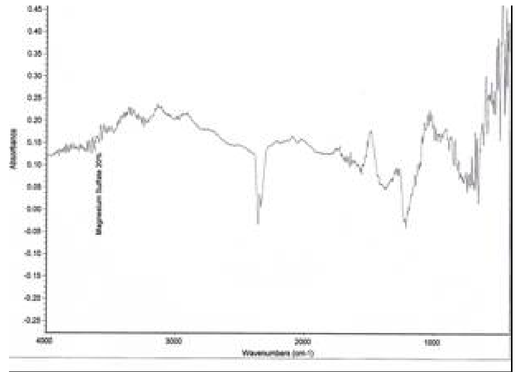

Figure 4: DRIFTS spectra taken for a 20% magnesium sulfate and 80% JSC Mars 1 soil composition.

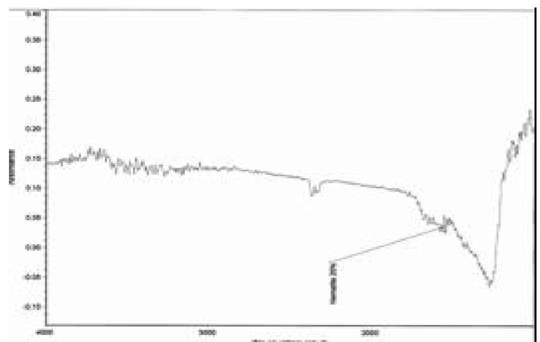

Figure 6: DRIFTS spectra taken for a 20% hematite and 80% JSC Mars 1 soil composition.

References: [1] Holler, James F., Nieman, Timothy A., and Skoog, Douglas A. (1998) *Principles of Instrumental Analysis*, 418-420.

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