THERMAL EMISSIONS SPECTROSCOPY OF OLIVINE. S. W. R. Tsang[1], A. M. Eckert-Erdheim[2], and L. H. Williams[3], [1] Durham Academy Upper School, Durham, NC, 27705, [2] Durham School of the Arts, Durham, NC, 27701, [3]North Carolina Museum of Natural Sciences, Raleigh, NC, 27601

Introduction: Although olivine is rather uncommon on Earth, it appears throughout the Solar System. With the model in [1], it is possible to identify the Fo value of olivine. Until the Mars Exploration Rovers (MER) landed in 2004, the only Martian spectra that existed were from orbit or Earth based observations. In the past several years, both rovers have taken spectra of numerous rocks which can be put into classes based on composition. Early results showed that all the rock classes contain olivine [2]. The rocks have revealed a wider range of Fo values on the surface of Mars than previously thought. Previous studies of Martian meteorites had always found olivine with Fo values between 60 and 90. Now with the MER, Fo values of 53 and 91 have turned up [3].

The model in [1] only characterizes the feature at 400 wavenumbers. While more and more rocks are being classified by the MER, the need to characterize the other features becomes much greater. The most important olivine absorptions occur between 2000 cm^{-1} and 200 cm^{-1} [3]. In this paper we have examined nine features that occur in all olivine spectra.

Analytical Approach: Olivine samples were identified using electron microprobes, x-ray diffraction, and visible identification. The samples were Fo_{93}, Fo_{91}, Fo_{89}, Fo_{87}, Fo_{47}, Fo_{38}, Fo_{9}, and Fo_{1}. All were crushed into pieces between 710 and 1000 µm in diameter. Each sample was handpicked and rinsed in ethanol to remove any remaining contamination. Labs at Arizona State University then took thermal infrared spectral data.

Results: Each sample contained at least nine consistently identifiable absorptions as seen in Figure 1. Each of the absorptions is caused by the vibrations that the cations and anions in the olivine are creating. The placement of the absorptions is affected by multiple factors including masses of atoms in the mineral and the strength of the bonds between each atom. [4]

Features. The feature near 1000 wavenumbers is very mobile. The absorption near 950 wavenumbers moves very predictably. The least prominent feature is found around 900 wavenumbers and is less precise than the feature around 950 wavenumbers. The fourth feature is relatively hard to find due to its size; it ranges from 840 to 825 wavenumbers. Absorption five is normally about 575 wavenumbers but can occur in a wide range of values. The sixth is found around 500 wavenumbers and the seventh at about 470 wavenumbers. The seventh is the least predictable absorption that was studied. The last two absorptions become more difficult to find due to noise in the data. When there is any water in any form in a rock, it will show up in this part of the spectrogram [3]. The eighth feature shows up around 360 wavenumbers. The last feature was the most mobile. When there is water, it is not easy to find but can found between 365 and 290 wavenumbers.

Linear Regressions. With nine absorptions identified, more precise Fo values are now obtainable. This model is accurate within 15 Fo values. (See Limitations for more explanation.)

Wavenumber	Equation
1000	y=0.5927x+999.06
950	y=0.4315x+943.6
900	y=0.4794x+896.73
825	y=0.1716x+823.28
575	y=0.5836x+572.71
500	y=0.4415x+506.01
470	y=0.6540x+464.16
360	y=0.6496x+360.65
300	y=0.6854x+299.84

Table 1: Equations for the model: in all of them, y is the wavenumber for the bottom of the absorption and x is the Fo value.

Trends. As the Fe amount increased, all of the features shifted closer to 0 as previously noted by [1] [5] [6]. The Fe increase also created a shift from distinctly defined absorptions to rounder, less defined absorptions.

Limitations. Unfortunately, since Mini-TES only takes readings every 10 wavenumbers, the Fo values derived from this data are not as accurate as desired. Before sol 420, Fo values could be predicted within 10 Fo values [2]. Since sol 420 (when the pointing mirror became dusty), Fo values can only be predicted within 15 Fo values.

Future Work: We will continue to refine this model. First, there are several anomalies in the range of 580 through 360 wavenumbers that we would like to further examine. In addition, we are in the process of adding another sample near Fo 73. We would also like to add some weathered samples to the model so that we can identify them on the surface of Mars. Since

all of the rocks that we see are on the surface, they will be weathered. When weathered samples are added to the model, we should be able to learn quite a bit about history on Mars, or anywhere else with olivine.

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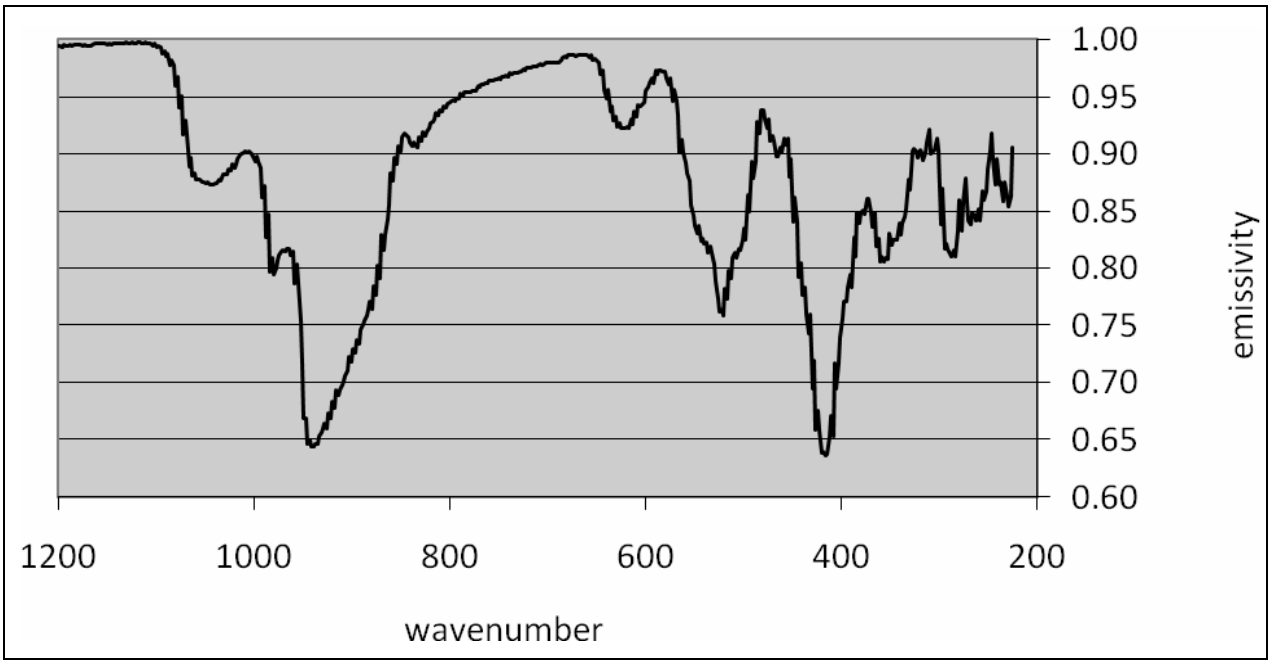

Figure 1: Olivine spectrogram with a Fo value of 91. The absorptions are numbered from left to right. The ninth absorption is barely visible.