A REINTERPRETATION OF ISM DATA: QUANTITATIVE ANALYSIS OF PYROXENE COMPOSITIONS. D. Steutel[1], P. G. Lucey[1], and V. E. Hamilton[1]. dsteutel@higp.hawaii.edu, [1]Hawai‘i Institute of Geophysics and Planetology, University of Hawai‘i, 1680 East-West Road, Honolulu, HI, USA, 96822.

Introduction: Near-infrared spectra of pyroxenes have distinct absorption features at approximately 1 and 2 µm. The positions of these features are dependent on the composition of the pyroxene [1,2]. Pyroxene spectra have been observed on the Martian surface [e.g., 3], and at high spectral resolution by the ISM imaging spectrometer [4] on board the Phobos-2 spacecraft in 1989. Previous researchers [5] have deconvolved ISM spectra to identify the components of the spectra which comprise the pyroxene signal and determined the 1 and 2 µm band center locations. We have developed a quantitative model for determining pyroxene Ca/Fe/Mg composition from the center position of the 1 and 2 µm features in laboratory pyroxene spectra. We have applied our model to the identified band centers of the ISM pyroxene spectra to more precisely estimate the compositions of pyroxenes on the Martian surface.

Methods: Spectra from 24 pyroxene samples [1] were used to determine a model relationship between Ca/Fe/Mg content and 1 and 2 µm absorption feature centers. Four spectra were not used because visual inspection of the spectra indicated contamination by other materials. The remaining 20 spectra were deconvolved into one linear wavelength continuum and five Gaussian functions, two of which indicated the 1 and 2 µm features.

We used a multiple linear regression analysis to model Ca and Fe content as a function of 1 and 2 µm band center position. Mg content is a constrained dependent parameter; the selection of Mg as the dependent parameter is arbitrary. Separate models were developed for low-calcium pyroxenes (LCP) and high-calcium pyroxenes (HCP).

Results: The linear regression analysis yielded equations for calculating the Ca and Fe content of both LCP and HCP. The model uncertainty (error) in Ca was 2.2% and 2.5% for LCP and HCP, respectively. For Fe content, the model uncertainty was 2.8% and 1.8% for LCP and HCP, respectively.

Mustard *et al.* [5] applied the Modified Gaussian Model [6] to determine band centers for the 1 and 2 µm features observed in ISM data of Mars. We applied our composition model to these data and calculated the compositions of the pyroxenes evident in the ISM data (Figure 1).

Discussion: The ISM spectra show a mixture of HCP and LCP. Based on the strength of the 1 and 2 µm absorption features, the relative abundance of HCP:LCP can be determined [7]. Mustard and Sunshine [8] applied such an analysis to the ISM spectra and showed that the relative abundance of HCP:LCP in ISM data is similar to the relative abundance of HCP:LCP in Martian meteorite EET A79001 (a basaltic shergottite). They concluded that “the volcanic compositions of the SNC [Martian] meteorites appear to be very common on the surface of Mars” [8].

The compositions of the pyroxenes in EET A79001 lie within the 95% confindence interval of some of the compositions of the pyroxenes on the Martian surface (Figure 1). Nevertheless, it appears likely that a real compositional difference does exist between EET A79001 pyroxenes and pyroxenes on the Martian surface imaged by ISM. Additionally, a recent search for a basaltic shergottite component in MGS TES spectra yielded a negative result [9]. Although the HCP:LCP abundance of EET A79001 is consistent with the ratio derived from ISM data, many different absolute abundances can have the same ratio. The lithology of EET A79001 and the Martian surface imaged by ISM appear to be dissimilar.

Some LCP compositions calculated by the compositional model have <0% calcium. There are a few explanations for this. These points generally have “1 µm” absorptions at wavelengths shorter than ~0.9 µm and likely are contaminated by Fe^{3+}. Also, there is uncertainty in the compositional model. Finally, the comopositional model is based on the assumption that the samples used to construct the model are pure.

Conclusions: We have modeled compositions of pyroxenes in ISM spectra over 26 regions described in [5]. HCP compositions are $Ca_{30-55}Fe_{10-45}Mg_{20-50}$; LCP compositions are $Ca_{<0-10}Fe_{0-35}Mg_{60-100}$. These compositions differ from the compositions of pyroxenes in the Martian meteorite EET A79001, so EET A79001 does not appear to represent the Martian surface imaged by these ISM spectra. However, some spectra are likely contaimated by Fe^{3+} and the assumption of purity in all samples used to construct the compositional model likely does not apply entirely. Further investigation into Fe^{3+} contamination and expansion of the range of compositions and number of samples in the source data for the compositional model is needed before robust conclusions may be drawn.

Future Work: We will collect spectra of additional pyroxenes of a greater range of compositions [10] in order to refine our compositional model and ensure that it is as representative of as broad a range of pyroxene compositions as possible.

References: [1] Cloutis, E. A. and Gaffey, M. J. (1991) *JGR* 96(E5): 22809-22826. [2] Lucey, P. G. (1998) *JGR* 103(E1): 1703-1713. [3] Adams, J. B. and McCord, T. B. (1969) *JGR* 74: 4851-4856. [4] Puget, P. *et al.* (1988) *Proc. SPIE* 865: 136-141. [5] Mustard, J. F. *et al.* (1997) *JGR* 102(E11): 25602-25615. [6] Sunshine, J. M. *et al.* (1990) *JGR* 95(B5): 6955-6966. [7] Sunshine, J. M. and Pieters, C. M. (1993) *JGR* 98: 9075-9087. [8] Mustard, J. F. and Sunshine, J. M. (1995) *Science* 267: 1623-1626. [9] Hamilton, V. E. *et al.* (submitted) *Met. Planet. Sci.* [10] Hamilton, V. E. (2000) *JGR*, 105: 9701-9716. [11] Sunshine, J. M. *et al.* (1993) *Icarus* 105: 79-91.

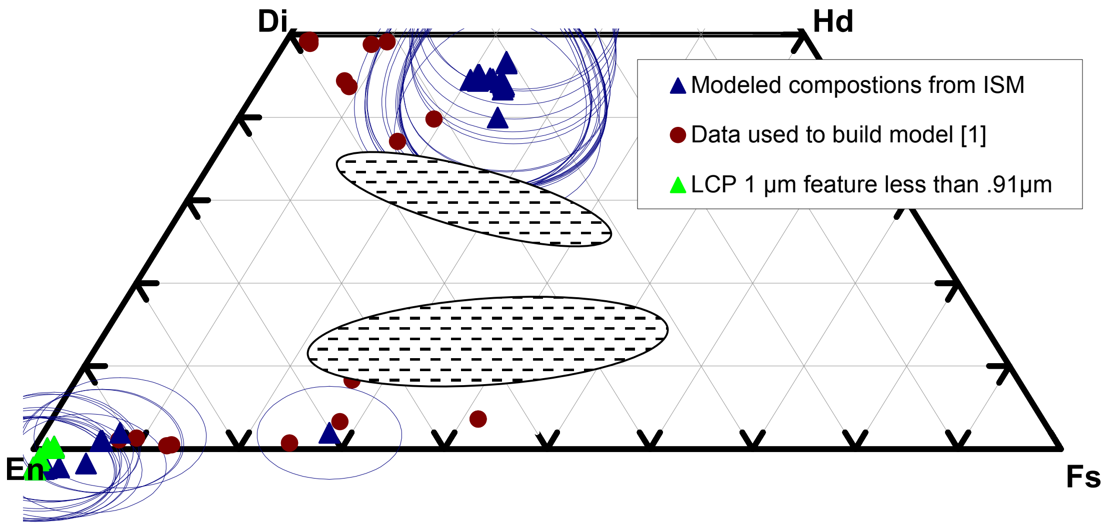

Figure 1. Compositions of pyroxenes imaged by ISM. Cloutis and Gaffey points [1] are compositions of pyroxenes used to create the compositional model. Blue ellipses are 1σ error ellipses, represented only uncertainty due to the model. Additional error comes from possible Fe^{3+} contamination and lack of purity in samples used to construct the model. Hatched ellipses represent compositions of EETA 79001 pyroxenes [11].