MID IR OPTICAL CONSTANTS OF ENSTATITE AND HYPERSTHENE. M. J. Rucks[1] and T. D. Glotch[1], [1]Dept. of Geosciences, Stony brook university, Stony Brook, NY 11794-2100, melinda.rucks@stonybrook.edu.

Introduction: Orthopyroxenes are common rock-forming minerals that have been detected on terrestrial bodies. Due to its iron content it is redily detected in the near-infrared range and can give clues to the petrogenic history of the area in which it is found [1].

The real and imaginary indices of refraction, n and k respectively, are essential inputs in light scattering models used in remote sensing of planetary bodies. Where n and k, also known as optical constants, are a function of wavelength shown by the complex index of refraction.

$$\tilde{n} = n + ik \quad (1)$$

Therefore, the determination of optical constants for orthopyroxenes and other common rock-forming minerals is necessary [2].

Background: Optical constants, n and k, can be determined through the methods outlined in [2,3] for crystal systems of orthorhombic symmetry or higher. The interaction between incident light and bound electrons within the structure causes the oscillation or displacement of atomic dipoles that can be described as Lorentzian damped oscillators. The resonant frequencies of each oscillator are a function of the incident E field and its interaction with the bound electrons [2].

Each oscillator can be described using four parameters: ε_0, ν, $4\pi\rho$, and γ. Which are respectively, the dielectric constant, the center of frequency for the oscillation, the band strength, and width of the oscillator[3].

$$n^2 - k^2 = \varepsilon_0 + \sum_j \frac{4\pi\rho_j \nu_j^2 \left(\nu_j^2 - \nu^2\right)}{\left(\nu_j^2 \nu^2\right)^2 + \left(\gamma_j^2 \nu_j^2 \nu^2\right)} \quad (2)$$

$$nk = \sum_j \frac{2\pi\rho_j \nu_j^2 \left(\gamma_j \nu_j \nu\right)}{\left(\nu_j^2 \nu^2\right)^2 + \left(\gamma_j^2 \nu_j^2 \nu^2\right)} \quad (3)$$

For minerals that belong to the orthorhombic symmetry class, it can be assumed that any oscillations that occur will be parallel to a crystal axes. Given that Reflectance can be described as a function of n and k

$$R = \frac{(n-1)^2 + k^2}{(n+1)^2 + k^2} \quad (4)$$

a reflectance spectra of each axis parallel to the incident polarized light source is needed.

A dispersion analysis can be completed through the use of equations 2 through 4 and the non-linear least squares optimization method found in [4] to iteratively fit the spectra with estimated values of the oscillator parameters. This modeling will result in calculated values for the optical constants.

Methods: Thick sections of single crystal hand samples, of both Enstatite and Hypersthene, were made and used for single crystal analysis to orient the samples along the a, b and c planes. The hand samples were then cut along these planes and polished to a 1 µm roughness. We obtained reflectance spectra for each polished surface by rotating the crystal to be parallel to two perpendicular planes, with respect to the incident polarization. This was repeated for each oriented plane, which resulted in three pairs of nearly identical spectra, the best of which was used for fitting.

Reflectance spectra were fit individually with the lsqcurvefit non-linear function available in Matlab. Estimates of the oscillator parameters within the model were initially guessed from the original spectra. From here we were able to obtain the optical constants from the model using the refined parameters.

Results and future work: All results shown are given for Enstatite only. Figure 1 shows the fitted spectra with the polarized light source parallel to the a axis.

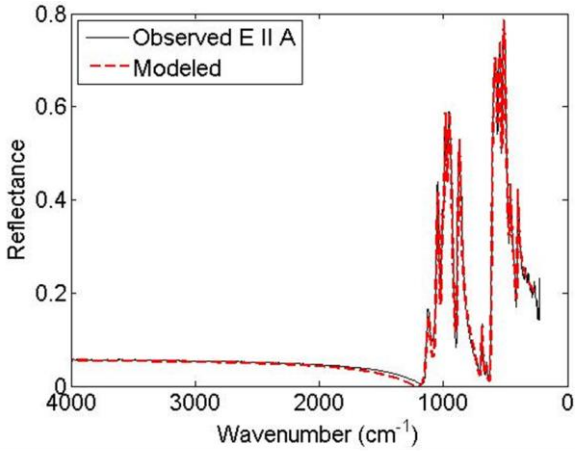

Figure 1: Fitted data for E parallel to the a axis

Figures 2 displays the fitted spectra for both the b and c axis. Figures 3 through 5 display the n and k values for the a, b, and c axes respectively. For future work we will apply this methodology to other minerals included in the orthopyroxene group.

References: [1] Lucey P. G. (1998) *JGR*, 103, E1, 1703-1713. [2] Glotch T. D. and Rossman G. R. (2009) *Icarus*, 204, 663-671. [3] Spitzer W. G. and Kleinman D. A. (1960) *Phys. Rev.*, 121, 5, 1324-1335. [4] Glotch T. D. et. Al (2007) *Icarus*, 192, 605-622.

Figure 2: Fitted spectra for b and c axis of enstatite.

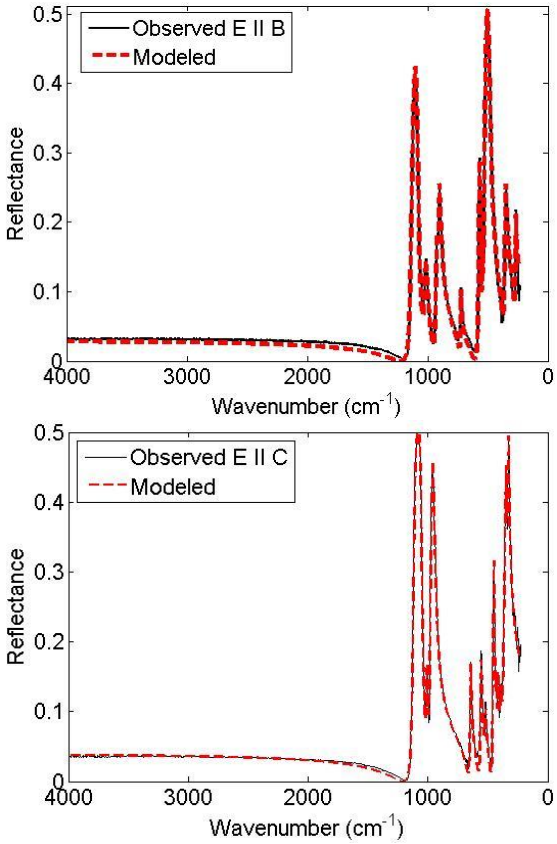

Figure 3: n and k values for the a axis of enstatite.

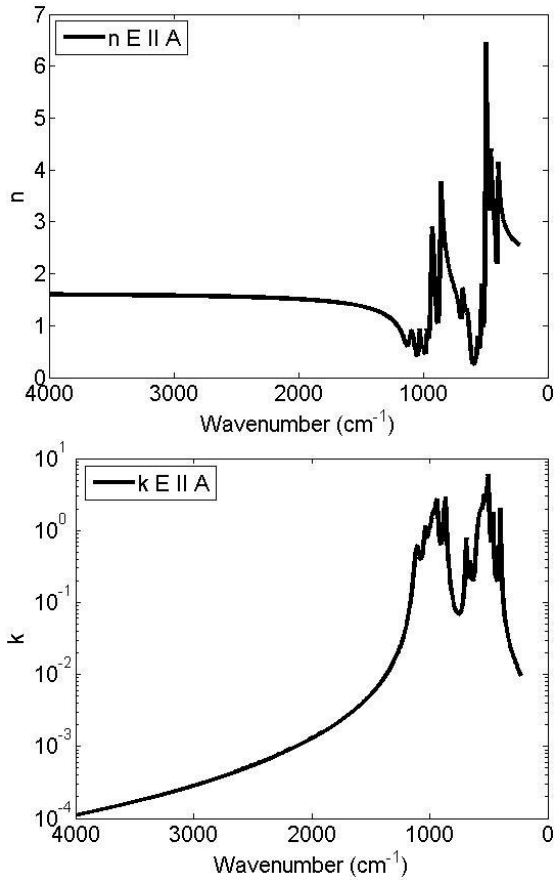

Figure 4: n and k values for the b axis of enstatite.

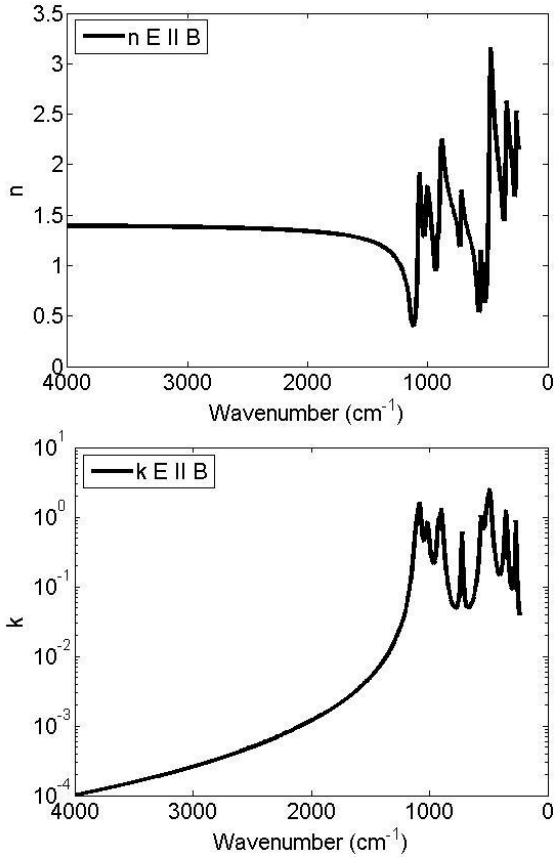

Figure 5: n and k values for the c axis of enstatite.