OPTICAL CONSTANTS OF MARS CANDIDATE MATERIALS USED TO MODEL LABORATORY REFLECTANCE SPECTRA OF MIXTURES. T.L. Roush[1], A. Brown[2,1], J.L. Bishop[2,1], D. Blake[1], and T. Bristow[3,1], [1]NASA Ames Research Center, Moffett Field, CA 94035, (ted.l.roush@nasa.gov), [2]SETI Institute, Mountain View, CA 94043, NASA Post-Doctoral Program, Oak Ridge Assoc. Univ., Oak Ridge, TN 37831.

Introduction: Data obtained at visible and near-infrared wavelengths by OMEGA on MarsExpress and CRISM on MRO provide definitive evidence for the presence of phyllosilicates and other hydrated phases on Mars. A diverse range of both Fe/Mg-OH and Al-OH-bearing phyllosilicates were identified including the smectites nontronite, saponite, and montmorillonite. To constrain the abundances of these phyllosilicates, spectral analyses of mixtures are needed.

We report on our effort to enable the quantitative evaluation of the abundance of hydrated-hydroxylated silicates when they are contained in mixtures. Here we focus on two component mixtures of the hydrated/hydroxylated silicates, saponite and montmorillonite (Mg- and Al-rich smectites) with each other and with two analogs for other Martian materials; pyroxene (enstatite) and palagonitic soil (an alteration product of basaltic glass, hereafter referred to as palagonite). We prepared three size separates of each end-member for study: 20-45, 63-90, and 125-150 μm. Here we focus upon mixtures of the 63-90 μm size fractions.

Sample Preparation and Characterization: The samples were prepared as powders using a series of sieves. Characterization of each sample included scanning electron microscopy (SEM) to document grain size, X-ray diffraction (XRD) to document structure, and reflectance spectroscopy to relate the laboratory measurements to observational data from Mars [1,2]. The grain size distributions for the 63-90 μm sieve fractions were determined via SEM image analyses are shown in Fig. 1.

Reflectance spectra, 0.35-100 μm, of the end-members and their mixtures were obtained at the RELAB [3] and data were combined by scaling the longer wavelength data to agree with the shorter wavelength range. The shorter wavelength data were obtained with incidence and emission angles of 0º and 30º, respectively. The results for mixtures of the samples are shown in Fig. 2 over the wavelength range approximately applicable to CRISM.

Analytical Approach: Retrieval of optical constants used four representations of the particle size distribution; median of sieve fraction and numerical, areal, and volumetric weighting of particles. We used the average real index, n, from the literature, and for

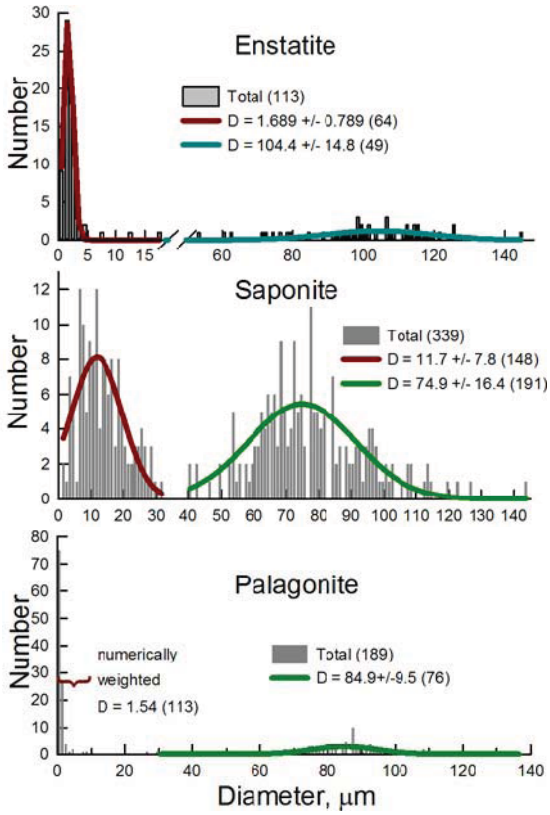

Figure 1. Sample particle size distributions.

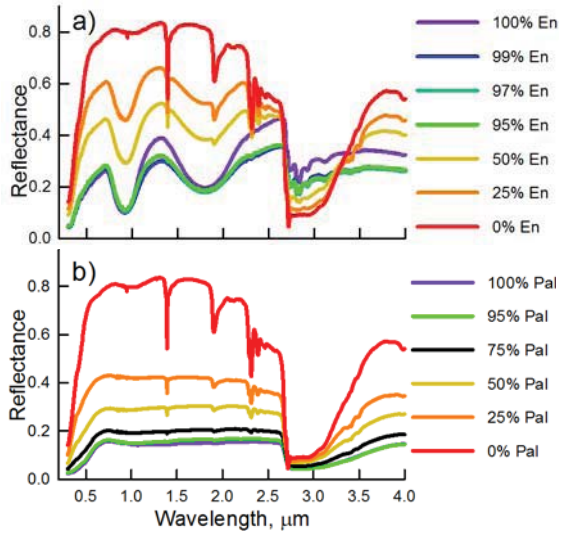

Figure 2. Reflectance spectra of saponite mixed with (a) enstatite (En) and (b) palagonite (Pal).

the palagonite assumed n = 1.5077 [4]. The Hapke model [5,6] is used to determine the imaginary index of refraction, k, at each wavelength by iteratively calculating the reflectance and comparing the result to the measured reflectance using a χ^2-criterion [7]. The results are shown in Fig. 3 to wavelengths of ~4 μm; the range most applicable to the CRISM data analysis.

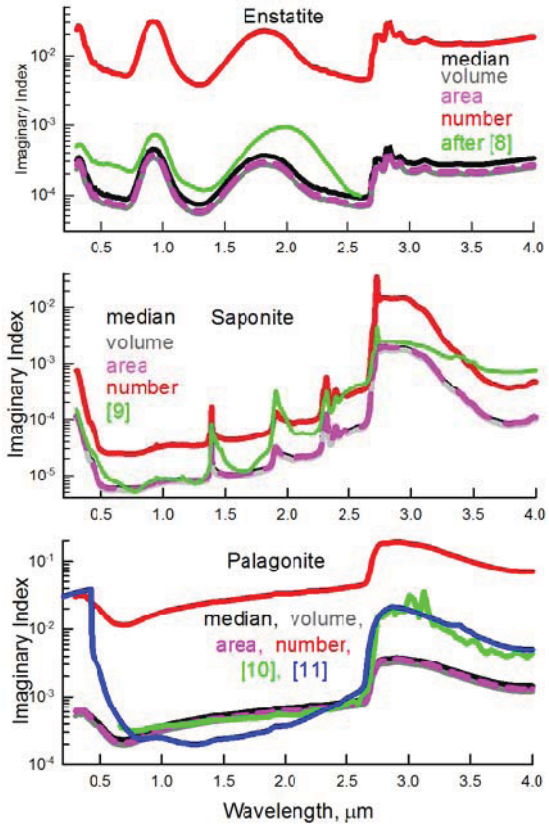

Figure 3. Initial estimates of the optical constants using different representations of the particle size distribution shown in Fig. 1.

Discussion and Future Efforts:

Discussion. Fig. 3 shows that the k-values estimated here are generally comparable to values in the literature (green and blue lines), with the notable exception of the results form numerical weighting (red line). Initial k-values estimated using numerical weighting of particles are consistently 1-2 orders of magnitude greater than any other representation. This is due to the large number of small grains when compared to their area (pink line) or volume (gray line). The k-values estimated using the median grain size of the sieve fraction (black line) is similar to those using a more complex grain size distribution. This suggests a simple method of estimating k-values would be adequate.

We used these various estimates to model the measured reflectance of the enstatite-saponite mixture in Fig. 2a. For each result we calculate the percent relative error at every wavelength. The results are shown in Fig. 4. In general, the median values provide a better match to the measured spectra.

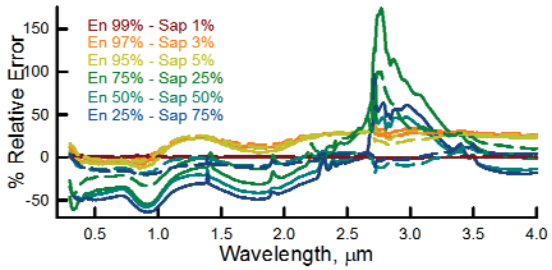

Figure 4. Percent error between modeled and measured mixture spectra. Solid lines use k-values from numerical weighting while dashed lines are from the sieve median size.

Future Efforts. Future work will focus on two areas. We intend to determine k-values from the median grain size for the remaining sample in our study. We will also estimate the wavelength dependence of n, using a subtractive Kramers-Konig (SKK) analysis. Ideally the SKK analysis requires data at all wavelengths. In our efforts we restrict the analysis to the k-values extracted from the reflectance measurements up to ~7 μm, except when data is available at longer wavelengths from the literature. As in [7], we will iteratively apply the Hapke and SKK analyses until the k and n do not change significantly.

References: **[1]** Brown, A., et al., 2012, 43rd LPSC, abstract 1747. **[2]** Roush, T., et al., 2012, AGU poster P13C-1905. **[3]** Pieters, C. and T. Hiroi, 2004, 35th LPSC, abstract 1720. **[4]** Roush, T., et al., 1991, Icarus, 94, 191-208. **[5]** Hapke, B, 1981, JGR, 86, 3039−3054. **[6]** Hapke, B., 1993, Cambridge Univ. Press, New York, NY, 455pp. **[7]** Roush, T., et al., 2007, JGR-Planets, 112, doi: 10.1029/2007JE002920. **[8]** Lucey, P. 1998, JGR-Planets, 103, E1, 1703-1714. **[9]** Poulet, F. et al., 2008, Astron. Astrophys., 487, L41-L44. **[10]** Clancy, R. et al., 1995, JGR, 100, 5251. **[11]** Clark, R. et al, 1990, JGR, 95, 14463.

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