GRAIN SIZE EFFECTS ON THE DIFFUSE REFLECTANCE SPECTRUM OF KIESERITE.

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Introduction: Hydrated magnesium sulfate salts are considered to be important components of the Martian and Europan surfaces [1-3]. For example, the monohydrate, kieserite ($MgSO_4 \cdot H_2O$), has been confirmed on Mars [4,5] and predicted to occur on Europa [2,3]. The highest spatial resolution spectra available for Europa are those from the Galileo Near-Infrared Mapping Spectrometer (NIMS), but even for these observations, spectral pixels inherently represent a combination of chemical species. Quantification of individual components requires deconvolution using laboratory spectra of each chemical species measured under appropriate pressures and temperatures.

Methodology: At the JPL Planetary Ice Characterization Laboratory (PICL) we have developed the capability to conduct diffuse reflectance spectroscopy while precisely controlling conditions affecting spectral behavior including composition, temperature, pressure, crystallinity and grain size. Our working wavelength range includes the visible to mid IR, covering the full spectral range returned by most spacecraft imaging spectrometers, such as Galileo NIMS, Cassini VIMS, LRO M^3, Mars Express OMEGA, MRO CRISM, and New Horizons LEISA.

Results: In this investigation we acquired spectra of kieserite at different grain sizes in order to detect, identify and constrain its abundance on the surface of Europa (Fig. 1). We synthesized kieserite through dehydration of epsomite under a controlled relative humidity [6] to produce the low humidity polymorph. We confirmed the molecular composition by x-ray diffraction (XRD) (Fig. 2). The samples were ground prior to dehydration and sieved to isolate a specific range of grain sizes. Grain sizes were verified with visual inspection using a cryogenic optical microscope (Fig. 3).

Discussion: Fig. 1 illustrates the significant effects of grain size upon absorption band depth. Note the differing relative band depths of the doublet features near 1500 and 2000 nm, arising from differences in relative contributions of volume and surface scattering combined with changes in the path lengths of photons traversing the grains. Studying materials such as kieserite under controlled conditions allows us to derive optical constants and more accurately model its surface abundance. This provides key information on distributions of magnesium sulfates and addresses questions of exogenic versus endogenic origins.

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Fig. 1. Room temperature reflectance spectra of a coarsely ground (blue) and finely ground (red) sample of kieserite.

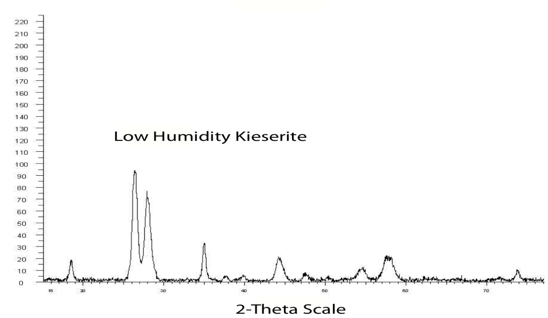

Fig. 2. X-ray diffraction pattern of the low humidity polymorph of kieserite.

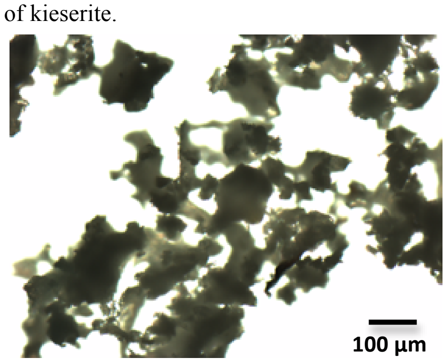

Fig. 3. Optical microscope image of kieserite crystals.