DISCRETE SPECTRAL ABSORPTION BANDS IN 4-8 µm INFRARED REGION: NEW TOOL FOR REMOTE COMPOSITIONAL ASSESSMENT OF FE CONTENT OF OLIVINE. C. H. Kremer[1], J. F. Mustard[1], and C. M. Pieters[1], [1] Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI 02912 (christopher_kremer@brown.edu).

Introduction: The composition of olivine is a valuable mineralogical parameter for constraining a planet's petrologic evolution. However, spectral signatures measured in remote visible-near infrared (VNIR, ~0.5 to ~2.6 µm) data make derivation of the composition of olivine on the Moon and other bodies difficult, since electronic transitions of Fe^{2+} in olivine's crystal structure produce three overlapping spectral bands near 1 µm, which also coincide with a ~1 µm absorption band in pyroxene [1,2]. Global compositional analyses of the lunar surface from orbit have thus yielded only qualitative estimates of olivine composition [e.g., 3].

Meanwhile, the adjacent 4-8 µm wavelength region of the infrared, where photons transition from being dominantly body-scattered to surface-scattered [4] remains generally unexplored. Detectors that measure spectra in this "cross-over" region are becoming available, making 4-8 µm spectral measurements potentially attractive for lunar remote sensing. We are investigating the spectral properties of several minerals in this region with laboratory data. Initial results indicate that olivine exhibits discrete absorption bands that clearly track the fractional abundance of Fe-Mg substitution (forsterite content) in olivine.

Methods: We use synthetic olivine samples described by [5] to assess the 4-8 µm spectral character of olivine. The 14 samples range in composition from Fo_0 to Fo_{100} and have grain sizes of <45 µm. A subset of these samples has been used [2] to establish the definitive VNIR absorption properties of olivine. We compiled data from the RELAB database measured using a biconical off-axis FT-IR [6]. We focus on two previously observed absorption bands at ~5.6 and ~6.0 µm in olivine proposed to arise from overtones of strong molecular vibrations at longer wavelengths [7]. We assess how their positions, shapes, and intensities vary as a function of forsterite content.

Preliminary Results: We find that the centers of both the ~5.6 and ~6.0 µm absorptions shift systematically by about 0.1 µm from Fo_0 to Fo_{100}, increasing approximately linearly toward longer wavelengths with decreasing forsterite number (Fig. 1). We also note weaker absorptions at ~5.0, ~5.2, and ~5.4 µm that exhibit a similar shift to longer wavelengths with decreasing forsterite number. With decreasing forsterite number, all of these absorptions exhibit decreasing spectral contrast, and the spectra overall exhibit decreasing reflectance. The absorptions in the "cross-over" region generally exhibit lower spectral contrast than the absorptions in the VNIR.

Implications and Ongoing Work: The presence of discrete spectral absorption bands whose position and shape are associated with olivine composition makes the "cross-over" region of the infrared highly attractive for future remote investigations of lunar surface composition. Our ongoing work includes examining spectral characteristics of synthetic pyroxene and particulate mixtures of natural pyroxene and olivine.

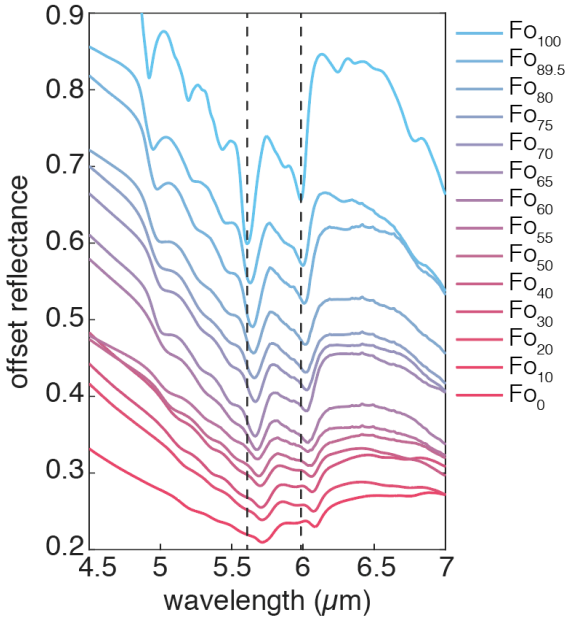

Figure 1. Reflectance spectra of synthetic olivine described by [5] measured in the 4-8 µm region. Dashed vertical lines highlight dependence of band center of major absorptions on Fo#, indicated by color.

References: [1] Sunshine J. M. and Pieters C. M. (1998) JGR, 103, 13,675-13,688. [2] Isaacson P. J. et al. (2014) Am. Min., 99, 467–478. [3] Isaacson P. J. et al. (2011) JGR, 116, E00G11. [4] Hapke B. (2012) Theory of Reflectance and Emittance Spectroscopy, CUP. [5] Dyar M. D. et al. (2009) Am. Min., 94, 883–898. [6] Pieters C. M. and Hiroi T. (2004) LPS XXXV, Abstract # 1720. [7] Salisbury J. W. et al. (1991) Icarus, 92, 280–297.

Acknowledgments: Olivine crystals were synthesized by Donald Lindsley and Richard Brooker; measured in RELAB. We appreciate encouraging discussion with Shuai Li.