**ASSESSING THE COMPOSITIONAL DIVERSITY OF INTRUSIVE ROCKS ON THE MOON USING NEAR-INFRARED SPECTROSCOPIC DATA.** Rachel L. Klima (Rachel.Klima@jhuapl.edu), Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA.

**Introduction:** Hyperspectral near-infrared data of the Moon from several missions in the last decade, including Chandrayaan-1 and SELENE have provided an unprecedented high-spatial resolution view of the mineralogy of the lunar surface. Coupled with measurements from gamma-ray and neutron spectrometers as well as thermal measurements from Diviner, these observations have advanced our understanding of the compositional diversity, including minor components such as thorium and hydroxyl, of intrusive lithologies exposed on the lunar surface.

**Major Compositonal Diversity of Intrusive Rocks:** At near-infrared wavelengths, transition metal-bearing minerals exhibit strong, distinctive absorption bands that allow mineral composition to be evaluated. Depending on the mineral structure and the cations substituting into that structure, compositions can be quantified to different levels of uncertainty. If only one or two cations generally substitute with iron, as in the case of olivine and pyroxenes, specific composition of the mafic minerals can be directly interpreted. Transition elements such as Cr and Ti can be identified by absorption bands at visible wavelengths, while others such as Al and Na can only be inferred based on the way their presence affects the structure of the crystals, and thus the positions of the major iron absorption bands.

As originally characterized using Earth-based telescopic observations [e.g., 1], and then mapped at higher spatial resolution using multispectral data from the Clementine mission [e.g., 2], intrusive rocks are present across the lunar surface. These rocks are most often excavated from depth, exposed within central peaks of craters or along basin rings. Hyperspectral data enable more detailed characterization of absorption band shapes and depths to investigate the specific chemical composition of different mafic mineral phases. Using data from the Moon Mineralogy Mapper ($M^3$) to quantify the specific composition of rocks that are spectrally dominated by orthopyroxene, Klima et al. [3] identified several broad regional enhancements of low-Ca, high-Mg pyroxene, including around the Imbrium and Apollo Basins. Also dominated by orthopyroxene, the South Pole-Aitken basin exhibits more iron-rich orthopyroxene than those surrounding the Imbrium basin. Gabbro, which is slightly more difficult to distinguish from basalt due to its similar clinopyroxene-rich mineralogy, is also observed, most notably near the center of the South Pole-Aitken basin in 'Mafic Mound' [4]. Finally, olivine exposures have also been discovered around numerous lunar basins using Spectral Profiler data from SELENE [5] and the composition of several olivine-rich regions has been explored using $M^3$ data [6].

**Minor Compositional Diversity of Intrusive Rocks:** In some cases, mafic rocks also exhibit an absorption band near 3 microns, indicative of hydroxyl. Because adsorbed hydroxyl is interpreted as being present across much of the lunar surface [7-9], it is difficult to distinguish hydroxyl bound in the rocks from that that may have formed due to solar wind implantation. Observations of the central peak of Bullialdus crater indicate that the norites there exhibit a distinctive hydroxyl absorption that is significantly stronger than the immediate surroundings, which has been interpreted as endogenic water within the norites of the central peak [10]. The central peak of Bullialdus is also enhanced in thorium, as measured by the Lunar Prospector Gamma-Ray Spectrometer, suggesting that it is also KREEP-rich [10,11].

**Relevance to the New Views of the Moon Two Book:** Though many individual papers have bee written about the results of near-infrared analyses of the Moon, these results really need to be evaluated in detail in a workshop-like environment with scientists from the sample community as well as those who study complementary remote sensing techniques. Though this has been done at smaller scales [e.g., 12], a unified view integrating compositional remote sensing techniques (as well as their respective uncertainties) with sample studies is key to understanding the compositional diversity and geological context of mafic material on the lunar surface.

**References:** [1] Pieters C. M. (1977) *LPSC 8,* 1037. [2] Tompkins S. and Pieters C. M. (1999) *MAPS, 34,* 25. [3] Klima, R. L. et al. (2011) *JGR, 116,* doi: 10.1029/2010JE003719. [4] Moriarty, D. P. and Pieters , C. M. (2015) *GRL, 42*, 7907. [5] Yamamoto et al. (2010) *Nat. Geosci. 3*, 533. [6] Isaacson et al. (2011) JGR, 116, doi: 10.1029/2010JE003731. [7] Clark, R. N. (2009) *Science, 326*, 562. [8] C. M. Pieters, C. M. et al. (2009) *Science, 326*, 568. [9] Sunshine, J. M. et al. (2009) *Science, 326*, 565. [10] Klima et al. (2013) *Nat. Geosci., 6,* 737. [11] Lawrence et al. (2006) *JGR, 111,* E08001. [12] McCubbin, F. M. et al. (2015)