VNIR brightness as an indicator of glass content in lava: Calibration of VNIR reflectance for crystallinity of basaltic lava flow surfaces. E. R. Rader[1], S. Ackiss[2], A. Sehlke[3], J. L. Bishop[4], B. Orrill[5], K. Odegaard[1], and M. Meier[1], [1]University of Idaho erader@uidaho.edu, [1]University of Idaho, Department of Geological Sciences, Moscow, ID 83844, 2Aerospace Corporation 2011 Crystal Drive, Suite 900 Arlington, Virginia 22202-3780, [3]NASA Ames Research Center/ Bay Area Environmental Research Institute, Moffett Field, CA 94035, [4]SETI Institute,189 Bernardo Ave, Suite 200 Mountain View, CA 94043, United States, [5]Arizona State University PO Box 875008, Tempe, AZ 85287-5008

Introduction: The high iron content of basaltic glass leads to the dark coloration characteristic of lava. In addition to glass, basaltic lava contains small white, green, and metallic crystals, causing a slight brightening of the overall rock color. The amount of darker glass compared to the lighter crystals can be attributed to differences in phenocryst content (indicative of magma chamber conditions) or cooling rate (sensitive to water-quenching). Both the prevalence of water and the conditions of magma storage are of interest to planetary science, and basalt is a common rock type in the solar system. Thus, a method of estimating glass content quickly and remotely would allow for better understanding of volcanic planetary surfaces without the need for extensive sampling. We investigate here the effect of crystal content on the brightness of basalt lava samples in visible/near-infrared (VNIR) reflectance spectra and how this can be used to estimate glass content. These terrestrial flows are analogous to lava on Mars, the moon, Venus, and Mercury.

Methods: We gathered hand samples of 18 young (<7000 years) unaltered basalt surfaces from five flow fields around the northwest USA including Hells Half Acre and Blue Dragon in Idaho and Diamond Craters, Devils Garden, and Four Craters in Oregon. We compared these samples to two reference samples, a synthetic shergottite glass and a fully crystalline basalt from Iceland [1]. Samples were scanned in-situ and in a laboratory setting with an ASD TerraSpec Halo handheld contact VNIR spectrometer and brightness was calculated by averaging the reflectance values between 0.5-1.0 µm for the field and laboratory analyses. Each spectrum was also classified as glass-rich, plagioclase-rich, olivine-rich, or alteration-rich depending on the location of absorbance features in the 300-2500 nm spectra. Petrographic analysis of the rocks consisted of scanning electron microscope (SEM) analysis to identify and quantify the extend of crystals in each sample.

Results: Brightness decreased with decreasing crystal content making the glassiest samples the darkest samples. This was true for all spectra regardless of mineralogical classification. The relationship between crystal content and overall reflectance is shown in Figure 1. The spectral classification for each sample was not completely representative of the mineralogy, with glass-rich samples containing the least amount of glass and the most amount of plagioclase. The alteration-rich samples containing the most glass and the least number of crystal phases overall. Plagioclase-rich samples contained moderate amounts of all phases and oxide-rich samples did contain the most oxides out of all the samples.

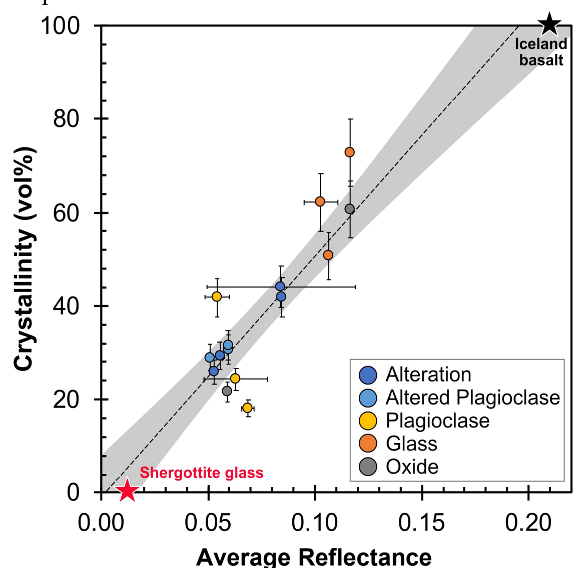

Figure 1. Relationship between VNIR brightness and crystal content linear regression with 95% confidence interval.

Discussion: The relationship of the 0.5-1.0 µm brightness to glass/crystal content on terrestrial flows allows for the use of VNIR analysis to estimate crystallinity across broad regions of lava flows. This method may even be used with CRISM data to compare spatial patterns of the relative amount of glass and crystals. Darker regions of a lava flow may signify water-lava interactions whereas brighter regions may indicate flows where more phenocrysts were brought up from the magma chamber.

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References:

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