A TOOL FOR RAPID NON-DESTRUCTIVE CHARACTERIZATION OF PLANETARY MATERIALS: HYPERSPECTRAL IMAGING IN THE VISIBLE/NEAR-INFRARED

K. M. Cannon[1], J. F. Mustard[1], R. E. Milliken[1], C. M. Pieters[1], T. Hiroi[1], and J. H. Wilson[2]. [1]Brown University, Department of Earth, Environmental, and Planetary Sciences, Providence RI. Email: kevin_cannon@brown.edu. [2]Headwall Photonics, Inc., Fitchburg MA.

Introduction: Reflectance spectroscopy is an invaluable and standard technique in planetary sciences for integrating telescopic and other remote sensing measurements of small bodies and planets with planetary materials measured in the laboratory [1-4]. Laboratory reflectance measurements are often limited to points with minimum spot sizes of ~1 mm, and spectral heterogeneity within samples can only be characterized by collecting many such points. This can be especially problematic for polymict breccias and other complex samples where important information might be lost by averaging over large areas.

Hyperspectral Imaging: Recent advances in hyperspectral technology will allow fine-scale spatially-resolved measurements of planetary materials. To test the capabilities of this technique, we measured a variety of meteorites including Northwest Africa (NWA) 7034, and a lunar regolith breccia (Apollo sample 60019) with Headwall Photonics, Inc.'s high efficiency visible/near-infrared (VNIR) and shortwave infrared (SWIR) hyperspectral imagers. The VNIR sensor covers 400-1000 nm with a 1.785 nm spectral resolution and has a spatial resolution of up to 44 µm/pixel. The SWIR sensor covers 950 to 2500 nm with a 12.066 nm spectral resolution at up to 133 µm/pixel. Samples are measured on a single-axis translation stage (Starter Kit™), and measurement times are less than 1 minute for samples <10 cm in length. The method is non-destructive and no sample preparation is necessary, preserving the integrity of precious samples.

Applications: VNIR spectroscopy provides mineralogical identification of mafic and secondary phases (e.g., olivine, pyroxene, glass, phyllosillicates, iron oxides) [5,6], semiquantitative crystal chemistry of pyroxenes and olivines [7,8], and information about the oxidation state of transition metals in various phases [5]. Hyperspectral imaging allows for all such features to be mapped in 2D at high spatial resolution, capturing critical textural information not available from point measurements alone. For example, in the Apollo sample 60019, we can resolve different clast types (anorthosite, norite) and map their textural relations with the surrounding matrix.

Hyperspectral imaging can be used as a detailed analysis tool or for rapid non-destructive characterization of newly discovered meteorites to guide further analyses. Large slabs can be imaged to determine regions of interest from which to cut thick and thin sections for further microprobe work or to identify zones appropriate for other more destructive analyses.

References: [1] Mustard J. F. and Pieters C. M. 1987. *Journal of Geophysical Research* 92:E617-E626. [2] Pieters C. M. and McFadden L. A. 1994. *Annual Reviews of Earth and Planetary Sciences* 22:457-497. [3] Hiroi T. et al. 1994. *Meteoritics & Plnaetary Science* 29:394-396. [4] Milliken R. E. and Rivkin A. S. 2009. *Nature Geoscience* 2:258-261. [5] Burns R. G. 1993. *Mineralogical Applications of Crystal Field Theory*. [6] Clark R. N. 1999. *Manual of Remote Sensing*. [7] Klima R. L. et al. 2007. *Meteoritics & Planetary Science* 42:235-253. [8] Isaacson P. J. and Pieters C. M. *Icarus* 210:8-13.