CHARACTERIZATION OF CRUSTAL COMPONENTS IN THE VESTAN MEGAREGOLITH: IMPLICATIONS FOR REMOTE SENSING. T.M. Hahn Jr.,1 N.G. Lunning,2 H.Y. McSween,3 and L.A. Taylor3
1Washington University, St. Louis (thahnjr@wustl.edu), 2Smithsonian Institution, 3Planetary Geoscience Institute, University of Tennessee, Knoxville, TN 37996.

Introduction: The modern surface of the asteroid 4 Vesta is covered by a regolith up to 1 to 2 km-thick, which is an effect of large- and small-scale impacts, causing redistribution of crustal and exposing likely mantle lithologies [1]. Asteroid regoliths are commonly considered as two-layer strata, with the near-surface representing the actively gardened portion and the underlying megaregolith composed of fragmented lithologies and bedrock. These two regolith layers can be distinguished in remote-sensing observations based on physical and mineralogical characteristics [2]. For example, the megaregolith is typically more resistant to erosion, and therefore appears as prominent features on the surface, which may have only recently been exposed [e.g. Arrunita crater; 3].

Howardites are complex breccias that serve as analogs for the vestan surface regolith and megaregolith, and are composed of eucritic and diogenitic lithic clasts, in addition to comminuted mineral fragments, impact melts, and exogenous materials. Eucrites are basaltic rocks composed primarily of pigeonite and plagioclase [e.g. 4 and references therein], thought to represent surface flows and shallow dikes [5]. Diogenites are orthopyroxenites, harzburgites, and dunites [6,7], thought to represent cumulates or residua formed during planetary differentiation [e.g. 8]. Various studies have systematically characterized howardites in an attempt to understand the diversity, heterogeneity, and properties of the vestan regolith, to allow improved interpretation of Dawn’s vestan data [e.g. 9].

Recently, Lunning et al. [10] conducted a characterization study of the Grosvenor Mountain (GRO) 95 howardite pairing group, which is a sample of the surface regolith [11]. Beck et al. [12] examined the Pecora Escarpment (PCA) 02 howardites, which represent the megaregolith, an interpretation based on the lack of solar-wind implanted noble gases determined by [13]. As a complement to these studies, we investigated the petrographic and geochemical characteristics of the lithic components in the Dominion Range (DOM) 10 howardites (total mass ~1.1 kg) to further characterize the vestan regolith. Here we summarize the modal mineralogy and mineral compositions of lithic clasts, and provide a discussion on the diversity of vestan lithologies and the heterogeneity of the vestan megaregolith.

Samples and Methods: We examined nine thin-sections from six meteorites within a proposed howardite pairing group collected from the Dominion Range (DOM), Antarctica in 2010. Major- and minor-element abundances in minerals were determined using the Cameca SX-100 EMP at the University of Tennessee. Lithologic distribution maps were produced, from elemental X-ray maps, for each thin-section to determine mineral abundances and variations in the distribution of lithologies [12,14].

Results: The DOM 10 howardites are composed of polycrystalline and polymineralic (lithic) clasts, in addition to secondary impact-derived breccia clasts (breccia-within-breccia), impact melts, and non-typical HED material, set in a fine-grained matrix of predominantly comminuted plagioclase and pyroxene. The abundance of lithic clasts varies between sections, with some containing less than 3 visible lithic clasts, while others include >15; lithic clasts are generally >1 mm in the longest dimension, although smaller clasts are observed, and can be up to 6 mm. Textures within the lithic clasts include subophitic to ophitic, spherulitic,
The DOM 10 howardites contain numerous lithologies (>21), and the abundance of large lithic clasts indicates, like the PCA 02 howardites and diogenites, an origin from the immature megaregolith on Vesta. Additionally, although no cosmic-ray exposure data are available for the DOM 10 howardites, the collective mass of the 6 howardites (~1.1 kg) is a factor of 8 larger than the PCA 02 howardites and diogenites, and therefore collectively might represent the largest piece of the vestan megaregolith in our collection that has been thoroughly characterized; subsequent cosmesogenic nuclide analyses are needed to confirm this hypothesis.

Developing a data set for rigorous interpretation of Dawn’s remote-sensing data of Vesta has been a principal objective of recent HED studies. Identification and mapping of eucrite, diogenite, and howardite terrains on the vestan surface has been based on VIR pyroxene absorption bands [17] and GRaND neutron absorption [18]; however, separation of HED subgroups is more challenging. We identified substantial large- and small-scale mineralogical and lithologic variations in basaltic eucrite:cumulate eucrite, eucrite:diogenite, and plagioclase:eucrite pyroxene ratios within megaregolith analogs (Figure 1). Differences in eucrite and diogenite ratios suggest three distinct breccia clasts are likely sampled (10:1; 4:1; 1:1), and further support is given by basaltic and cumulate eucrite ratios. Specifically, the observation of distinctive eucrite:diogenite ratios, in combination with the array of basaltic eucrite:enstatite eucrite ratios, make the DOM 10 howardites ideal candidates for spectral calibration studies. Such investigations might make it possible to recognize these lithologic units on the vestan surface.


granular, and granoblastic; clast grain sizes range from very fine-grained (<0.1 mm) to coarse-grained (>5 mm). Three types of breccias can be distinguished: monomict diogenite, polymict eucrite, and a howardite breccia containing large and abundant Mg-rich olivines. Lithologic classification images will be included in the E-poster.

We identified 21 petrologically distinct lithologic types based on mineralogy, pyroxene chemistry, and textural characteristics: 8 basaltic eucrites, 4 cumulate eucrites, 7 diogenites, a Mg-rich harzburgite-dunite [15], and an evolved dacite lithology [16]; a summary of their mineral chemistry is given in Table 1.

**Discussion and Conclusion:** We identified petrographic characteristics that further establish the pairing of these stones. First, the DOM 10 howardites contain a diverse array of lithologies, although we observe these to be shared lithologies between the various meteorites. Second, we have identified a Mg-rich harzburgite-dunite lithology with a 2-phase symplectite of chromite and orthopyroxene that has not been recognized in other howardites, and is common to all six DOM 10 pairing group stones. We attribute the intrasample mineralogical diversity to reflect the sampling of different breccia clasts within the pairing group.