SUBSTANTIAL LITHOLOGIC DIVERSITY ON 4 VESTA: EVIDENCE FROM THE PETROLOGY AND SPECTRA OF ANTARCTIC EUCRITES. R. G. Mayne[1], J. M. Sunshine[2], T. J. McCoy[3] and H. Y. McSween Jr.[1], [1]Planetary Geosciences Institute, Earth and Planetary Sciences Department, University of Tennessee, TN 37996-1410 (rmayne@utk.edu). [2]SAIC, Chantilly, VA 20151. [3]Department of Mineral Sciences, Smithsonian Institution, Washington DC 20560-0119.

Introduction: Here we describe preliminary results of a combined spectral and petrologic study of the unbrecciated eucrites, concentrating solely on those samples recovered from Antarctica.

Our aim is to thoroughly characterize the selected samples in terms of the petrologic factors that affect their spectra, such as mineral chemistry, proportion, grain size, and texture. This information can then be used in conjunction with spectral comparisons to calculate which factors have the greatest impact on the spectra, and in turn may allow us to see what degree of spectral diversity may be observed and interpreted using the spectrometers aboard the *DAWN* spacecraft as it observes asteroid 4Vesta, the presumed parent body of HED meteorites [1].

Results: The Antarctic Meteorite Collection contains a much wider range of textures etc… than the corresponding non-Antarctic suite, which consists of mainly large-grained, cumulate-type eucrites. For the purposes of this abstract, we are therefore concentrating on minimally weathered samples selected from the Antarctic suite only, specifically EET 87520, ALH A81001, PCA 91078, BTN 00300, MET 01081, and MAC 02522.

The resulting spectra were analyzed using the Modified Gaussian Model [2,3]. Four different mineral combinations (opx, opx + plag, opx +cpx, opx+cpx+plag) were tested with MGM. Each fit was examined to see which, if any, best represented the measured spectrum for each meteorite.

All six of the Antarctic eucrites selected show differences in their individual spectra, with respect to both band position and depth (Figure 1). These differences were reflected in the MGM fits for each sample. EET 87520 and MET 01081 were the only two samples for which an excellent fit could readily be achieved. Both required two pyroxenes, which is in agreement with the pyroxene composition data measured on the electron microprobe. EET 87520 is a coarse-grained, exsolved, Mg-rich eucrite that has been suggested as a partial cumulate, or melt from a magneisan-rich source [4]. It, therefore, represents a slowly cooled lithology not formed directly on the surface of its parent body. MET 01081 is a medium-grained basaltic eucrite in which both pyroxene and plagioclase show shock mosaicism.

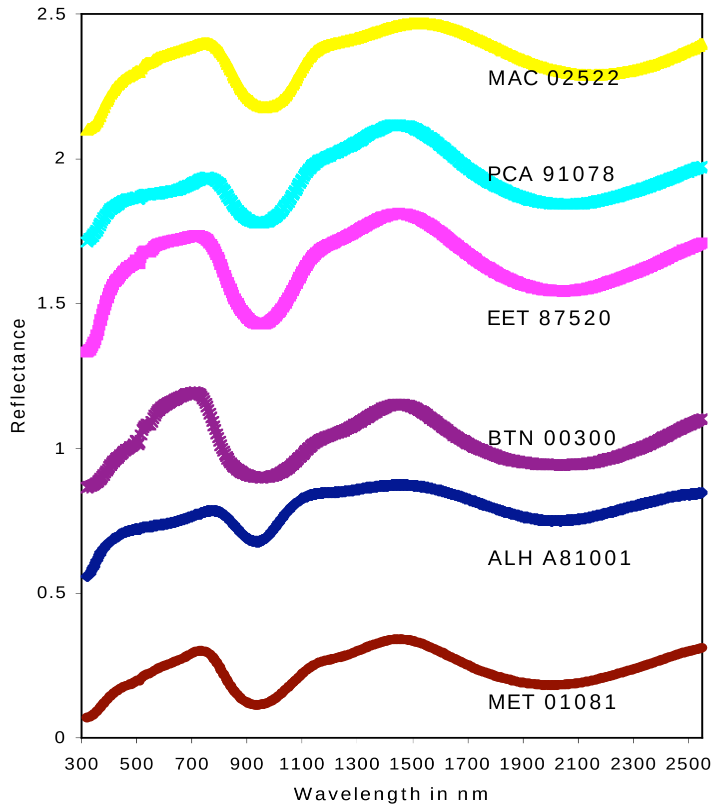

Figure 1: Spectra for all 6 unbrecciated Antarctic eucrites. Each spectrum is offset by 0.4 for clarity.

ALH A81001 is the finest-grained sample analysed, and it also shows reduced spectral contrast relative to the others. Although this eucrite was best fit by one pyroxene, it was not modeled well between 0.4-0.8µm. We conclude that the presence of extremely fine-grained ilmenite throughout this sample is probably the cause of both the poor fit and reduced contrast. The fine-grained nature of the ilmenite is a result of the fast cooling of this sample. ALH A81001 is quench textured and it has been proposed that it could be either an impact melt [5] or the rind of a lava flow [6]. Either of the formation mechanisms for this rock suggest it formed near the primary surface of the body (or an impact surface) and, thus, a spectral signature like this – with a substantial spectral contribution from fine-grained ilmenite – might be a tracer of such a locale.

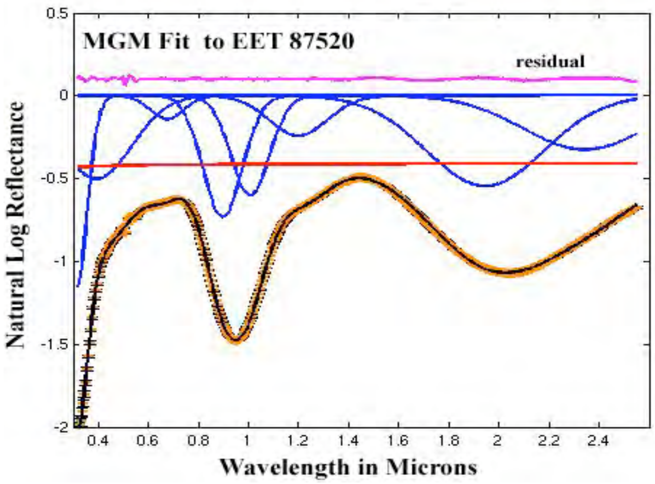

Figure 2: MGM fit to EET 87520 using two absorption bands in the 1- and 2-µm regions. The RMS error of this model is 0.56%. From top to bottom in this figure: The residual error (pink) between the log of the modeled spectrum and the log of the actual spectrum, the modified Gaussian distributions (blue) representing absorption bands, the modeled spectrum (black) superimposed on the actual spectrum (orange).

PCA 91078, a coarse-grained sample which shows extremely fine exsolution in its pyroxenes, is the only sample where the addition of plagioclase was judged to improve the fit of the MGM model, even though it is present in amounts close to that of pyroxene in each of the eucrites studied. In highly shocked samples the absence of plagioclase absorption bands in the model could be attributed to the loss of crystal structure in the plagioclase [7,8], although none of these samples contain maskelynite. Previous authors have also noted that it is difficult to distinguish the plagioclase band from that of the m1 high-Ca pyroxene band [7] and it is important to note that calibrations for pyroxene-plagioclase mixtures are incomplete at present, so it is impossible to currently quantify the degree to which the plagioclase affects the spectra.

Both MAC 02522 and BTN 00300 did not fit well with any of the deconvolution models used. MAC 02522 is a coarse-grained basalt with an ophiitc texture. MAC 02522 required two pyroxenes to model the 2µm band; however, the result contained co-equal absorption in the 1µm region, but not in the 2µm region, a physically implausible result. The mineral chemistry analyses indicate only one main pyroxene is present, although this sample does contain areas of Si-rich mesostasis in which FeO-rich pigeonite has broken down to form augite and fayalite (not volumetrically important from a spectral point of view) [9]. We believe that the Ca-rich nature of the pyroxene in this sample results in some of the Fe being forced into the M1 site, as in some iron-rich martian high-calcium pyroxenes [10], which requires a more complex absorption band model. A good fit could not simply be achieved for BTN 00300. However, this sample is comparatively rich in opaque minerals (ilmenite and chromite) relative to the other samples, which could explain the problems in our preliminary modeling efforts. The strong visible band may indeed indicate that Cr is contributing to the overall signature.

In summary, the unbrecciated Antarctic eucrites show a great variety in textures, grain sizes, and even spectral differences relative to the non-Antarctic suite. In the six samples selected for in-depth study, we are able to see distinct differences in spectra. Our preliminary efforts were able to produce plausible MGM models for the spectra of four or our six meteorites. The remaining two have unique chemistries, which will require more complex modeling than has been attempted to date.

Implications: The data analyzed here have several implications for the *DAWN* mission to Vesta. Firstly, it appears that unbrecciated Antarctic eucrites offer a better sampling of the range of petrologic/spectral heterogeneity that occur on a differentiated asteroid like 4 Vesta, than the non-Antarctic suite.

Our results also indicate that spectral signatures might be able to differentiate between rapidly-cooled lithologies (e.g., those that are fine-grained like ALH A81001 or contain a single pigeonite like MAC 02522) and those that are slowly-cooled with 2 pyroxenes (e.g. EET 87520). Therefore, we may able to obtain depths of excavation on the surface of Vesta by observing the different spectral signatures present.

Although the Antarctic samples do hint at the diversity we can expect to find on the surface of 4 Vesta, they do not tell us anything about the scale of these lithologies. This might, however, be constrained by examining the Vestoids, assessing their spectral diversity, and thus provide limits on the size of individual igneous provinces/lithologies.

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