UNBRECCIATED EUCRITE MAC 02522: PETROLOGY OF A "TYPICAL" EUCRITE AND IMPLICATIONS FOR SPECTROSCOPY. R.G. Mayne[1], T.J. McCoy[2] , and H.Y. McSween Jr[1] [1]Planetary Geosciences Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996-1410 (rmayne@utk.edu), [2]Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0119.

Introduction: We have begun a project to petrologically and spectrally characterize a suite of unbrecciated eucrites with the aim of understanding if correlations exist that will allow us to extract mineralogical, chemical or genetic information from visible and near-infrared spectra collected by the DAWN mission at Vesta.

While numerous petrologic-chemical studies of eucrites exist in the literature, few have focused on (1) collecting spectra and petrology on correlated, well-characterized samples, (2) studying the extensive suite of Antarctic meteorites, particularly those that are unbrecciated, and (3) examining in detail small and/or rare phases that might strongly influence the spectra (e.g., spinels). To achieve these goals, we have examined a suite of unbrecciated Antarctic eucrites in both hand sample and thin section to check degree of weathering and confirm the lack of brecciation. Sampling unbrecciated, unweathered meteorites is critical if we hope to relate petrology and chemistry to asteroid spectra. The majority of eucrite samples are polymict breccias, resulting from impact mixing of basalts on the surface of the parent body. Analyzing such samples would "mix" the spectra of different end-member clasts they may contain, making interpretation difficult. Therefore it is essential to use samples that are unbrecciated – at least at the scale of spectrally analyzed samples. Likewise, terrestrial weathering alters the resulting spectra, even when weathering effects are very modest [1]. Mittlefehldt and Lindstrom [2] demonstrated that rare earth element (REE) data were particularly susceptible to mobilization in the terrestrial environment.

The first meteorite for which we have conducted the detailed petrologic analysis is MAC 02522, with an initial mass of 5. 7g [3]. Although it is in many respects a "typical" eucrite, the petrology may offer some interesting implications for the spectra.

Methodology: Mineral abundances have been quantified and their chemistries analyzed using the electron microprobe at the University of Tennessee. Particular importance has been given to those elements that have a large effect on the reflectance spectra, e.g. iron. Optical grain sizes and textures have also been shown to contribute to the overall appearance of the individual spectra [4]. Therefore, the SEM at the Smithsonian Institution, Department of Mineral Sciences has been used to produce elemental x-ray maps of each thin section (Figure 1). These maps can be combined to produce mineral maps, allowing modes to

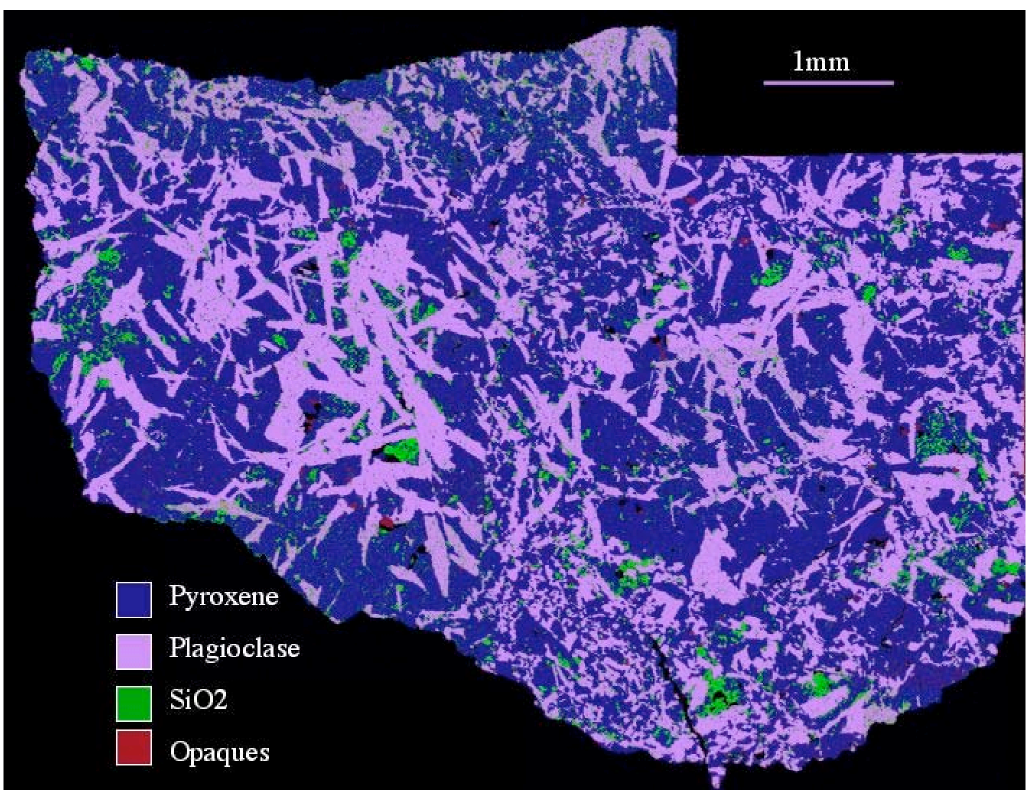

Figure 1: SEM mineral map of MAC 02522. This demonstrates the abundance of mesostasis patches within this meteorite, which occur in the regions of high SiO_2, shown in green.

be calculated, grains measured, and textures examined.

Petrography and Mineral Chemistry: MAC 02522 is a coarse grained basalt, with crystallization grain sizes ranging from 0.5mm to 1mm. It has an ophitic texture and consists mainly of equal amounts of pyroxene (47%) and plagioclase (47%), with SiO_2 (5%), and minor amounts of olivine, chromite, ilmenite, and rutile (1% in total). It exhibits evidence of extensive shock, which has produced undulatory extinction in the plagioclase and mosaicism in pyroxene. The composition of pyroxene is intermediate ($Fs_{57}Wo_9$ to $Fs_{52}Wo_{16}$), often showing zonation from more Fe-rich compositions at the rims to more Ca-rich in the cores. The plagioclase present is fairly calcic at An_{86-90}. Chemical profiles also revealed that some plagioclase grains exhibit relatively albite rich cores (from An_9 at the rim to An_{13}).

Within one of the two sections there appears a much finer grained area (Figure 2). It is here we find the olivine along with SiO_2, plagioclase, and pyroxene (Figure 2). The olivine is extremely iron rich (Fa_{89}) and the other minerals present show different compositions to those found elsewhere within the section. Pyroxene is more Ca-rich, up to $Fs_{38}Wo_{33}$, and the plagioclase compositions show greater variation with respect to Ca and Na content ($An_{82}Ab_{17}$ to $An_{93}Ab_7$). This would suggest FeO-rich pigeonite has broken down to form augite and fayalite, with excess SiO_2. However, the amount of SiO_2 present is much greater than would be suggested by this reaction alone, and therefore additional mechanisms must be considered.

Discussion: When looking at the chemistry of MAC 02522 in terms of those minerals which will impact the spectra, it is obvious that, as with all eucrites, it will be pyroxene which dominates, due to its abundance within the sample and the iron content within it [5]. However, the resulting spectrum will allow us to derive an “average” pyroxene. But when examining this entire rock with respect to pyroxene composition (e.g., zoned pigeonite, including FeO-rich rims, augite in mesostasis), it is clear that such a derived average pyroxene might not have much physical meaning (Figure 3). One could, for example, get the exact same composition in a slowly-cooled, exsolved coarse-grained eucrite, but that would have a completely different genesis.

This means that a technique that allows compositional components of eucrites (e.g., zoned pigeonite, exsolved pyroxenes, multiple compositions, breccias, etc.) to be distinguished needs to be developed.

Although mineral chemistry will have the greatest influence on the spectra of a sample, there are several other variables that should be considered. In the case of MAC 02522, initially it appears we are observing a coarse-grained basaltic eucrite. However, mosaicism acts to reduce the effective optical grain size (that seen by the spectrometer) of pyroxene to as little as 1μm.

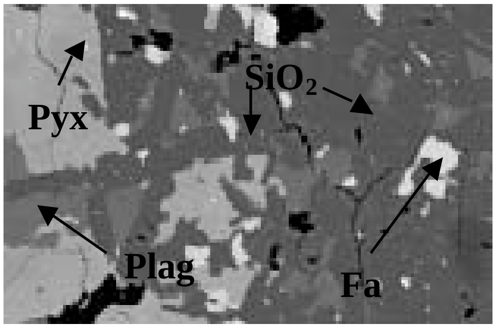

Figure 2: Shows dominant mineralogy present in the mesostasis.

Consequently, in terms of its reflectance spectra, this eucrite is actually a fine-grained basalt.

The fine-grained textural region found within this meteorite appears to represent a late-stage pocket of mesostasis. It contains a significant proportion of late-stage crystallizing phases, such as silica, ilmenite, rutile, troilite, magnetite, chromite, and iron-rich olivine (fayalite). The mineralogy of these regions is dominated by SiO_2, which is a spectrally neutral background. Therefore, the presence of spinels (e.g. ilmenite and magnetite), and a more Ca-rich pyroxene in the mesostasis may have a spectral contribution to a spinel and pyroxene signature far in excess of what might be expected from a simple volumetric calculation.

In short, the presence of significant mesostasis significantly alters the derived pyroxene composition and probably has implications for spinel, despite its low abundance.

References: [1] Mittlefehldt and Lindstrom 1991 *Geochimica et Cosmochimica Acta*, 55, 77-87 [2] Gaffey 1999 *LPSC* XXX, # 1375 [3] 2003 Antarctic Meteorite Newsletter 23 [4] Hiroi et al. 1994 *MAPS* **29**, 394-396 [5] Gaffey 1976 *JGR* **81**, 905-920

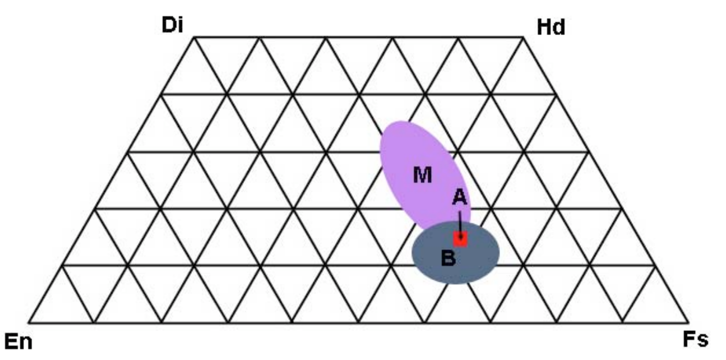

Figure 3: Shows pyroxene compositions from coarse grained areas of MAC 02522 (B), the mesostasis (M) and the average composition of pyroxene throughout the sample (A). It is clear that the average value plotted does not have much meaning when compared to the actual compositions of pyroxene found within this meteorite.