NWA 10452, AN UNUSUAL BASALTIC EUCRITE L. R. Caves[1], T. M. Hahn[1], H. Y. McSween[1], and L. A. Taylor[1] ,[1]Planetary Geoscience Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996, USA, lcaves@vols.utk.edu.

Introduction: The asteroid 4 Vesta is considered to be the "smallest terrestrial planet" (525 km diameter) due to its intact, differentiated interior and basaltic crust [1]. Vesta is hypothesized to be the parent body responsible for the world's collection of howardite-eucrite-diogenite meteorites [2]. With more than a thousand HEDs, we have sampled much of the petrologic diversity of this asteroid. However, there are still some surprises. NWA 10452 is an unusual eucrite that reveals some not-yet understood processes that demonstrate that Vesta's petrogenesis was complex.

Petrography: NWA 10452 was found in Morocco and is characterized as an unbrecciated basaltic eucrite. Minerals present in this meteorite: 39 modal % pigeonite, 13 % augite, 44 % plagioclase, 3 % silica, and less than 1 % minor minerals (troilite, ilmenite, chromite, and apatite). The proportion of augite in NWA 10452 is higher than in other basaltic eucrites. These modal abundances were determined from 4 electron microprobe (EMP) chemical X-ray maps using ENVI software; the minerals are displayed in Figure 1.

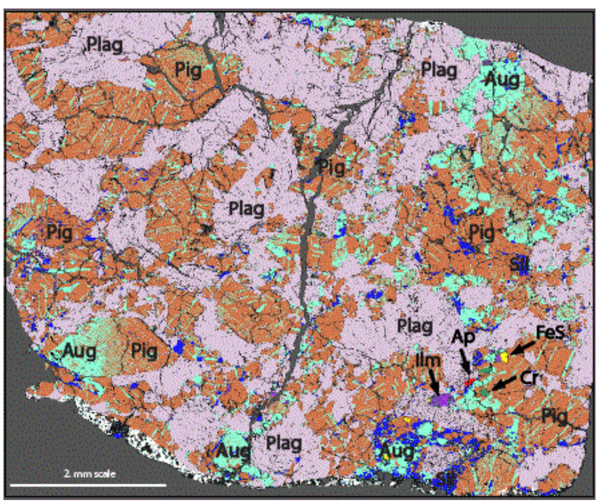

Figure 1: Compositional map showing mineralogy.

The section is fairly coarse-grained with an allotriomorphic granular texture. Most plagioclase grains are not tabular and appear to have formed interstitially between the pyroxene phenocrysts. They also show albite twinning, although some undulose extinction is present. In most basaltic eucrites, augite only occurs as exsolution lamellae in pigeonite. However, augite occurs as fairly abundant (i.e., 13 modal %), distinct grains in NWA 10452 (Fig. 1). Also, some pyroxene grains display a diffuse transition from pigeonite to augite. One transitional grain, illustrated in Figure 2, shows pigeonite with exsolution lamellae of augite and vice versa within the same euhedral crystal. Is this a replacement texture, or some unusual kind of exsolution?

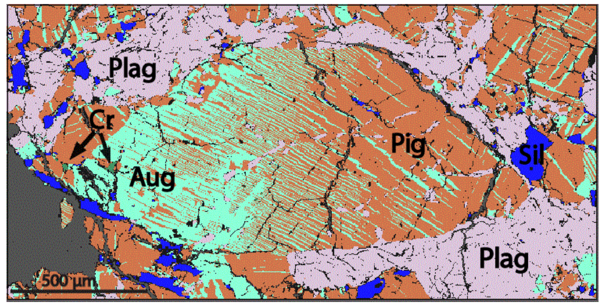

Figure 2: Enlarged ENVI image of transitional pyroxene grain showing unusual exsolutions texture.

Silica and the opaque phases present in this sample seem to be directly associated interstitially with the augite. The pyroxene grains are more heavily fractured than the plagioclase grains. The difference in fracturing of the plagioclase and pyroxene grains alludes to one or more shock events in the meteorite's past.

Mineral Compositions: The molar Fe/Mn values for pyroxenes, measured by the EMP, confirm the eucrite classification (Fig. 3). The data with lower values represent the augite, and the larger values represent pigeonite.

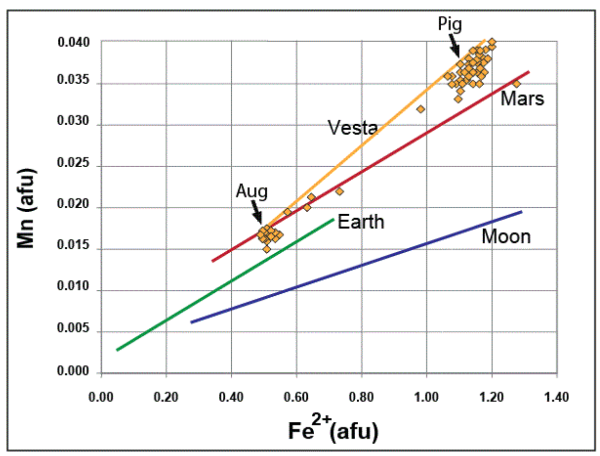

Figure 3: NWA 10452 Fe and Mn values (diamonds) compared to values of other terrestrial bodies [4].

The analyzed pyroxenes, shown in Figure 4, reveal pyroxene compositions that are more evolved than cumulate eucrites and diogenites, making them characteristic of basaltic eucrites. The pigeonite is wellequilibrated and has an Mg# of 39, consistent with eucritic pigeonite. The augite, also equilibrated, is characteristic of augites in previously studied basaltic eucrites. The augites are more homogeneous in minor elements (Cr, Al, Ti) than the pigeonites (Fig. 4). Because of slower diffusion, the minor elements in pyroxenes often preserve igneous zoning, even though Mg and Fe are re-equilibrated. Several patterns of zoning have been previously recognized [5], as illustratrated by colored bands in Fig. 4 inset. Pyroxenes in this meteorite conform to a more highly evolved trend, where Cr has already been depeleted in the magma by spinel crystallization. This pattern is less common than pyroxenes dominated by Cr and Ti [5].

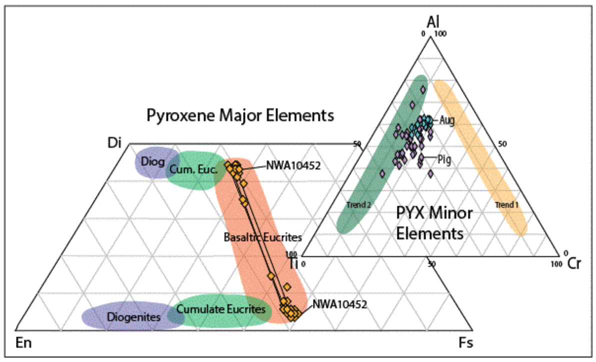

Figure 4: Pyroxene compositions of NWA 10452 compared to HED data [6] and pyroxene minor element trends [5].

The plagioclase compositions measured in NWA 10452 range from An_{82-92} and are plotted in Fig. 5 along with previously studied eucrite plagioclase compositions [5]. The plagioclase analyses were taken from core to rim and show little variation. Most basaltic eucrites contain plagioclase compositions in the range An_{74-92} [6]. Considering this sample's average An content of 91 mol.%, it lies slightly on the high side for calcium enrichment compared to the majority of basaltic eucrites.

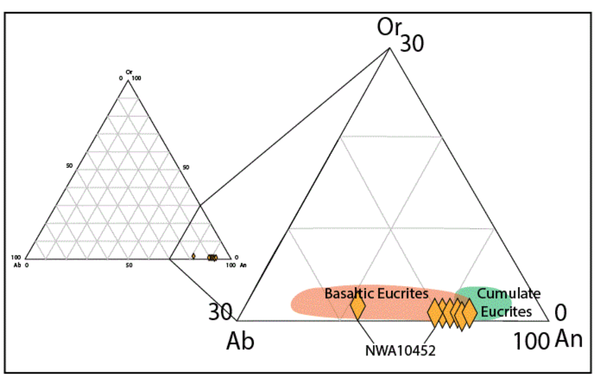

Figure 5: NWA 10452 plagioclase compositions compared to eucrite data [5].

One unusual characteristic of NWA 10452, is that it contains two separate compositions of spinel (Fig. 6). Chromite has a high--Cr content (Cr_{72}) and low--2*Ti (Ti_{11}) and Al (Al_{17}) content. The other spinel has moderately high--Cr (Cr_{42}) and 2*Ti (Ti_{50}) contents with low--Al (Al_7) content. This is shown in comparison with spinel data from other HEDs [3] in Fig. 6. Both spinel populations range within the basaltic eucrite compositions. Also, one chromite analysis displays as an outlier for the cumulate eucrite range with a composition of Al_{11} Cr_{63} $2{*}Ti_{25}$.

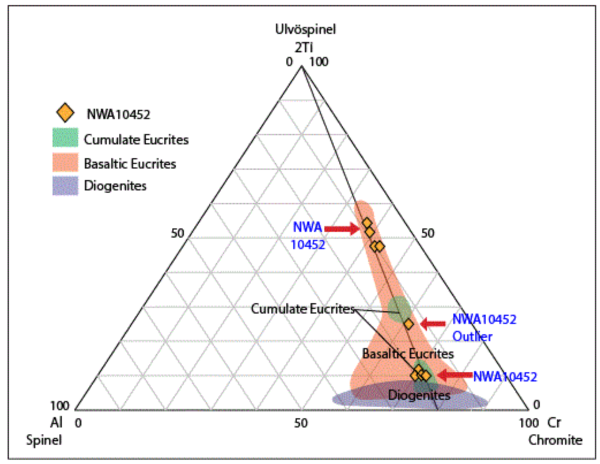

Figure 6: NWA 10452 spinel compositions compared to HED data [6].

Summary: Samples like the unbrecciated, basaltic eucrite NWA 10452 show that we have not fully sampled the petrologic variations among HED meteorites. This sample is more gabbroic than basaltic, and some of its properties, such as the unusual relationships between high-Ca (augite) and low-Ca (pigeonite) pyroxenes and the occurrence of two distinct spinel phases, defy easy explanation. Eucrites that are unbrecciated are especially useful, and NWA 10452 adds to the complexity already noted in unbrecciated eucrites [5].

References:

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