CRESCENT-SHAPED FEATURE IN EUCRITE NORTHWEST AFRICA (NWA) 12282: IMPLICATIONS FOR THE IMPACT HISTORY OF VESTA. M. E. Karageozian, S. M. Dillon, R. T. Fitch, M. A. Sedler, Z. G. Teichert, E. T. Dunham. The School of Earth and Space Exploration, Arizona State University, 781 Terrace Mall, Tempe, AZ 85287 (mekarage@asu.edu).

Introduction: The Howardite-eucrite-diogenite (HED) suite of meteorites are crustal rocks formed through igneous and impact processes on a differentiated asteroid parent body, thought to be 4 Vesta [1]. These impact processes mixed and welded igneous rocks and rock fragments from various depths into fragmental breccias. Eucrites are divided into fine to medium-grained ophitic to subophitic basalts and cumulate gabbros, while diogenites are coarse grained, brecciated orthopyroxenites. Howardites are composed of a combination of eucritic and diogenitic materials and formed from impact mixing [2]. In this study, we report the petrography and geochemistry of a prominent crescent-shaped feature in eucrite NWA 12282 to discuss the impact history of Vesta.

Methods: To determine petrography and mineralogy, a polished thin section of NWA 12282 was examined via petrographic microscope and electron microprobe energy dispersive X-ray spectroscopy. Compositional data were gathered through wavelength dispersive X-ray spectroscopy on the JXA-8530F Electron Probe Microanalyzer in the LeRoy Eyring Center for Solid State Science, at Arizona State University. Within the crescent-shaped feature, four regions were analyzed with WDS as well as further EDS work completed in seventeen regions.

Results:

Bulk Petrography. NWA 12282 is classified as a polymict eucrite breccia [3], dominated by angular to sub-rounded grains and clasts. The bulk meteorite consists of pyroxene and plagioclase grains in a fine matrix of similar composition (Fig. 1, left portion of panels PPL and XPL). Accessory minerals include ilmenite, chromite, silica, and Fe-sulfides. The pyroxene clasts are low to average in wollastonite content ($Wo_{6.5-22.0}$), with most pigeonite measuring $Fs_{52.6\pm4.4}$ and $Wo_{10.4\pm5.6}$. In some pigeonite grains, augite exsolution lamellae are present ($Wo_{41.9\pm0.7}$ and $Fs_{27.3\pm0.9}$). The plagioclase is highly variable, with values ranging from An_{99} - An_{80}, averaging $An_{88.5\pm6.0}$.

Crescent Clast Petrography. NWA 12282 contains a crescent-shaped clast distinct from the bulk meteorite texture and composition. It is 1.0-1.5 cm in diameter and only present in one region of the sample (Fig. 1). The clast exhibits a very fine-grained

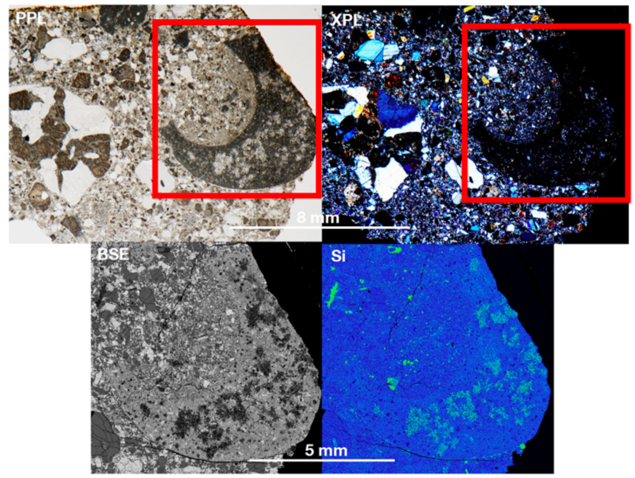

Figure 1. Panels PPL and XPL are plane polarized and cross polarized light images of the majority of the NWA 12282 section respectively. Panels BSE and Si are back-scatter image and Si elemental map of the crescent, as indicated by red boxes in the PPL and XPL panels.

brecciated texture and has similar pyroxene and plagioclase compositions to the bulk meteorite. The crescent has distinct boundaries as seen in transmitted light (Fig. 1, panel PPL), and in BSE images (Fig. 2) distinguishing its finer-grained texture from that of the coarser-grained bulk meteorite. Mirroring observations outside of the crescent, some orthopyroxene ($Wo_{4.4\pm0.9}$ and $Fs_{57.2\pm0.7}$) grains have exsolved augite lamellae (high $Wo_{41.9\pm0.7}$ and low $Fs_{7.3\pm0.9}$) (Fig. 2). When compared to the bulk meteorite, the crescent area contains more silica glass, sulfides (i.e. troilite), and accessory phases (a small number of kamacite, taenite, and zircons grains ~5µm in diameter were found). The opaque mineral grains are located in the Si-rich regions (Fig. 2) within the center of the crescent (Fig. 1, panel Si).

Discussion:

The crescent clast is petrographically and compositionally distinct from the bulk of polymict eucrite NWA 12282. Based on the gathered data, i.e. elemental maps, mineralogy, and fine-grained brecciated texture, this clast is a different lithology than the bulk of NWA 12282.

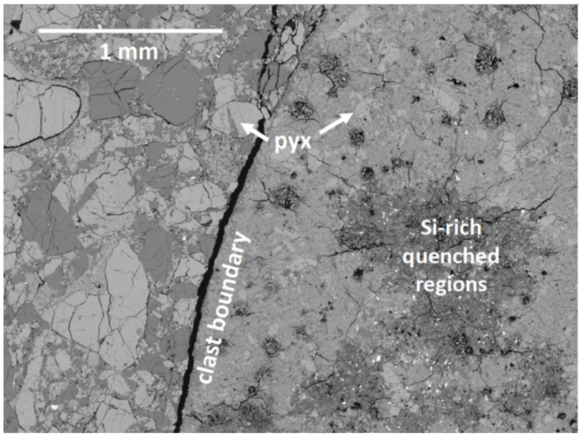

Figure 2. BSE image of a small portion of the crescent clast and bulk composition of NWA 12282, including pyroxene (pyx) in both regions, the defined boundary between the clast and bulk meteorite, and one of the Si-rich quenched regions in the center of the crescent clast.

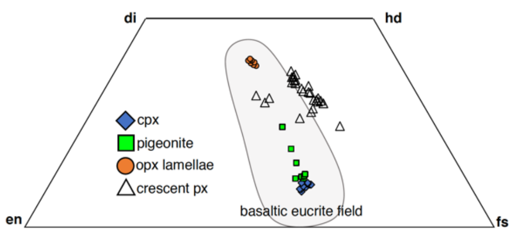

Figure 3. Ternary pyroxene diagram comparing the composition of the bulk NWA 12282 eucrite clinoproxene (cpx), pigeonite, and orthopyroxene (opx) lamellae to the pyroxene in the crescent clast. The gray field indicates the pyroxenes composition of other basaltic eucrites [2].

Origin hypothesis: implications for cooling and lithification The crescent clast is finer-grained in texture than the bulk of NWA 12282. The grain size difference suggests that the two distinct lithologies experienced different cooling histories. Similar textures to those found in the crescent clast were noted in Allan Hills (ALH) 81001 [5], which was described to contain dark clasts with fine-grained textures. [5] interpreted this as rapid cooling or a quench texture. The bulk of the meteorite displays no evidence of rapid cooling, which furthers our hypothesis that the crescent clast is a distinct lithology of impact origin. The opaque grains of zircon and taenite were only found within the crescent clast in the Si-rich regions. This suggests that the clast may have originated from a specific sampling location and time; when Vesta was fully differentiated and the stratigraphy where the clast derived had an evolved melt composition [4]. This is also evident in the differences in composition seen in the pyroxene within the crescent clast (Fig. 3) which is more Fe-rich. After being cooled quickly, this region of Vesta may have been incorporated into the polymict brecciated eucrite sample during impact events.

Origin hypothesis: implications for shock history This variation in texture can also be an indicator of complicated shock processes during impacts [6]. The crescent clast could be a relic of the complexity of shock experienced on Vesta in which some regions experienced higher levels of shock than others due to the nature of shock effects and the heterogeneity of mineralogy/composition on planetary-body surfaces [6].

Conclusion: The crescent feature in the analyzed thin section of NWA 12282 presents a challenge in the classification due to its distinct petrography and geochemistry. Based on texture and accessory mineral compositions within the crescent clast, it can be assumed that the it is not representative of the bulk meteorite in which it resides. The origin of the crescent clast is most likely to be either 1) a sample from a quickly cooled evolved melt (magmatism occurring later in Vesta's evolution) which was incorporated into NWA 12282 by impact processes, or 2) an impact melt sample from the complex shock and impact history that was experienced on Vesta.

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