EBSD Study of Lattice Preferred Orientation (LPO) of HEDs (Howardite NWA 2696, Eucrite Camel Donga, Olivine-Diogenite NWA 5480).

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Introduction: Howardite-Eucrite-Diogenite (HED) meteorites are thought to have originated from various crustal levels of the asteroid 4 Vesta, or a Vesta-like body [1]. Structural analysis on the Howardite NWA 2696, the Eucrite Camel Donga and the Olivine-Diogenite NWA 5480 is being carried out using electron backscatter diffraction (EBSD), which allows us to measure and visualize the crystallographic orientation of each crystal to discover any lattice preferred orientation (LPO) [2]. Comparison of structural results between intraclasts and matrix and between the three specimens offers first insight into the complex, polyphase deformation and texture formation undergone during the formation of Vestoids, its crustal evolution and impact history.

Specimens: We present results of EBSD analysis on NWA 2696, Camel Donga and NWA 5480 to offer a structural comparison of meteorite specimens originating from different depths of the Vesta-like parent body. The Howardite NWA 2696 is a polymict regolith breccia of both eucritic and diogenitic fragments in a finer grained matrix. The Eucrite Camel Donga is a monomict breccia domninated by plagioclase and pyroxene and contains over 2 vol% metallic iron. The Diogenite NWA 5480 is an olivine-rich (57 vol%) diogenite with olivine patches/streaks of over 90% olivine in an orthopyroxene matrix and with a distinct lack of plagioclase.

Electron Backscatter Diffraction (EBSD): Structural analysis is performed applying electron backscatter diffraction (EBSD). This allows the crystallographic axis orientation of each crystal to be measured and visualized to discover any preferred crystal alignment [2]. Under evacuated conditions in a scanning electron microscopy chamber, an electron beam (15 kV) is directed at a point of interest on a crystalline sample, tilted 70° from the horizontal. The atoms in the material scatter a fraction of the electrons with a small loss of energy to form a divergent source of electrons close to the surface of the sample. Electrons which incident on atomic planes at angles which satisfy the Bragg equation ($n\lambda = 2d \sin \theta$), are diffracted and then detected on a fluorescent (phosphorous) screen. This produces characteristic Kikuchi bands, which can be indexed with the respective Miller indices of the crystal planes that generated them and the axis orientations. [3]

Results: Our EBSD analysis on the Howardite NWA 2696 and the Eucrite Camel Donga have so far revealed no detectable preferred orientation of the crystallographic main axes of pyroxenes nor feldspars. Figure 1 shows EBSD results of Howardite NWA 2696 from a major clast *(Fig. 1a)* and from the matrix *(Fig. 1b)*, presented as equal area projections (upper hemisphere), whereby in each case the upper three projections represent pole figures and the lower three projections represent inverse pole figures. These results reveal a surprisingly homogenous distribution of axial orientation for all identified phases and in both the matrix and intraclasts. Similarly, EBSD results of the Eucrite Camel Donga reveal no detectable LPO *(Fig. 2)*.

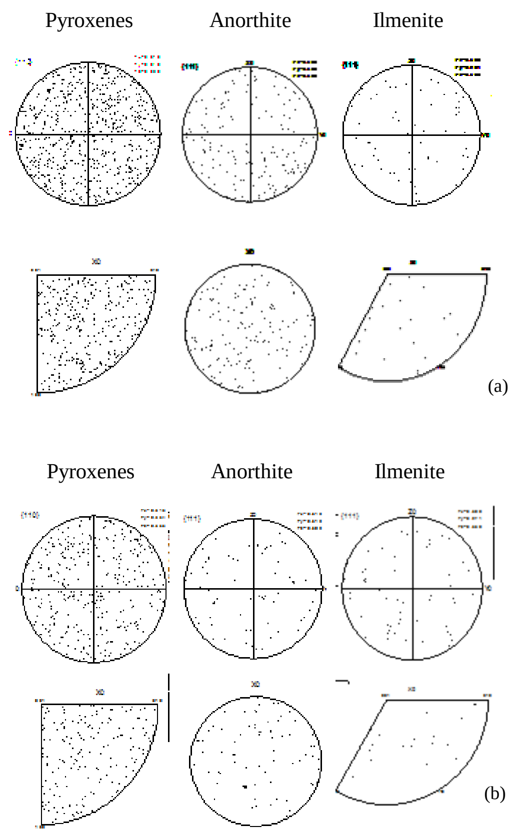

Fig. 1: Howardite NWA 2696. Results of EBSD Analysis presented as equal area projections, showing no detectaböe LPO (a) in a major clast (b) in the matrix. In each case the upper three projections represent pole figures and the lower three projections represent inverse pole figures.

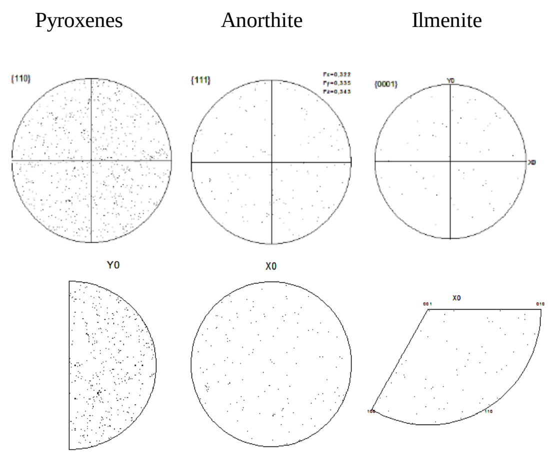

Fig. 2: Eucrite Camel Donga. Results of EBSD Analysis presented as equal area projections, showing no detectable LPO. The upper three projections represent pole figures and the lower three projections represent inverse pole figures.

These results suggest that the multiple deformation events due to impacts on the surface of Vesta seems to have introduced no preferred orientation of the minerals, which indicates the absence of directed compaction. Structural analysis of the olivine-diogenite NWA 5480 is still in progress to date, the results of which will provide interesting comparison, since it is considered to be of primary mantle material, formed at deep crustal levels as cumulate in a magma chamber.

Comparison of the results of these structural analyses may offer first insight into the complex, polyphase deformation undergone during Vesta's formation, crustal evolution and impact history or a similar Vesta-like object. This study is of particular interest, since Vesta itself in 2011 awaits the arrival of NASA's DAWN probe, from which further information on the evolution and current structural state of its surface is expected.

References: [1] McSween Jr., H. (2010) *Space Sci Rev DOI 10.1007/s11214-010-9637-z.* [2] Prior, D. et al. (1999) *Amercian Mineralogist, 84, 1741-1759.* [3] Oxford Instruments PLC (2005), *http://www.ebsd.com/ebsd-explained/*