SILICA-RICH VESTAN CRUSTAL TERRANES? INTERMEDIATE COMPOSITIONS REVEALED BY AN INHOMOGENEOUS IMPACT SPHERULE IN NORTHWEST AFRICA 12231.

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Introduction: The HED suite of meteorites (howardites, eucrites, and diogenites) is generally believed to originate from the both the outer crustal layers of 4 Vesta (howardites and eucrites) as well as the solidified Vestan mantle (diogenites) [1]. Howardites are polymict breccias whose lithic constitution is composed primarily of fragmental eucrites and diogenites, dispersed throughout the Vestan regolith by impactors and subsequently lithified under the force of Vesta's gravity [2]. This work will focus on the compositions derived from an impact spherule in a howardite, Northwest Africa 12231.

Methods: Oxide wt. percentages were determined with EDAX energy-dispersive x-ray spectroscopy (EDS). A probe current of 1.9nA was employed, as well as a voltage of 15kV. A spot size of 4 μm was employed.

Results: Analysis of a glassy impact spherule in Northwest Africa 12231 has yielded inhomogeneous compositions, ranging from 53-58 wt% SiO2, with most analyses yielding 'andesitic' compositions. Summary of the average data is presented in Table 1. The compositions analyzed here are intermediate between eucritic bulk compositions (EBC) and proposed Vestan felsic terrranes [3] (VFT), as evidenced by mixing lines between EBC and VFT. Here, it is proposed that the felsic composition of the glass is attributable to the mixing of the two compositions by an impactor. To verify that the compositions were not a result of impact-induced vapor fractionation, the compositions have been plotted on an Al2O3/CaO vs. K2O/CaO and K2O/CaO vs. FeO/CaO diagram (Fig. 1). Due to the differences in volatility of K2O and more refractory oxides (FeO, CaO, Al2O3), the enrichment could be resultant of the selective volatilization and condensation of less refractory oxides [4]. This effect was ruled out, as the behavior of K2O in the analyzed glass systematically varies with FeO, CaO, and Al2O3 (Fig. 1). Due to the linear trend of the data (Fig. 2), it is possible that the values observed here could be obtained by impact melting and subsequent mixing of two compositionally heterogeneous materials, namely the eucritic bulk composition and another more felsic endmember.

Figures:

SiO2	Na2O	MgO	Al2O3	P2O5	MnO	SO2	K2O	CaO	TiO2	FeO
54.90477	1.726446	10.73421	14.58807	0.169584	0.398883	0.195203	0.912947	7.195977	0.150333	8.842365

Table 1: Average wt% oxide compositions of the glass spherule analyzed here.

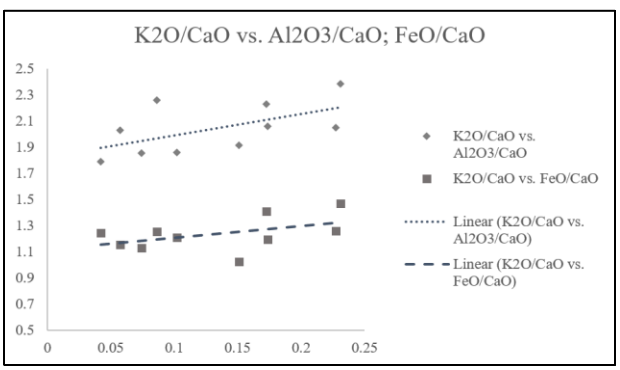

Figure 1: Diagram controlling for volatility of K2O during impact induced vapor fractionation. Here, the K2O content varies systematically with more refractory oxides, and thus, enrichment attributable to impact fractionation can be ruled out.

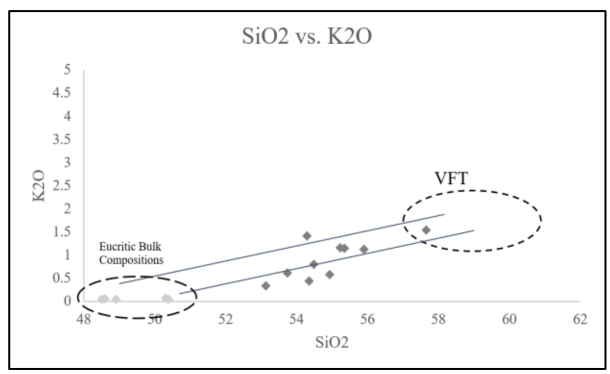

Figure 2: Diagram indicating possible mixing lines between EBC and a more felsic material, possibly a proposed Vestan felsic terrane. Compositions here are 'andesitic', and range from 53-58% SiO2.

References: [1] Binzel R. P. and Xu S. 1993. Chips off of asteroid 4 Vesta: Evidence for the parent body of basaltic achondrite meteorites. Science 5105:186–191 [2] TAKEDA, H. (1997), Mineralogical records of early planetary processes on the howardite, eucrite, diogenite parent body with reference to Vesta. Meteoritics & Planetary Science, 32: 841-853. doi:10.1111/j.1945-5100.1997.tb01574.x [3] Barrat, Jean-Alix & Bohn, Michael & Gillet, Philippe & YAMAGUCHI, A. (2009). Evidence for K-rich Terranes on Vesta from impact spherules. Meteoritics & Planetary Science. 44. 359 - 374. 10.1111/j.1945-5100.2009.tb00738.x. [4] Delano, J. W., Pristine lunar glasses; criteria, data, and implications. In Proceedings of the 16th Lunar Planet. Sc. Conf.; (eds. Ryder, G. & Schubert, G.). J. Geophys. Res. B. 91, 4, D201-D213 (1986).