RELATIVE CHRONOLOGY OF CRUST FORMATION ON ASTEROID 4-VESTA: INSIGHTS FROM THE EU ANOMALIES IN DIOGENITES

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Diogenites are ultramafic cumulates probably derived from asteroid 4-Vesta [1-2]. They are usually chiefly composed of orthopyroxene crystals, with minor amounts of olivine and other minerals. Although these rocks provide an important record of the magmatic history of their parent body, their study is difficult: they are generally brecciated, and many of them have suffered an intricate thermal history. Furthermore, they display very low incompatible trace element abundances, which are difficult to analyze. We have selected a large series of diogenites (33 distinct diogenites) and determined the REE and a few other trace element abundances in bulk rock powders, and in residues after a strong acid leaching step, using an improved ICP-MS procedure [3]. Our results show that many diogenites contain minute amounts of phosphate whose contribution to the REE budget is often significant. The residues after leaching mirror closely the composition of the orthopyroxenes and give important constraints on the petrology of the diogenites.

Diogenites display a remarkable range of REE abundances [e.g., 2,3] and, unsurprisingly, their orthopyroxenes (i.e., the residues) are no different [4]. For example, the Yb abundances obtained here range from 5 to 593 ng/g. More importantly, diogenitic orthopyroxenes are characterized by an impressive range of negative Eu anomalies (Eu/Eu^*=0.04-0.76), and heavy REE enrichments ($(Dy/Lu)_n$=0.01 to 0.8). Neither the REE abundances, nor the REE ratios (e.g., Dy/Lu, Eu/Eu^*) are correlated with major elements.

The wide range of negative Eu anomalies displayed by the orthopyroxene crystals cannot be explained by traces of plagioclase in the analyzed fractions, nor by a wide range of fO_2 during the crystallization of the parental melts of diogenites. The very low Eu/Eu^* values suggest that the parental melts of some diogenites were contaminated by melts displaying an extremely large negative Eu anomaly. Such melts could have been easily generated by low degrees of melting of the eucritic crust [5,6]. Thus, these anomalies are the first firm indication that the parental magmas of some diogenites have intruded the eucritic crust, and consequently are younger than eucrites.

References: [1] Drake M. 2001. *Meteoritics & Planetary Science* 36: 501-513. [2] Mittlefehldt D. W. 1994. *Geochimica et Cosmochimica Acta* 58: 1537-1552. [3] Barrat J. A. et al. 2008. *Meteoritics & Planetary Science* 43: 1759-1775. [4] Fowler G. W. et al. 1994. *Geochimica et Cosmochimica Acta* 58: 3921-3929. [5] Barrat J. A. *et al.* (2007) *Geochimica et Cosmochimica Acta* 71: 4108-4124. [6] Yamaguchi A. et al. 2009. *Geochimica et Cosmochimica Acta* 73, 7162-7182.