PETROLOGY AND THERMAL HISTORY OF A UNEQUILIBRATED DIOGENITE, DHOFAR 700.

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Introduction: Diogenites, derived from asteroid 4 Vesta, are usually orthopyroxene cumulates with minor amount of olivine and other minerals. Diogenites seem to have crystallized from a few distinct magmatic bodies [e.g., 1-3] and are generally assumed to have formed at great depth. Here, we show that some of them have cooled more quickly than generally thought. Dhofar (Dho) 700 is one of the best examples of these diogenites.

Results and discussion: Dho 700 is one of the rare unbrecciated diogenites. It displays a granular texture composed of pyroxene (~99 vol%) with minor phases such as plagioclase, chromite, olivine, silica minerals, and Fe-FeS. Unlike other diogenites, the pyroxene in Dho 700 shows igneous zoning; the Mg' value (= 68-72) and the contents of CaO and Al_2O_3 increase toward the rims. The rims of granular pyroxene have thin (1-2 µm thick) discontinuous lamellae or worms of augite. The cores of the pyroxene are dusty due to the presence of fine (<1-2 µm) inclusions of Fe-FeS.

We found rounded inclusions (100-200 µm) in the granular pyroxene grains. One of the inclusions has mafic minerals with higher Mg'. The Mg' of olivine in the inclusions are relatively constant at ~71-72. The pyroxene in the core of the inclusion is ~75 with steep compositional gradient toward the host granular pyroxene. The FeO/MnO ratios of the inclusion (~23-24) are slightly lower than those of the host pyroxene (~25-28). The CaO, Al_2O_3, and Cr_2O_3 contents are lower than those of the host pyroxene whereas TiO_2 contents are similar. The similarity of the FeO/MnO and Al_2O_3 and TiO_2 relationship of pyroxene indicates that the inclusions are genetically related to the magma that crystallized the granular pyroxene.

The presence of igneous zoning and Mg-rich inclusions indicates that Dho 700 cooled rapidly. Using diffusion coefficients of Fe-Mg in orthopyroxene [4] and assuming an initial temperature of 1250 °C, the cooling rates are estimated to be several hundreds °C/year. The cooling rates are too low for impact melt rocks, but too fast for plutonic rocks. Three other diogenites, Garland, Y-74013 and NWA 4215 have similar chemical zoning in pyroxenes [2,5,6]. It appears that the cooling rates of these diogenites are comparable to those of unequilibrated eucrites (types 1-4) [7]. The rapid cooling rates of these unequilibrated diogenites strongly argue against a plutonic origin. They may have crystallized in shallow intrusions or extruded on the surface.

References: [1] Mittlefehldt D. W. 1994. *Geochimica et Cosmochimica Acta* 58: 1537-1552. [2] Fowler G. W. et al. 1994. *Geochimica et Cosmochimica Acta* 58: 3921-3929. [3] Barrat J. A. et al. 2008. *Meteoritics & Planetary Science* 43: 1759-1775. [4] Ganguly J. and Tazzoli V. 1994. *American Mineralogist* 79: 930-937. [5] Takeda H. et al. 1981. *Memoirs of the National Institute of Polar Research, Special Issue* 20: 81-99. [6] Barrat J. A. et al. 2006. *Meteoritics & Planetary Science* 41: 1045-1057. [7] Takeda H. and Graham A. L. 1991. *Meteoritics* 26: 129-134.