TIMING OF CRYSTALLIZATION OF THE MAGMA OCEAN ON THE HED PARENT BODY

T.-H. Luu and T. Elliott, Bristol Isotope Group, School of Earth Sciences, University of Bristol, Bristol BS8 1RJ, UK (tutu.luu@bristol.ac.uk).

Introduction: Asteroid 4 Vesta (~525 km diameter), the parent body of the Howardite-Eucrite-Diogenite (HED) meteorites, is widely believed to be layered with a iron-rich core, an olivine-rich mantle and a crust made of diogenite (orthopyroxene-rich) in its lower part and of basaltic eucrite in its upper part [1-2]. Whether Vesta underwent a global or a partial melting is still debated. Two main scenarios were invoked to explain the formation of eucrites and diogenites. In the first scenario, they were formed before the core-mantle differentiation, with non-cumulate eucrites formed from the extrusion of the first partial melts from the silicates, followed by cumulate eucrites and diogenites formed by crystallization from a shallow magma ocean [3]. Conversely, the second model suggests that diogenites crystallised from a global magma ocean after the core-mantle differentiation, and that the residual liquid left behind after magma crystallization represents eucrites [1-2]. However geochemical arguments, such as the depletion of moderately siderophile elements (Ni, Co, Mo, W and P) in HEDs [4], seem to favour the latter scenario.

Material and Methods: We have re-investigated this issue by measuring, using a Thermo Finnigan Neptune MC-ICPMS at the University of Bristol, the bulk Mg isotopic compositions of three diogenites (Johnstown, Tatahouine and Shalka) and six basaltic eucrites (Cumulus Hills 04049, Elephant Moraine 87520, Queen Alexandra Range 97053, Béréba, Stannern and Juvinas). Intense Mg beams (typically > 2 nA on ^{24}Mg) over suitable durations (typically >100 min total acquisition time) were used to allow sufficient counting statistical precision, and following a standard-sample-standard bracketing method. In these conditions, a precision of 2-3 ppm (2σ, n>20) is reached for the bulk mass-independent Mg isotopic compositions (Δ'^{26}Mg).

Results: Eucrites show radiogenic Δ'^{26}Mg up to +30 ppm, while diogenites are much less radiogenic with Δ'^{26}Mg values down to -6 ppm. As previously reported by [5], the Δ'^{26}Mg of diogenites scale with their bulk CaO content, supporting the fractional crystallization origin for the diogenite suite. Overall our data are consitent with the range of bulk Δ'^{26}Mg variations for diogenites and eucrites previously reported by [5-8].

Preliminary discussion: For the first time to our knowledge, we will show that the range of Δ'^{26}Mg variations from the least radiogenic diogenite to the most radiogenic eucrite does not support the model described in [3], but instead favours the formation of diogenites prior to the formation of eucrites. We will also compare our ^{26}Al model ages for diogenites and eucrites to Al-Mg ages from literature [5-8], as well as whole rock Hf-W ages [9] and Mn-Cr ages [10] for HEDs.

References: [1] Righter K. and Drake M. J. (1997) *Meteoritics & Planetary Science* 32:929–944. [2] Mandler B. E. and Elkins-Tanton L. T. (2013) *Meteoritics & Planetary Science* 48:2333–2349. [3] Neumann W. et al. (2014) *Earth and Planetary Science Letters* 395:267–280. [4] Righter K. and Drake M. J. (1996) *Icarus* 124:513–529. [5] Schiller M. et al. (2011) *Astrophysical Journal Letters* 740:L22. [6] Schiller M. et al. (2010) *Geochimica et Cosmochimica Acta* 74:4844–4864. [7] Hublet G. et al. (2017) *Geochimica et Cosmochimica Acta* 218:73–97. [8] Bizzarro M. et al. (2005) *The Astrophysical Journal* 632:L41–L44. [9] Touboul M. et al. (2015) *Geochimica et Cosmochimica Acta* 156:106–121. [10] Trinquier A. et al. (2008) *Geochimica et Cosmochimica Acta* 72:5146–5163.