INVESTIGATING MANTLE RESERVOIRS ON VESTA USING Pb SYSTEMATICS

J. A. Cartwright[1], I. Kouvatsis[1] and M. J. Whitehouse[2]. [1]Department of Geological Sciences, University of Alabama, Tuscaloosa, AL 35487-0338, USA. [2] Department of Geosciences, Swedish Museum of Natural History, SE-104 05 Stockholm, Sweden. Email: jacartwright@ua.edu

Introduction: Asteroid 4 Vesta, the largest differentiated asteroid in the asteroid belt, with a distinct metallic core, ultra-mafic mantle and basaltic crust (e.g. [1]), is considered the likely parent body to the Howardite-Eucrite-Diogenite (HED) meteorite clan (e.g. [2]). Eucrites present as either cumulate (e.g. gabbroic) or basaltic in texture, formed at depth within the vestan crust or from emplacement of dykes/sills or erupted flows, respectively [2]. These materials thus have the potential to preserve valuable information about their original magma reservoirs.

Lead (Pb) isotopic analyses are routinely performed on extra-terrestrial materials (including HEDs, e.g. [3-6]) to determine uranium (U)-Pb and/or Pb-Pb ages, given the long-half-lives and robust nature of these chronometers to reveal accurate ages of ancient samples. An additional application of U-Pb-based analysis is an examination of Pb components within samples and associated modeling of various contributions to constrain the evolution and differentiation history of planetary bodies, like Earth and Mars (e.g. [7-8]). Typically, extra-terrestrial materials display data that can be modeled based on primordial Pb, radiogenic Pb and terrestrial contributions, within the framework of the initial $^{238}U/^{204}Pb$ ratio, also known as the 'μ-value'. Importantly, variations in μ must be considered when interpreting U-Pb and Pb-Pb age data, where contamination can lead to misrepresentation of crystallisation ages.

In previous work [3], we reported preliminary Pb-Pb ages for two eucrites (basaltic and/or brecciated) and three mesosiderites, where melt clasts and phosphate grains were targeted, respectively. Here, we are reporting Pb data collected for cumulate eucrite Northwest Africa (NWA) 8564, with comparison to this previous data, to determine a Pb-Pb age and investigate Pb components present at depth within Vesta.

Methods: A ~0.6 g fragment of NWA 8564 was epoxy-mounted and polished in the Cartwright Cosmochemistry Laboratory (CCL) at the University of Alabama (UA). Subsequent scanning electron microscopy (SEM) using a *Thermofisher Apreo* Field-Emission SEM at UA was used to acquire both SEM images and Energy-Dispersive X-Ray Spectroscopy (EDS) elemental maps, to identify appropriate target clasts for Pb analysis. The mounted sample was analysed for ^{207}Pb-^{206}Pb-^{204}Pb using a *Cameca IMS 1280* Secondary Ion Mass Spectrometer (SIMS) at the NordSIMS facility in the Swedish Museum of Natural History, using protocols similar to [9].

Results & Discussion: We made 16 spot analyses on targeted pyroxene and feldspar grains within NWA 8564. Of significant interest is that we were **unable to obtain an isochron age for these data**, as no consistent $^{207}Pb/^{206}Pb$ value could be inferred. Investigating further, with consideration of different potential μ values (Fig.1), the NWA 8564 analyses fall along an **unconventional trend line** that likely represents linear mixing between terrestrial contamination (Modern Pb [12]) and an apparent exotic initial Pb ratio, without any obvious influence from a radiogenic component. We continue to investigate the cause of this trend, noting that consideration of multiple differentiation events, as explored for Mars [7], is unlikely, especially when comparing our data with other Vesta-like achondrites (Fig. 1). One extreme consideration might be that this exotic Pb contribution heralds from another planetary body with a high μ reservoir.

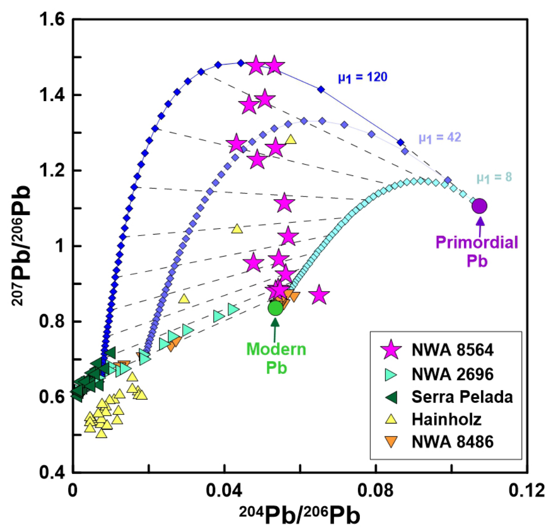

Fig. 1: Three isotope plot for Pb highlighting NWA 8564 data, plotted alongside eucrites NWA 2696, Serra Pelada, mesosiderite Hainholz [3] and ungrouped achondrite NWA 8486 [10]. Variable μ evolutions (8, 42, 120) are plotted with paleoisochrons at 0.5 Gyr intervals. Primordial Pb [11] and Modern Pb [12] are also included.

References: [1] Keil K. (2002) *Asteroids III*, 573-584. [2] Mittlefehldt, D. W. (2015) *Chemie der Erde*, 75, 2:155-183. [3] Kouvatsis I. et al. (2022) 53rd LPSC, (abs.#1248). [4] Hopkins M. D. et al. (2015) *Icarus,* 245:367-378. [5] Zhou Q. et al. (2013) *Geochmica et Cosmochimca Acta,* 110:152-175. [6] Liao S. & Hsu W. (2017) *Geochmica et Cosmochimca Acta*, 204:159-178. [7] Bellucci J. et al. (2018) *Earth and Planetary Science Letters*, 485:79-87. [8] Hofmann A. (2008) *Nature:Geoscience*, 1:812-813. [9] Snape J. F. et al. (2016) *Geochmica et Cosmochimca Acta,* 451:149-158. [10] Cartwright J. A. et al. (2016) 79th Metsoc, (abs.#6231). [11] Tatsumoto et al. (1973) *American Association for the Advancement of Science,* 180:1279-1283. [12] Stacey J.S. & Kramers J.D. (1975) *Earth and Planetary Science Letters*, 26:207-221. **Acknowledgements:** This work was funded in part by NASA ROSES grant 17-SSW17-0262.