"SOLAR-WIND-RICH" HOWARDITES: TRUE REGOLITH VS. CM-IMPLANTED COMPONENTS.

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Introduction: Howardite, eucrite and diogenite meteorites (collectively HED) likely originate from asteroid 4-Vesta [1], one of two asteroids targeted by NASA's Dawn mission. Many howardites (polymict breccias of E and D material) contain "regolithic" features, including impact-melt clasts, fragmental breccia clasts, and carbonaceous chondrite fragments. True regolithic nature can be determined through noble gas analysis, as Solar Wind (SW) is implanted into the upper-most surfaces of solar system bodies. Whilst previous work [2] suggested that high siderophile element contents (e.g. Ni of 300-1200 µg/g) were regolith indicators, we found no obvious correlation between SW and these indicators in our initial howardite noble gas analyses [3]. We observed CM-like fragments in a number of our howardites, whose textures suggest late addition to the breccia assemblage [4]. As typical CMs contain mixtures of SW (in matrix) and planetary (in clasts) components [5], we investigate the dominance of such components in SW-rich howardites. This will help determine the extent of implanted SW in HED grains vs. SW and planetary gases from CM fragments, and allow better understanding of regolith processes.

Results: Noble gas analysis was performed using furnace step-heating on an MAP 215-50 noble gas mass spectrometer. Our results are shown in Table 1. Only 4 howardites show potential SW (e.g. GCR-SW mixing $^{20}Ne/^{22}Ne$ 1–13.75, $^{21}Ne/^{22}Ne$ 0.85–0.03 [6]), of which 3 contain CM fragments. A pure CM clast (PRA CM) was analysed to assess CM dominance compared to bulk PRA. LEW (no CM) has the highest $^{20}Ne_t$ concentration and SW-Ne ratios. The CM-rich samples show typical mixes of SW (seen in Ne) and planetary (seen in Xe) components as observed for CM Murchison ($^{20}Ne/^{22}Ne$ ~9, $^{136}Xe/^{132}Xe$ ~0.322). Our estimated CM fractions (from petrological analysis [4]) are roughly consistent with observed heavy noble gas concentrations. Significant late addition of CM (with matrix) to howardite assemblages may thus overprint latent SW components. The effects are not as strong with low CM fractions (e.g. MET) - possibly due to less incorporated matrix. Elevated Xe concentrations may help identify potential CM-rich howardites.

Table 1: "SW-rich" Howardite noble gas results.

Noble Gas (cc/g)	LEW 85313	MET 00423	SCO 06040*	PRA 04401	PRA CM
^{22}Ne (10^{-8})	36.7(8)	19.6(6)	2.7 (2)	6.6(3)	4.9(2)
$^{20}Ne/^{22}Ne$	9.68(4)	8.90(1)	1.61 (2)	3.22(4)	3.57(3)
$^{21}Ne/^{22}Ne$	0.157(1)	0.272(2)	0.814(7)	0.670(6)	0.567(4)
$^{20}Ne_t$ (10^{-8})	347(22)	169(9)	2.3(2)	16.9(11)	14.3(9)
$^{132}Xe_t$ (10^{-10})	2.1(1)	0.64(2)	5.1(2)	39.9(13)	78.0(27)
$^{129}Xe/^{132}Xe$	1.023(3)	1.004(8)	0.992(2)	1.046(3)	1.042(3)
$^{136}Xe/^{132}Xe$	0.334(1)	0.358(3)	0.334(1)	0.324(1)	0.323(1)
CM fraction	-	< 1%	~10%	~60%	~100%

*Errors in parentheses. t = trapped. *incomplete analysis.*

References: [1] Drake M.J. (2001) *Meteoritics & Planetary Science*, 36:501-513. [2] Warren, P.H. *et al.* (2009) *Geochimica et Cosmochimica Acta*, 73:5918-5943. [3] Cartwright, J.A. *et al.* (2011) 42nd Lunar & Planetary Science Conference *(abs. # 2655)*. [4] Herrin, J.S. *et al.* (2011) 42nd Lunar & Planetary Science Conference *(abs. #2806)*. [5] Nakamura, T. *et al.* (1999) *Geochimica et Cosmochimica Acta*, 63:257-273. [6] Grimberg, A. *et al.* (2008) *Geochimica et Cosmochimica Acta*, 72:626-645.