The Dawn mission showed asteroid 4 Vesta to be an extensively cratered body, ancient in age, with craters in a variety of morphologies and preservation states [1-3]. Tying Vesta's relative crater ages to an absolute impact history can be accomplished through investigations of the HED (howardite, eucrite, diogenite) meteorites. Eucrites are crustal basalts and gabbros, diogenites are mostly orthopyroxenites representing lower crust or upper mantle materials, and howardites are mixed breccias containing both lithologies. Eucrite 53Mn-53Cr systematics show that the HED parent body globally differentiated by ~4.56 Ga and fully crystallized soon afterwards [4]. Much later, many eucrites were brecciated and heated by large impacts into the parent body surface. Disturbance ages in eucrites show that multiple large impacts occurred within 1 Gyr after crystallization, showing a history that largely resembles that of the Moon [5-7].

Dawn images also showed that Vesta is covered with a well-developed regolith that is spectrally similar to howardite meteorites [8]. Howardites are polymict regolith breccias made up mostly of clasts of eucrites and diogenites, but which also contain clasts formed by melting of the regolith by relatively large, energetic impact events. Impact-melt clast ages from howardites extend our knowledge of the impact history of Vesta, expanding on eucrite disturbance ages and helping give absolute age context to the observed crater-counts produced using Dawn data.

The distribution of 40Ar-39Ar ages of impact-melt clasts in howardites shows that they formed within the time period 3.3-3.8 Ga [9]. These, and other impact-melted HED materials, have distinct age and compositional characteristics that suggest they formed in discrete impact events. In order to create these crystalline impact-melt products on the surface of Vesta, the impacts during this time period must have had velocities much higher than 5 km/s, the main belt average [10]. This is inconsistent with formation by a normal distribution of impact velocities and points instead to a unique period where high-velocity collisions were more frequent than currently observed.

Until now, impact-reset ages in the HED meteorites have been be interpreted under the umbrella of the canonical lunar cataclysm where an increase in the absolute number of bombarding objects is responsible for creating larger absolute amounts of impact-affected and impact-melted rocks, statistically increasing their chances of being found on Earth and dated. However, the distribution of age among the howardite impact-melt clasts may not necessarily result from an increased number of impacts, but rather result from impacts of higher velocity. The changeover from a typical main belt velocity profile to this regime of increased velocity population at Vesta occurs contemporaneously with a similar transition at the Moon, indicating that howardite impact-melt clast ages reinforce the notion of a dynamically unusual episode of bombardment in the inner solar system beginning at around 4.0 Ga.

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