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WHERE ARE ALL THE TERRESTRIAL METEORITES?

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Meteorites clearly can reach Earth from the Moon and from Mars, launched by larger impacts. This raises the inevitable question: can solid debris be ejected from Earth by large impacts, to return subsequently, survive re-entry, and be recognized as a meteorite?

Recognition: Meteorites launched from Earth will not be recognizable from lithology or geochemistry. The only diagnostic feature would be a fusion crust formed during re-entry, but this will not develop on many sedimentary rocks [1]. The Antarctic collection programmes are the best prospect for recognizing a fusion-crusted terrestrial meteorite but no candidate has yet been reported. Might this absence be significant and not merely chance?

Residence Times in Space and on Earth: CRE ages for Lunar meteorites [2] are typically $< < 1$ Ma, which suggests that ejected terrestrial debris will have comparably short space residence times. In geological terms return may be almost synchronous with the impact launch event. Maximum terrestrial residence times of achondrites are < 1 Ma [3]. Combined space and terrestrial residence times of a terrestrial meteorite, probably < 1 Ma, require a launching impact within the last few hundred ka for there to be any prospect of such a meteorite being recognized at the surface.

Launch Conditions: Minimum crater diameters necessary to achieve significant dispersal of Lunar and Martian material into space are 0.4 km and 3km respectively. Scaling-up to Earth-based parameters suggests a minimum crater diameter of $\sim$25 km, even before the effects of atmospheric drag on Earth-launched projectiles is considered. Spallation may launch solid material at high velocities from a narrow and very shallow zone around the impact site [4], with vaporization of volatiles in the target rock perhaps providing further acceleration. To escape Earth's gravity requires launch velocities perhaps 75% of impact velocity, which exceeds most published estimates [5] and questions the potential existence of terrestrial meteorites. For the high shock pressures associated with a suitably large Earth impact, any potential meteoroids will be small, probably < 20 cm [6], with obvious implications for survival during re-entry.The shallow location of the spallation zone has significant implications for recognizing 'terrestrial' meteorites. The target lithologies for many large impacts were sedimentary (e.g., limestone for the Chicxulub, Manicouagan, and Ries sites). Fusion crusts would not form on such lithologies and hence it would be effectively impossible to identify them as having re-entered the atmosphere as a meteorite.

Conclusions: A fusion crust is the only feature by which a terrestrially derived meteorite might be recognized. None have yet been reported. Minimum crater diameter of $\sim$25 km and combined space and terrestrial residence times of < 1 Ma for potential Earth-derived meteorites precludes the existence of any at the surface today; a crater of such size and recency is unlikely to have been overlooked by impact hunters scouring Google Earth. Ancient terrestrial meteorites might be sought in strata that slightly post-date major impacts in the geologic past.

References: [1] Brandstätter F. et al. 2008. *Planetary and Space Science* 56:976–984. [2] Eugster O. et al. 2006. *Meteorites and the Early Solar System* II. pp. 829–851. [3] Jull A. J. T. 2006. *Meteorites and the Early Solar System* II. pp. 889–905. [4] Melosh H. J. 1984. *Icarus* 59:234–260. [5] Wells L. E. et al. 2003. *Icarus* 162:38–46. [6] Nyquist L. E. 2001. *Space Science Reviews* 96:105–164.

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A STUDY OF GLASSES IN HOWARDITES: IMPACT MELT CLASTS VERSUS PYROCLASTS

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Introduction: Theoretical calculations predict that explosive eruptions ought to have occurred on volatile-bearing asteroids of sufficient size [1, 2]. The resulting deposits, pyroclastics, should then be preserved in samples derived from these asteroids. The large asteroid 4 Vesta is one candidate that might have experienced explosive volcanism, but pyroclastic material has not yet been definitively identified in meteorite samples (HEDs) from this body [3]. Preliminary work by David Mittlefehldt has identified what may be pyroclasts in several howardite samples (personal communication). The purpose of this research is to identify, describe, and analyze glasses in howardites and distinguish their origin: impact melt-derived or pyroclastic.

The following table outlines expected differences between the two glass types: impact melt clasts and pyroclasts.

Significance: Impact melt clasts act as representative samples of surface lithologies, the study of which will further constrain the range of compositions that occur on Vesta. Pyroclasts, if recognized as such in HEDs samples, could yield information on eruptive conditions operating in/on Vesta and could indicate a new role for volatile elements on Vesta.

Expected Results: This work will focus on compositional results obtained from electron microprobe analysis. Variation diagrams will help distinguish the two compositionally (i.e., CaO versus MgO, FeO/MgO versus Al_2O_3) and in regard to volatile elements (i.e., Na_2O/CaO versus Fe# and K_2O/CaO versus Fe#). For an example of such diagrams relating to HEDs, see [4]. Impact melt clasts should plot near a howardite composition on such diagrams since they represent pre-existing material on the surface that was impacted. Pyroclasts should plot near a primitive basaltic eucrite composition since they represent the initial melt. Any xenocrysts in the impact melts clasts should have evolved compositions. Phenocrysts in pyroclasts should have primitive compositions. We expect to present chemical results at the meeting.

References: [1] Wilson L. and Keil K. 1997. *Meteoritics & Planetary Science* 32:813–823. [2] Wilson L. et al. 2010. *Meteoritics & Planetary Science* 45:1284–301. [3] Keil K. 2002. In *Asteroids III* pp. 573–85. [4] Mittlefehldt D. W. et al. 1998. In *Planetary materials*. pp. 4–122.

	Impact melt clasts	Pyroclasts
Composition	Howardite-like and mineral-like Evolved melt Heterogeneous	Eucritic-like Initial melt Homogeneous
Volatile-element content	Low	High
Incompatiable-element content	Low	High
Texture	Vitric Vitrophyric Dendritic Partly resorbed clasts Schlerin	Vitric Vitrophyric Dendritic