DWELL TIME AT HIGH PRESSURE OF METEORITES EJECTED FROM MARS.

T. J. Bowling[1], B. C. Johnson[2], and H. J. Melosh. [1]Deptartment of Earth, Atmospheric, and Planetary Sciences, Purdue Univeristy, tbowling@purdue.edu. [2]Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology.

Introduction: The Martian (or SNC) meteorites are currently the only available samples of Mars' surface available for terrestrial analysis, and linking individual specimens in the collection back to their source terrains can significantly increase its scientific value. Because the SNCs were ejected from Mars' surface following a relatively recent crater forming impact or impacts [1], constraining the size of the source crater which ejected the samples is a critical step in identifying their source terrains. Several studies have attempted to use the amount of time martian meteorites have spent at high pressure, or the high pressure 'dwell time' τ, to infer the size of the impactor which ejected them [2-3]. The relation used to make this inference relates τ to the impactor radius R and the impact velocity U as

$$\tau = 2RU^{-1} \quad \text{[Eq. 1]}$$

This relationshipt is based on a misinterpretation of the shock rise time assumed in [4], and does not provide a physical basis for τ. Numerical simulations of hypervelocity impacts provide a much more accurate tool for understanding how τ and R are related.

Modeling: We use the iSALE shock physics code [5-7] to simulate the impact of a 10 km diameter spherical basalt body into a Mars-like basalt target. Because only a small amount of material is ejected at speeds greater than Mars' escape velocity, extremely high spatial resolutions (5 m) are used to resolve this high speed ejecta. We define τ as the amount of time any parcel of material spends above pressures of 1 GPa. In our simulations, τ is calculated to an accuracy of 1 ms.

Results: We calculate τ for material ejected faster than Mars' escape velocity for 3 impact velocities: 7.5, 13.1, and 20 km s^{-1}. In each simulation dwell times vary considerably, are 5-10 times lower than determined by Eq. 1, and are not strongly dependent on impact velocity. Scaling for impactor size, the mass average value of τ (in seconds) is

$$\tau_{ave} = (1.5 \times 10^{-5})R \quad \text{[Eq. 2]}$$

while the maximum value of τ is

$$\tau_{max} = (2.9 \times 10^{-5})R \quad \text{[Eq. 3]}$$

The minimum value of τ in each simulation is indistinguishable from the temporal resolution of 1 ms. Because of the equation of state used here, equations 2 and 3 technically only apply to basaltic SNC meteorites. However, similarity between our results and those from a study using SiO_2 [8] suggest our results can be applied loosely to all Martian meteorites.

References:

[1] Fritz, J et al. (2005) *MAPS*, 40, 1393. [2] Baziotis, I. P. et al. (2013) *Nature Comm.,* 4, 1404. [3] Beck, P. et al. (2005) *Science*, 435, 1071. [4] Melosh, H. J. (1984) *Icarus*, 59, 324. [5] Amsden, A. et al. (1980) *LANL Report*, LA-8095. [6] Collins, G. S. et al. (2004) *MAPS*, 39, 217. [17] Wünnemann, K. et al. (2006) *Icarus*, 180, 514. [8] Johnson, B. C. and H. J. Melosh (2014) *Icarus*, 228, 347.