EXPERIMENTAL INVESTIGATION OF EJECTA EMPLACEMENT ON MARS, O.S. Barnouin[1,2], C.M. Ernst[1] and K. Wada[2] [1]JHU/APL, Laurel MD 20723 (olivier.barnouin@jhuapl.edu); [2]Planetary Exploration Research Center, Chiba Institute of Technology, Japan.

Introduction: Many martian craters possess fluidized ejecta morphologies and topographies indicative of surface flow. These morphologies are usually thought to be the product of surface volatiles [1-8]. However, two other viable processes (Figure 1) have also been proposed: strong atmospheric winds that entrain ejecta [9-14] and deposition by simple granular flow [15]. A combination of these models may also explain the observed morphologies [9, 11, 16, 17]. Each model possesses specific implications for the volatile content and atmospheric properties of Mars.

Regardless of the mechanics involved, it is generally agreed that excavated ejecta at these craters must have flowed across the surface. Several studies have modeled the fluidized ejecta emplacement process as a continuum surface flow, but to this point none of these models match all the aspects of the observed ejecta.

This study presents the first results on the mechanics of ejecta emplacement using the new JHU/APL ejecta emplacement simulator (EESim). The EESim is a large apparatus, capable of throwing sheets of debris 0.9 m in height, 2 m wide, and several cm thick. Such a large mass of material is significantly greater than any ejecta curtain one could create during laboratory impact experiments and are required to obtain a good understanding of the dynamics of granular flows [e.g., 18]. The first set of experiments explore the emplacement of ejecta as a granular flow onto a smooth surface. Later, more complex ejecta and surface material will be considered, including wet ejecta. The data will provide ground truth for ongoing numerical simulations [19] and continuum models. Furthermore, new qualitative and quantitative insights will be obtained on how ballistic ejecta interact with a surface during its emplacement. All these results are expected to provide important new information on the deposition mechanics of the continuous ejecta at planetary scales.

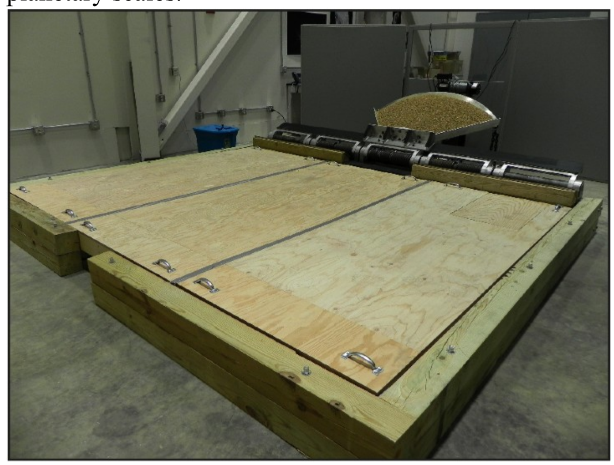

Figure 2. The front of the EESim with its ejecta launcher plate loaded.

Experimental setup: The EESim (Figure 2) consists of an ejecta launcher plate, a series of strong springs, and a target box. The plate, on which debris is

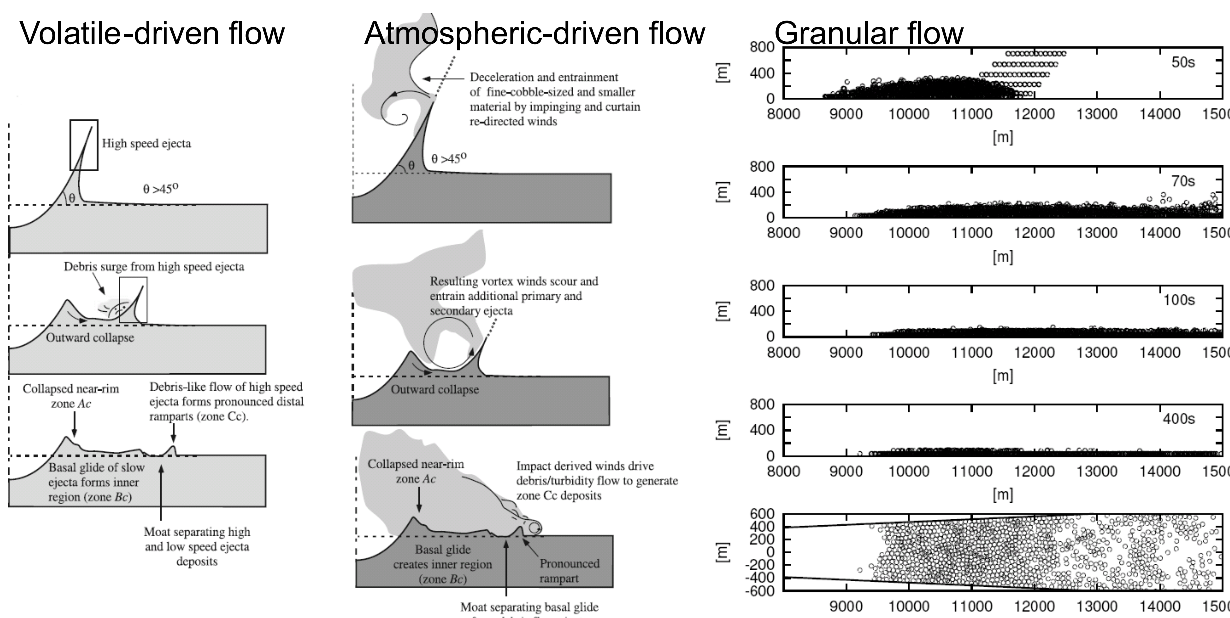

Figure 1: Models for ejecta emplacement that could be responsible for the formation of layered or fluidized ejecta on Mars.

loaded, is curved to reproduce the radial geometry of ejecta. The simulated curtains have velocity distributions and structures that are similar to ejecta curtains generated by impacts. At its maximum speed of 10 m/s, the EESim curtain is approximately equivalent to that generated by a 20 meter-diameter crater, far larger than craters produced during laboratory experiments. The simulated crater size can be changed by varying the launch velocity.

The current experiments keep the launch velocity (Figure 3) constant but change the mass and distribution of the debris to be launched to simulate different portions of an ejecta curtain. The target surface is smooth to investigate ejecta emplacement with minimal target influence. High-speed video, pressure gauges, and laser sheets are used to investigate the detailed physics of ejecta emplacement that influence runout, morphology and topography, including the amount of work lost during the emplacement of the continuous ejecta. The results are used as a first step towards establishing what factors influence ejecta deposition and subsequent flow for a simple set of deposition conditions. For example, the measured energy loss once ejecta first reaches a surface (prior to sliding) improves constraints on the runout efficiency of martian fluidized ejecta. Comparison of this efficiency with that of other large mass movements, such as wet debris flows [e.g., 20], leads to important inferences on whether or not volatiles are required.

References: [1] Carr, M.H., et al. (1977) JGR 82, 4055-4065. [2] Gault, D. E. and Greeley, R. (1978) Icarus 34, 486-495. [3] Mouginis-Mark, P. (1979) JGR 84, 8011-8022. [4] Greeley, R., et al. (1980) Proc. LPSC 11th, 2075-2097. [5] Mouginis-Mark, P.J. (1981) Icarus 45, 60-76. [6] Wohletz, K.H. and Sheridan, M.F. (1983) Icarus 56, 15-37. [7] Ivanov, B.A. (1996). Solar System Research 30(1), 36–50. [8] Baloga, S.M. and O. S. Barnouin-Jha (2006). LPSC 37, #1309. [9] Schultz, P.H. and Gault, D. E. (1979) JGR 84, 7669-7687. [10] Schultz, P.H. and Gault, D.E. (1982) In Geological Implications of Impacts of Large Asteroids and Comets on the Earth, L. T. Silver and P. H. Schultz, editors, 153-174, GSA Special Paper 190. [11] Schultz, P.H. (1992). JGR 97, 11,623-11,662. [12] Barnouin-Jha, O.S. and Schultz, P.H. (1996) JGR 101, 21099-21116. [13] Barnouin-Jha, O.S. and Schultz, P.H. (1998) JGR 103, 25739-25756. [14] Suzuki, A., et al. (2007) GRL 34,doi:10.1029/2006GL028372. [15] Wada, K. and Barnouin-Jha, O.S. (2006) MAPS 41, 1551-1569. [16] Barnouin-Jha, O.S., et al. (2005) JGR 110, doi:10.1029/2003JE002214. [17] Barlow, N.G., et al. (2006) MAPS 41, 1423–1424. [18] Iverson, R.M. (1997) Rev. of Geophys., 35, 245-296. [19] Wada, K. and Barnouin, O.S. (2011) LPSC 42, this issue. [20] Barnouin-Jha, O.(2005) LPI contribution 1273, pp. 21-22.

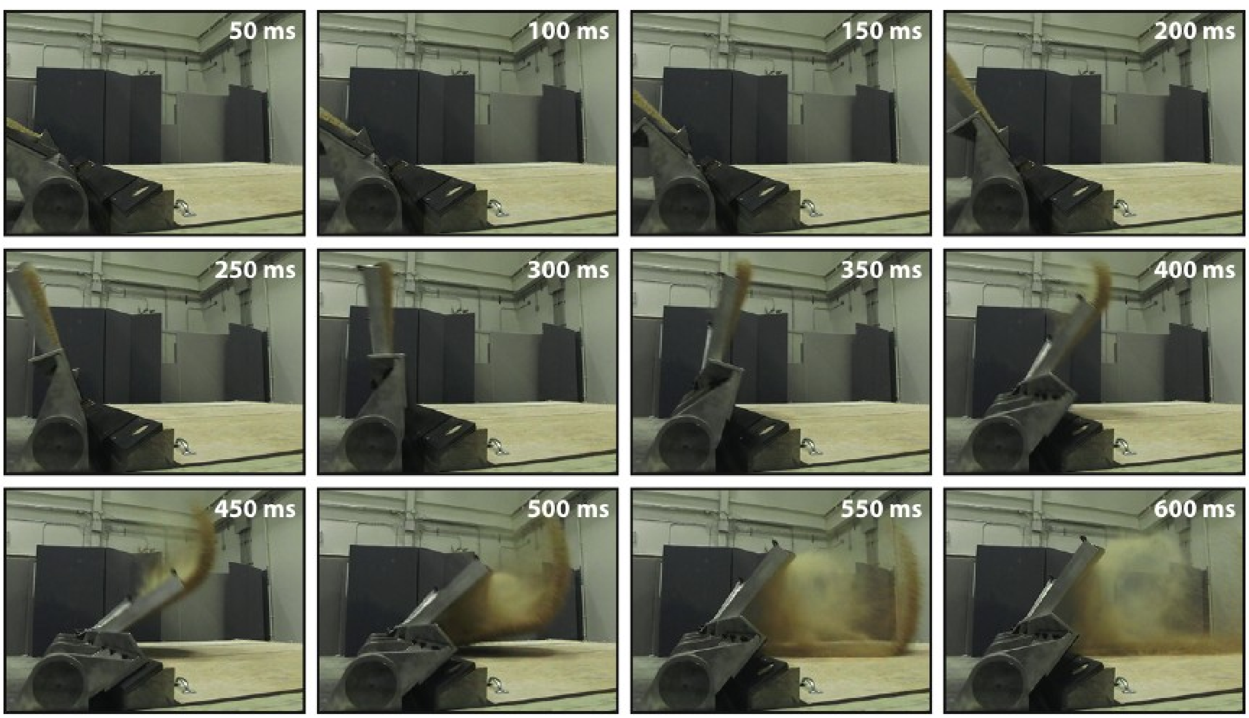

Figure 3. Data from the first EESim experiment showing ejection and emplacement of debris analogous to ejecta. The time elapsed since release of launcher plate is indicated in each frame.