LABORATORY SIMULATIONS OF SURFACE ALTERATION ON SMALL BODIES THROUGH SEISMIC ACTIVITY. S. A. Malanoski[1] and N. R. Izenberg[2], [1]Reservoir High School, 11550 Scaggsville Road, Fulton, MD 20759, (sammalanoski@comcast.net), [2]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, (noam.izenberg@jhuapl.edu).

Introduction: Impacts on small bodies within our solar system generate seismic signals [1]. The small volume of such bodies can cause seismic energy to remain highly concentrated following large impacts. Their low surface gravities also permit even small-magnitude seismic accelerations to destabilize loose regolith resting on slopes and crater walls [1, 2]. As destabilized regolith shifts down slopes, topographic features may undergo substantial alteration, such as decreasing slope angles, or crater degradation and possible erasure.

This process of surface alteration on small bodies is suggested by the NEAR-Shoemaker mission to asteroid 433 Eros [3], which provided numerous images that show down slope regolith movement and a presence of degraded craters, along with a dearth of smaller craters (radius <100m) [4]. This evidence motivates a series of laboratory experiments seeking to clarify and explore the role of seismic shaking in the process of surface modification on small bodies like Eros.

Experiments Using the Asteroid Surface Process Simulator (ASPS): Laboratory simulations are conducted with a shaker table in the Vibration Test Laboratory (VTL) [5]. The ASPS is a Plexiglas box (approximately 1 square meter, .4 meters deep) which we bolt to the shaker table and fill with a regolith simulant. A Plexiglas cover that latches to the box with a series of clasps prevents material from escaping and allows for clear viewing and filming during testing.

The most recent series of experimental runs observed the effects of horizontal impulses on modeled slopes and crater forms within the ASPS. In order to better represent the seismic signals that are actually produced by impacts, the shaker table was programmed to create sine burst shakes. These particular signals are characterized by a series of oscillations that quickly reach maximum amplitude before linearly decreasing (Fig. 1). The signal's magnitude, frequency, and duration can be altered to adjust the wave's characteristics, as desired.

In these runs, plain sand represented a simple regolith. Powder paint of contrasting color covered areas of the surface layer serving as a tracer and an added density contrast in the regolith. Pebbles of varying size, up to a few centimeters, represented boulders and were incorporated into the topography of the simulation.

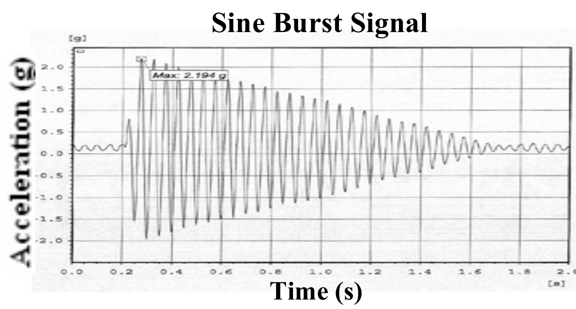

Fig. 1. An example of the characteristic sine burst signal from current testing.

Two sets of tests focused on the down slope movement of particles on a slope of repose. In one set, the slope underwent small sine burst accelerations that increased in magnitude with each run, from 0.4g to 2g. The second set of tests induced repeated accelerations on the ASPS with signals of constant magnitude (1.2g max. acceleration).

Our final set of experimental testing looked at a combination of crater forms as topographic features of interest. We created five main craters with diameters of 12 in, 8 in, 6 in, 4 in, and 2 in, in addition to various small pits. Initially, a low magnitude sine burst impulse (0.25g) jolted the ASPS; each progressive run increased the magnitude of the signal, until it reached full force (2g); at full force, we recorded three successive runs.

Observations: We used a high speed video camera, a regular video camera, and a digital still camera to record the experiments for subsequent analysis. The recorded data allowed us to make effective, direct comparisons between frames and enabled us to trace the movements within selected surface areas.

Slope Experiments. For these tests, we focused on the effects of shaking on one slope that filled the area of the ASPS. A stripe of powder paint sat lightly on the surface layer of sand (Fig. 2). Under the conditions of these tests, shaking significantly decreased the angle of the slope following several shakes, as Fig. 2 illustrates. Small ridges and grooves in the initial slope quickly disappeared after a few runs. The down slope movement of both powder paint and sand was another visible effect of shaking. The majority of powder paint particles moved together with the sand, which shifted down slope with each event. However, several individual particles of powder paint demonstrated continual down slope movement, even after shaking stopped and the sand came to rest. By the end of shaking, nearly all the powder paint congregated against the Plexiglas wall at the foot of the slope, spreading a few inches wider than the stripe's initial width. The sand also buried a number of powder paint particles along the slope, and especially near the bottom wall.

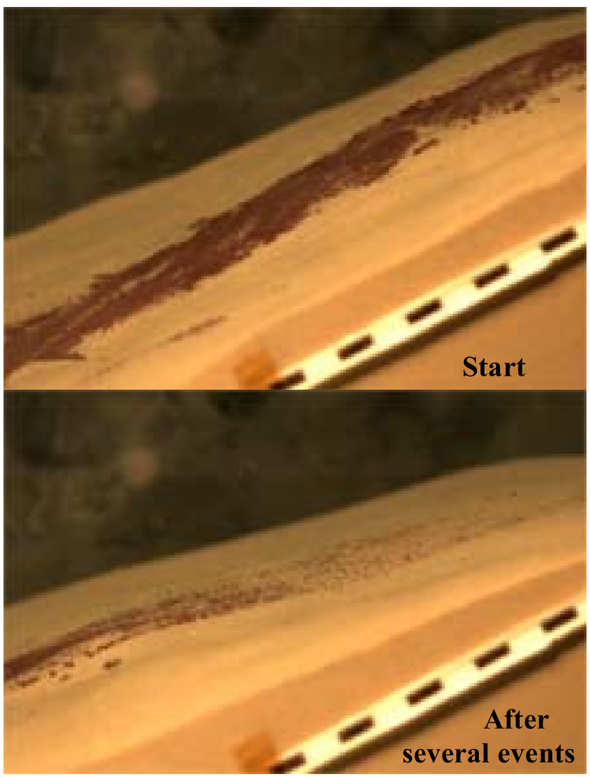

Fig. 2. Repeated seismic shaking on a slope. Accelerations caused down slope movement in both sand and powder paint in addition to a decreasing angle of incline.

Crater Experiments. With this set of experiments, we looked at the effects of shaking on crater forms of varying size (Fig. 3). Several rocks and a layer of powder paint across one area of the crater provided additional objects for observation. Crater rims degraded as a result of repeated shaking, and the craters themselves shallowed. As observed in the slope experiments, most of the powder paint moved with the sand, although individual particles often moved down slope faster than the sand, continuing down slope movement after shaking and sand movement ceased (this effect was more apparent in these runs). After several events, many "boulders," especially those surrounded by concentrated areas of powder paint, were completely buried. Others partially sank and followed the movement of the sand or remained stationary.

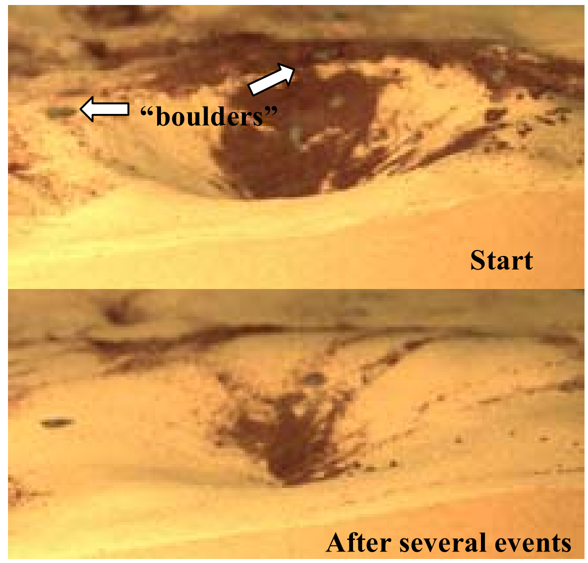

Fig. 3. Constant seismic shaking on large crater form, increasing in amplitude with each event (until repeated events at maximum amplitude). Shaking resulted in softening of crater rims as well as small slope failures, particularly notable in powder paint movement.

Conclusions: In both sets of experiments, shaking resulted in the same types of sand and powder paint movement. In general, the top layer of powder paint moved as the sand. This, in addition to the decreasing slope angles, softening crater rims, and overall shallowing of craters reflected the presence of "ghosted" or degraded craters found on Eros. The individual particles of powder paint that moved downward faster than the sand may suggest slight ponding effects; however, these effects were not pronounced enough to provide an explanation for ponding.

References: [1] Cintala *et al.* (1978), *Proc. Lunar Planet. Sci. Conf. 9th*, 3803-3830. [2] Richardson *et al.* (2005), *Icarus 179*, 325-349. [3] Veverka *et al.* (2001), *Science 292*,484-488. [4] Chapman *et al.* (2002), *Icarus 155*, 104-118. [5] Izenberg and Barnouin-Jha (2006), *LPSC 37*, #2017.

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