Low-velocity impact cratering experiments in granular slopes and a comparison with Vestan craters

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Low-velocity impact cratering experiments are conducted in sloped granular targets to study the effect of the slope angle *theta* on the crater shape and its scales. We use two types of granular matters, sand and glass beads, former of which has a larger friction coefficient $mu_s = \tan(theta_r)$, where $theta_r$ is the angle of repose. Experiments show that as *theta* increases, the crater becomes shallower and elongated in the direction of the slope. Furthermore, the crater floor steepens in the upslope side and a thick rim forms in the downslope side, thus forming an asymmetric profile. High-speed images show that these features are results of ejecta being dispersed farther towards the downslope side and the subsequent avalanche which buries much of the crater floor. Such asymmetric ejecta dispersal can be explained by combining the Z-model and a ballistic model. Using the topographic maps of the craters, we classify crater shape regimes I-III, which transition with increasing *theta* : a full-rim crater (I), a broken-rim crater (II), and a depression (III). The critical *theta* for the regime transitions are larger for sand compared to glass beads, but collapse to close values when we use a normalized slope $theta\hat{} = \tan(theta) / \tan(theta_r)$. Similarly we derive $theta\hat{}$-dependences of the scaled crater depth, length, width and their ratios which collapse the results for different targets and impact energies. We compare the crater profiles formed in our experiments with deep craters on asteroid Vesta and find that some of the scaled profiles nearly overlap and many have similar depth / length ratios. This suggests that these Vestan craters may also have formed in the gravity regime and that the formation process can be approximated by a granular flow with a similar effective friction coefficient.

Reference
Hayashi, K. and I. Sumita, Low-velocity impact cratering experiments in granular slopes, *Icarus* (submitted).

Keywords: Granular slopes, Impact processes, Asymmetric craters, Scaling relations, Asteroid Vesta

