

IMPACTS INTO LATERALLY HETEROGENEOUS SURFACES. J. D. Kendall¹ and H. J. Melosh²¹Purdue University, West Lafayette, IN. (email: kendallj@purdue.edu), ²Purdue University, West Lafayette, IN

Introduction: On the lunar surface, researchers have performed crater counting to get an estimate of the age of the surface[1]. Recent research has used high resolution camera data to count craters along boundaries between different mare and highlands in order to age the surface[2]. These techniques might be affected by incorrect impactor diameter values for small craters along the boundaries between these surfaces. We have proposed a numerical model that tests what happens to crater morphology for impacts along the boundaries of two surfaces that have different strengths, such as on the lunar surface at the boundary between mare and highlands terrain. We tested basic vertical layers in a half space in iSALE 3D. This has allowed us to test if the crater morphology, specifically the final crater diameter, is altered by having areas of weaker material. For small scale crater diameters, on the order of 100 m and less, we anticipate this has a significant effect upon the final crater diameter. However, for larger craters, such as 1 km or 10 km in scale, we do not anticipate any meaningful difference. For a given impact, this proposed model will allow us to better understand how the weaker material will affect the flow of material in the crater during the impact process.

Methods: We used the iSALE shock physics code with the latest iSALE-3D features[3,4]. This is a Eulerian hydrocode and is used to numerically simulate hyper-velocity impacts. In our model we use surface layers that are laterally layered or more specifically two layers each with a different material property whose boundary is a vertical plane. This allows us to simulate the boundary between two surfaces in a simple form. For the two surfaces we use an intact dunite material and a broken dunite material. We chose a simple vertical layer setup where half the surface is intact material and the other half is broken material. The boundary between these layers is where the impact occurs in the simulation. The impactor uses intact dunite material properties. We used the ANEOS equation of state for dunite. We have tested vertical and oblique at 45 and 135 degree impacts, both in the direction of the broken dunite layer and away from the broken dunite layer. These tests had an impact velocity of 11.5 km/s with lunar gravity. The impactor size ranges from 1 m to 10 km in diameter. For oblique impacts, we have offset the impact location uprange by one diameter of the impactor to allow the final crater to be centered on the boundary between the intact dunite and broken dunite layer. For each simulation, we have also conducted a simulation with a homogeneous surface of intact dunite

for the whole half-space. This acts as a control for which we use to compare final crater morphologies.

Conclusions: For large craters we did not see any noticeable effect of the vertical layers. For a 1 km and 10 km diameter impactor impacting at 11.5 km/s compared to an impact into a homogeneous surface shows no discernible difference. This agrees with our initial assessment that the role of broken rock in the surface will be negligible for large scale impactors on order of 1 km and more. In the case of small craters, we see differences on the scale of the size of the initial impactor diameter. Figure 1 shows a vertical impact has an asymmetry to the impact with a deeper and wider flow of material on the broken dunite side. By testing impacts into laterally heterogeneous surfaces and homogeneous surfaces, we are able to use the differences in the crater profiles to conclude the effects heterogeneous surface boundaries have upon final crater sizes.

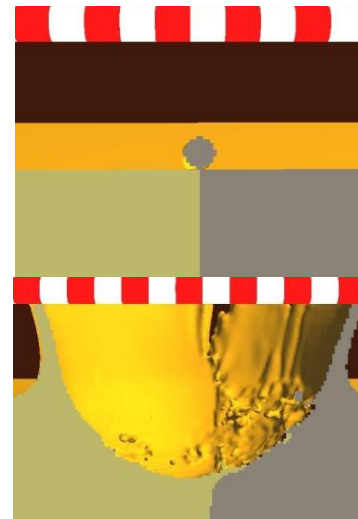


Figure 1: Numerical simulation of a 10 m diameter impactor with 11.5 km/s velocity. The dark material on the right is intact dunite and the tan colored material on the left represents broken dunite. The top image is at $t=0s$ and the bottom is $t=3s$. The red and white scale bar shows the original impactor diameter.

References: [1] Cho, Y. et al. (2012) *GRL*, 39, L11203. [2] Gaddis L. et al. (2011) *LPSC XLII*, Abstract #2584. [3] Amsden, A. et al. (1980) *Los Alamos National Lab Report*, LA-8095:101p. [4] Ivanov, B. A. et al. (1997) *International Journal of Impact Engineering*, 20, 411-430.