NUMERICAL MODELING OF EJECTA DISTRIBUTION AND CRATER FORMATION OF LARGE IMPACT BASINS ON THE MOON

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Introduction: Large impact basins are the most prominent and oldest landforms on the Moon. Although only a relatively small number of roughly ~50-60 basin structures are known, basin-forming impactors clearly dominate over the smaller projectiles in terms of the mass and energy they delivered to the Moon. The impactors penetrate deep into the crust and may even excavate mantle material. They produce large volumes of impact melt and ejecta, which may cover an area with a radius several times larger than the actual basin. Only a few such events may have completely resurfaced the Moon by inverting the crustal stratigraphy, and by emplacing impact melt and originally deep seated crustal or mantel material into the near surface strata. Several attempts have been made to model the formation of impact basins emplyong so-called hydrocodes [e.g. 1-5] and using basin morphology and gravity signature as constraint. The ejecta distribution (thickness of the ejecta blanket as a function of distance) has not been considered due to the relatively poor preservation of the ejecta deposits of the old basins that have been modified by impact gardening. However, in a recent study the ejecta distribution at the youngest impact basin, Orientale, has been reconstructed [6] and serves as additional constraint for numerical modelling of basin formation [7]. We present a systamtic study of ejecta distribution at large impact basins as a function of impactor properties (size and velocity) and target properties (crustal thickness and thermal gradient). The goal is to predict the thickness, composition (crustal or mantle material), and melt content of the ejecta blanket as a function of distance.

Modeling: We used the iSALE [8,9,10] shock physics code to simulate basin formation. We used tracer particles to record the shock conditions and to determine angle and velocity of ejection. Subsequently, we calculated the ballistic trajectories for each tracer to work out the deposition distance. We carried out a suite of impact models: impact velocity: v=10, 20 km/s; impactor diameter L= 50-130 km; crustal thickness h=30, 60 km; thermal gradients according to [1, 2, 3]. We consider both a planar and a spherical target depending on the size of the impactor relative to the curvature of the surface.

Results: Our preliminary results show that the thickness of the ejecta layer decreases proportionally to a power-law with a decay exponent that depends on the thermal gradient. The warmer and softer the target the further material is ejected and the smaller the decay exponent. The same holds true for the excavation depth. Warmer and softer targets are easier to penetrate and the excavation depth is deeper (relative to the transient crater diameter) than for colder and stronger targets. Additionally, the melt production is increased.

References: [1] Ivanov et al., 2010. *GSA Special Paper* 465. [2] Miljkovic et al., 2015, *EPSL* 409. [3] Potter et al., 2013, *JGR* 118. [4] Potter et al., 2012, *JGR* 39. [5] Melosh et al., 2013, *Science* 340. [6] Fassett et al., 2011, *GRL* 38. [7] Zhu et al., 2015, *LPSC* 1832. [8] Amsden, A. et al. 1980, *Los Alamos National Laboratories Report*, LA-8095. [9] Wünnemann K. et al. 2006, *Icarus*, 180. [10] Collins G.S. et al. 2004, *M&PS* 39.