NUMERICAL INVESTIGATION OF COMPLEX CRATER COLLAPSE.

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Introduction: The formation of complex impact craters is not fully understood since standard strength models fail to explain the collapse at the observed simple-complex transition diameter where a significant change in the depth-to-diameter ratio occurs. One of the most successful approaches to explain temporary strength degradation is Acoustic Fluidization (AF, [1], [2]) or the somewhat simplified variant, the Block Model [2], [3], which is based on the assumption that the transient cavity is surrounded by fractured rocks. Such a system of debris are excited by acoustic waves in the wake of an expanding shock wave, and behaves similar to a Bingham fluid with a Bingham cohesion that depends on the amplitude of the acoustic wave, which is a function of time as the acoustic wave attenuates. This study aims at a better understanding of the mechanics of complex crater formation, by constraining AF parameters by means of morphometric crater parameters.

Method: Numerical models have been carried out with the iSALE shock physics code ([4], [5], [6], and [7]). In all simulations we assume the same target setup resembling typical conditions on the Moon: a 50-km gabbroic anorthosite crust, overlying a dunite mantle. The thermodynamic behavior of the crust and mantle are described by the Tillotson equation of state and ANEOS [8], respectively. The mechanical response of rocks against deformation is described by a pressure and damage-dependent strength model [9]. The projectile is assumed to be of dunitic composition, with radii varying between 100 m to 9 km, and an impact velocity of 15 km/s.

Result: We present the results of a systematic numerical modeling study with the iSALE shock physics code, where we tested the effect of the AF parameters on crater morphometry over a broad range of sizes of complex impact structures. Simulations with a similar setup but without the activation of the AF model were also conducted for comparison. Furthermore, we introduce preliminary results on the correlation between the final and transient crater diameter.

We found that the decay time is the most influential parameter causing the largest variations in the final crater morphometry (e.g., diameter and depth), and whether or not a central uplift is formed. A longer lasting decay time best reproduces the observed trend in the lunar crater record [10], and favor the uplift of the central peak. The corresponding impact structures have a depth-to-diameter ratio smaller than ~0.8.

Finally, we derive from the model series with the best agreement to the observed morphometric parameters a relationship between final and transient crater diameter ([11], [12], and [13]). With respect to published scaling laws based on observations we find generally smaller transient-to-final crater diameter ratios in our models. Other sets of AF parameters result in variations up to 20% for the ratio between the transient and final crater diameter. It is important to note that the final and transient crater diameter relation derived from the models without the activation of the AF model is instead in complete agreement with the curves of literature.

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