

CONSTRAINING IMPACT NUMERICAL MODEL PARAMETERS WITH THE HELP OF FRESH SIMPLE CRATERS ON THE MOON. N. C. Prieur¹ and S. C. Werner², ¹Centre for Earth Evolution and Dynamics, University of Oslo, Norway (contact: nilscp@geo.uio.no).

Introduction: Impact numerical model parameters are often tuned with the help of results from small-scale laboratory and/or large explosive cratering experiments [e.g., in 1,2,3]. However, whether model parameters derived from such studies are also adequate to describe larger impact events and if the physical properties in such experiments reflect materials present at the surface of other planetary bodies remains to be tested. At the same time, the complexity of numerical models are increasing, leading to a better description of the crater formation processes. But also leads to a larger number of model parameters, which needs to be tuned. Thus, the quantity of combinations that reproduce a specific impact crater may increase, resulting into a larger number of non-unique results. In a previous abstract [4], we compared three popular model setups, which could be used to replicate a specific simple impact crater under lunar conditions (diameter < ~14–31 km on the Moon [5]). We experience that for a similar projectile diameter, crater diameters could differ by more than 30% depending on the complexity of the strength models and cohesion, friction and porosity values. The answer to which numerical model setup gives the best crater diameter estimates is thus still unknown. In an attempt to answer this question, we make use of the freshest simple impact craters on the lunar surface and a number of morphological parameters describing their shapes. Earlier studies have conducted similar steps [6, 7], however, we here focus on simple impact craters and increase the number of studied geomorphological parameters to compare the numerical models with, including depth-diameter ratios (d/D), middle and upper cavity slopes, cavity shape exponents and rim heights. The goal of this study is to develop a single (or several) model setup(s) that will match the lunar observations over a large crater diameter interval (from tenth of meters to ~14–31 km).

Methods: A database of 1512 rayed impact craters is used [8]. To select only the least eroded craters, this database was re-processed based on the degree of freshness of the craters. The freshness was estimated based on the density of boulders and craters on the continuous ejecta blankets of candidate fresh impact craters, the texture of the ejecta and whether or not rays are visible [9, 10]. 715 craters were found to be of very young age, i.e., low density of craters and large density of boulders on the ejecta blanket. For these craters, we made use of a robust routine developed by Geiger and

Watters [11, 12], which derive morphological parameters all around the detected crater rims (Figure 1).

Results & Discussion: A distribution of fresh simple impact craters with their d/D (for craters with diameter larger than one kilometer) is depicted in Figure 2. For this range of crater diameter, d/D seems not to be influenced by the terrains (mare vs highlands), as low (~0.10–0.20) and large values (>0.20) are observed regardless of the terrains. Such variations in d/D could be the result of different impact bombardment history, emplacement history or origin (impact melt floor, highly brecciated materials on the continuous ejecta blanket or different megaregolith thicknesses). We underline that at large crater diameters (close to the simple to complex transition), a smaller variation in d/D is observed, which could be either due to the smaller amount of fresh impact craters detected due to the larger return period of such events, to the more homogeneous target properties at depth [5], or because the strength of the target is not the major contribution. Additional geomorphological parameters are depicted in Figure 3, and compared to our cohesionless numerical models (describe well sand targets) [13]. Among these results, we observe that crater shapes vary from more conical to paraboloid as crater diameter increases (also seen in [12]) and that d/D correlates with the middle-cavity slopes [14]. Such variations are also reproduced in our numerical models by only tuning the coefficient of friction important during the later modification stage. Geomorphological comparison between more numerical model setups (e.g., rock targets) and observations will be presented at the conference.

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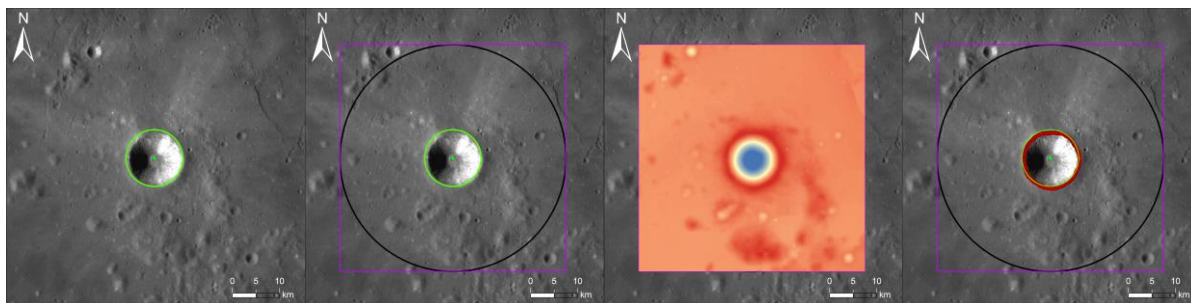


Figure.1 Steps in the routine to detect the crater rim. Similar to [11, 12]. a) The GIS tool craterTool is used to fit an ellipse through the candidate fresh impact crater. b) a square zone that is four times the diameter of the crater is created. c) a DTM [15] is clip for the zone of interest (ZI). d) the routine detects local and maxima elevations in the ZI.

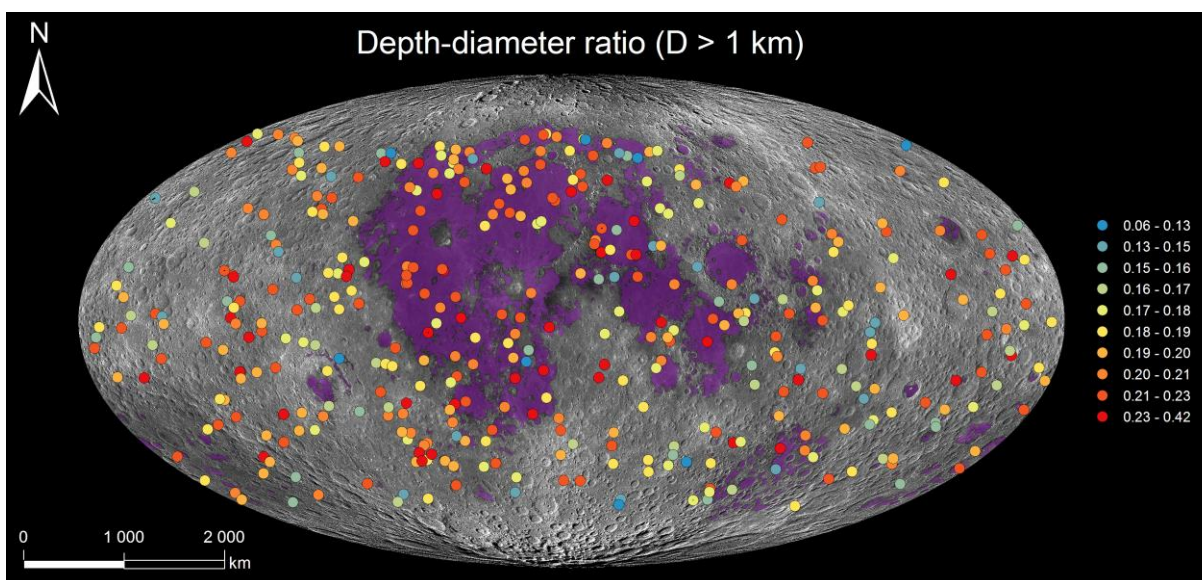


Figure.2 Locations and depth-diameter ratios of fresh simple craters in this study. The surface of the Moon is Mollweide projected. The background image is a global WAC image [NASA/GSFC/Arizona University]).

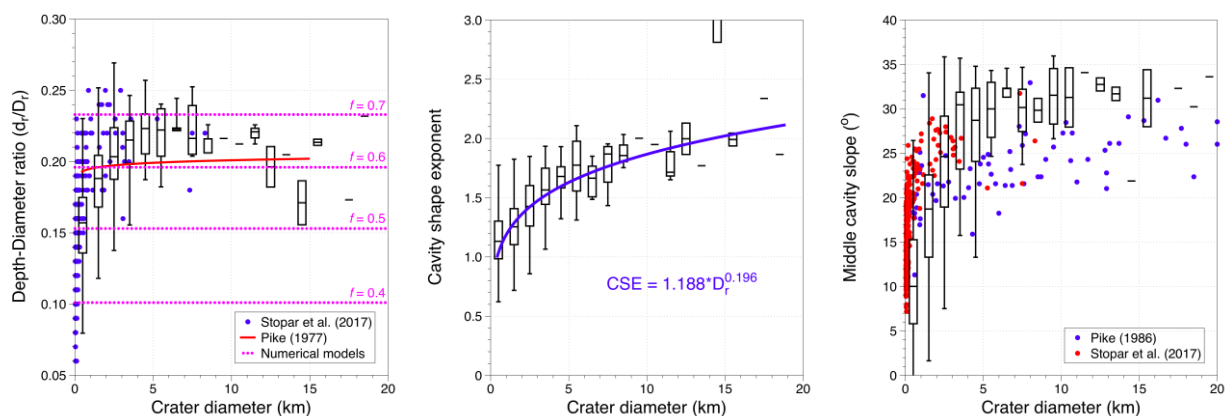


Figure.3 d/D , cavity shape exponents (1~conical and ~2 paraboloid) and slope in function of the crater diameter for the 715 freshest simple craters. Results are also compared against observations (in black) [5,14] and numerical models [13]. The box whisker plots show the min , 25%-, median, 75%- and max percentile for bins of 1 km.