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Dynamics of ejecta during the formation of an impact crater: discrete numerical simulations

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The ability of crater chronometry techniques to assess ages and evolution of planetary surfaces has been recently challenged, especially in the case of using small impact craters because of the expected secondaries. Many studies have detailed the secondaries formed by a well-recognized primary impact in terms of shape and repartition, based on the high resolution imagery available on the surfaces of the Moon or Mars. However, well-used numerical models of impact crater formation which use continuous approaches (hydrocodes) are not always well suited to reproduce the fragmentation processes at small scales that are required to explain the secondary cratering. Because they rely on a mesh, these models, though very efficient in predicting the deformations within the target and the properties of the subsequent crater, cannot take into account explicitly the fragmentation of material, which leads to the ejection of particles of variable sizes.

Therefore, we propose here a new Discrete Element Method (DEM) to simulate impact cratering in order to better understand the fragmentation of ejected material and consequently the secondary craters formed after a primary impact. We model the impact of a small projectile on a target made of 800,000 particles, initially bound together by cohesive forces. We validate this approach by investigating he growth of the transient crater as well its final shape, and compare them to the results of classical continuous simulations. The volume of ejecta and their velocity distribution is compared to existing analogical experiments of impacts in granular materials. The size and trajectory of all blocks of particles ejected during the impact is computed explicitly, which allows us to determine the radial distribution of secondary craters.

Mots-Clés : impact cratering ; ejecta blanket ; secondary craters ; discrete element simulations

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