Numerical Simulations of Crater Formation with Dilatancy for Analysis of GRAIL data

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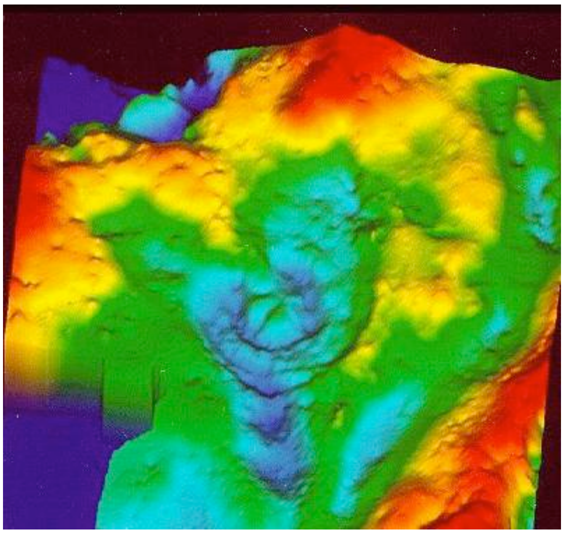

Background The most characteristic geophysical signature of an impact crater is a circular negative gravity anomaly [1], centered over the crater (see image of the Chicxulub crater gravity anomaly). The cause of the gravity low is dilatancy: fracturing and brecciation, induced by the passage of the shock wave and comminution during crater formation, creates pore space between fragments and fractures, reducing the bulk density of the sub-crater material. Calculation of damage accumulation is routine in modern numerical impact simulations [2]; accounting for dilatancy is not. As a result, most impact simulations do not correctly predict density changes beneath an impact crater, which limits the scope for comparison of model results with geophysical data.

Numerical simulations of crater formation with dilatancy would allow direct comparison of simulation results with gravity and seismic velocity anomalies, providing much greater observational constraint on simulation results. This is of particular significance for models of terrestrial craters where the surface expression has been removed by erosion and the geophysical signature is the only vestige of impact. Moreover, numerical simulations of cratering with dilatancy will aid in the interpretation of high-resolution gravity data soon to be collected over lunar craters by GRAIL (http://moon.mit.edu/).

The Project The aim of this project is to develop, test and refine algorithms that account for porosity creation caused by fracturing and shear deformation of rock materials in an impact. Simulations of crater formation using the new dilatancy model will be compared with observed density and porosity variations beneath terrestrial craters to test the model. Further simulations will make predictions about the role of dilatancy in the formation of lunar craters, which will then be tested against high-resolution gravity data returned by the GRAIL spacecraft. Further applications for impact simulations with dilatancy include modeling cratering and disruption of small porous solar system bodies such as asteroids and comets.

The Candidate The successful candidate will join, and be supported by, a dynamic research group with world-class expertise on modelling geophysical flows. The candidate will have the opportunity to develop their career and profile by presenting at international conferences and publishing in high impact journals. Candidates for PhD positions should have a good mathematical background and a good degree in an appropriate field such as earth science, physics, mathematics, computer science or engineering.

[1] Pilkington M & Grieve RAF, 1992, Reviews of Geophysics, 30(2):161—181.

[2] Collins et al. 2004. Meteoritics & Planetary Science, 39: 217—231.

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