Planetary Science Conference

The 5th National Mars Science Seminar

11.10.2024 | https://mars.uj.edu.pl

Modelling magma-induced crustal deformation on the Moon, Mars, and Earth

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Uplifted and fractured terrain and impact craters on the Moon and Mars are inferred to form by the intrusion of magmatic sills and laccoliths at shallow depths in their crust. Analytical and numerical models that are used to deduce magma intrusion characteristics coarsely simplify the host rocks´ response to linearly elastic, however, whereas complex magma-induced host rock deformation is found on Earth. We have simulated highly discontinuous deformation and dynamic fracturing around an inflating laccolith intrusion in the two-dimensional (2D) Discrete Element Method (DEM). For equal rock strength and amounts of intruded magma, our model results show more vertical surface displacement at the gravitational acceleration of the Moon compared to that of Mars, and more at Mars than on the Moon. Rock strength controls the amount of fracturing more than gravity does. Combining observations from intrusions on Earth with our model, helps better understanding volcanism on Mars and the Moon.

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