POLS 2020 Call (National Science Centre Poland) proposal **-** *486889*

DeMo-Planet

Modelling of crustal deformation caused by magma intrusion on terrestrial planetary bodies

POPULAR SCIENCE ABSTRACT

Planetary bodies in the inner Solar System are also called terrestrial planetary bodies and include Mercury, Venus, Earth, Mars and the Moon. When heated rock melts at a depth of several kilometers below the surface of these planetary bodies, magma is produced. This magma then rises and is emplaced at shallow depth in the planetary crust, or it erupts at the surface. During shallow emplacement, magma creates space for itself and it deforms the surrounding rocks. As a result, the planetary surface is deformed as well, and this deformation can be observed by using monitoring stations on the ground on Earth, or by using satellite imaging at other planets.

Both linear and dome-shaped surface features have been found at the surface of terrestrial planetary bodies, and are suggested to result from magma emplacement. Dome-shaped features include a series of impact craters on the Moon that possess uplifted and fractured crater floors. On terrestrial planets, including the Moon, obtaining geological field observations is impossible. Numerical models can be used instead to estimate magma intrusion geometry, orientation, depth and volume. On Earth, such numerical models help assess volcanic hazards and forecast volcanic eruptions. Most existing numerical models of magma emplacement assume that the host rock behaves elastically. This means that, when the magma, here the source of deformation, would be removed again, the rock would return to its original state. Geological observations on Earth have shown, however, that the rock properties and fractures cause that rock to behave non-elastically as well. The impact of simplifying rock behaviour on the modelled magma intrusion characteristics is therefore poorly understood.

This project will use an innovative approach to numerically model the emplacement of magma in fractured rocks using a two-dimensional Discrete Element Method (DEM). This model will be parametrised by using geological observations. Host rock samples will be collected around solidified and exposed magma intrusions in South-West Poland. The mechanical characteristics of these intact rock samples will be measured in the laboratory. Fracture networks in the host rocks will be mapped digitally using state-of-the-art photogrammetry techniques used in field geology. These mechanical characteristics and fracture networks will then be implemented in the 2D DEM model. In this realistic host medium, the emplacement of magma will then be systematically simulated. The model results will be compared to the topography and fracture networks mapped on the Moon by using satellite images, to better understand how important non-elastic behaviour of the crust of the Moon was during magma emplacement.

In summary, the proposed multidisciplinary approach will allow to produce new complex models of how shallow magma emplacement deforms planetary crust. This way, this project will improve the interpretation of surface features on terrestrial planetary bodies caused by magma, as well as improve models of magma intrusion used to reduce volcanic hazards on Earth.