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Detection of lunar floor-fractured craters using machine learning methods

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Abstract

About 200 Floor Fractured Craters (FFCs) have been identified by Schultz (1976) on the Moon, mainly around the lunar maria. These craters are a class of impact craters that are distinguished by having radially and concentric floor-fractured networks and abnormally shallow floors. In some cases, the uplift of the crater floor can be as large as 50% of the initial crater depth. These impact craters are interpreted to have undergone endogenous deformations after their formation.

The recent theoretical model for the dynamics of crater-centered intrusions of Thorey and Michaut (2014) and recent morphological and geological studies by Jozwiak et al. (2012) showed that intrusion of magma beneath the crater floor is the most plausible scenario to produce the morphological features observed at floor-fractured craters. In addition, taking advantage of the resolution of the lunar gravity field obtained from the NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission, in combination with topographic data obtained from the Lunar Orbiter Laser Altimeter (LOLA) instrument, Thorey et al. (2015) showed that their gravitational signatures are also consistent with the intrusion of large volumes of magma below their floors.

Recent estimate from the GRAIL mission confirms the relatively low density of the lunar crust (Wieczorek et al., 2013). Given the large density of the melt inferred from the composition of the mare basalts (Wieczorek et al., 2001), the volume of intruded mantle melt into the lunar crust might be large. Identifying potential sites for magmatic intrusions is important to understand the thermal and magmatic evolution of the Moon. In addition, these shallow magmatic reservoirs tell us more about the structure and geological evolution of the lunar crust and the trajectory of the magma.

Herein, we will discuss the possibility of using machine learning algorithms to try to detect new crater-centered intrusions on the Moon among the ~ 60000 craters referenced in the most recent catalogs (Salamuniccar et al., 2014). In particular, we will use the gravity field provided by the GRAIL mission and the topographic dataset obtained from the LOLA instrument to design a set of representative features for each crater. We will then discuss the possibility of designing a binary supervised classifier, based on these features, to discriminate between the presence or absence of a crater-centered intrusion below a specific crater. First predictions from different classifier in terms of their accuracy and uncertainty will be presented.

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