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Estimated Rock Abundance and Thermophysical Parameters in Oppenheimer Crater on the Moon

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Oppenheimer crater is located in the north-east of the South Pole-Aitken basin (SPA), the largest impact structure on the Moon [e.g., 1]. The crater is ∼215km in diameter and has an estimated age of ∼4.1 Ga [2]. The floor of Oppenheimer shows evidence of dark mantling deposits and a concentric system of graben structures close to the rim of the crater [3]. Image and topography data show that the floor is flat apart from the graben structures and subsequent impacts on the floor. Oppenheimer-U (∼40km) and -H (∼35km) are floor-fractured craters within the north-west and south-east portions of Oppenheimer crater [3].

Dark mantling deposits on the floor are associated with the graben system. [3] estimated an age between ∼3.98Ga and ∼3.66Ga for the pyroclastic activity, based on crater size-frequency distribution (CSFD) measurements on Lunar Reconnaissance Orbiter (LRO) WAC and NAC images.

In this study we compare the mapping results of [3] with temperature data of the LRO Diviner experiment [4] using a numerical model [5, 6]. Nighttime temperature variations are directly influenced by the surface and subsurface thermophysical properties, namely bulk density, heat capacity, and thermal conductivity [7, 8]. These properties can be summarized to a thermal inertia, which represents the ability to conduct and store heat [8]. Low thermal inertia units, such as dust and other fine grained material, quickly respond to temperature changes, which results in large temperature amplitudes between the lunar day and night. On the other hand, high thermal inertia material, e.g. rocks or bedrock, take more time to heat up during the day and reradiate the heat during the night [8].

Relative rock abundances are derived from temperature measurements of the same location at different wavelengths. Brightness temperatures are a function of wavelength and increase with decreasing wavelength [9, 10]. This nonlinearity of the Planck radiance can be used to determine the amount of anisothermal surfaces and, thus, the abundance of rocks within a field of view [e.g., 6, 9, 10].

The thermal maps show low temperatures, thus low thermal inertia and low rock abundances on the flat floor of Oppenheimer. Dark mantle deposits have similar thermal signatures as the floor. Higher rock abundances and thermal inertias are associated with the graben structures close to the rim of Oppenheimer and the floors of Oppenheimer-U and -H. We found that the highest values correlate with fresh craters in the northern part of Oppenheimer. High-resolution NAC images confirm the presence of boulders on the surface.

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