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Lunar Surface Properties from Diviner Eclipse Observations

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The thermal behavior of planetary bodies can reveal information about fundamental processes shaping their surfaces and interiors. Diviner [1] has been mapping the Moon's diurnal temperatures since the Lunar Reconnaissance Orbiter (LRO) arrived in 2009, yielding new insights into regolith formation [2, 3], the distribution of volatiles [4, 5], lunar volcanism [6, 7, 8], and impact processes [9]. The Moon's cooling during eclipse provides complementary information on the physical properties of the uppermost surface layer, which can be used to further investigate these and other processes.

We used data from Diviner's seven thermal infrared spectral channels to measure surface temperatures before, during and after the 8 Oct., 2014 eclipse. In its standard nadir-pushbroom mode, Diviner maps surface temperatures in a ∼6-km swath with a spatial resolution of ∼250 m. Using Diviner's independent scanning capability [11], we also targeted two regions of interest on sequential orbits to create a time series of thermal observations: 1) Kepler crater (-38°E, 8°N) and 2) an unnamed nighttime "cold spot" (-33.3°E, 3°N). Pre-eclipse surface temperatures in these regions were ∼380 K. As a relatively young Copernican-aged impact crater, Kepler was selected to investigate the abundance and size distribution of rocks in the ejecta and interior. Lunar nighttime "cold spots" are anomalous features around very young impact craters, extending for up to hundreds of crater radii, notable for their low temperatures in the Diviner nighttime data [9]. Although their origins are not fully explained, they are likely the result of in-situ disruption and decompression of regolith during the impact process. The selected cold spot (one of hundreds or even thousands on the lunar surface) was located with good viewing ge- ometry from LRO, and had a diameter of ∼10 km surrounding a crater < 1 km in diameter.

At Kepler crater, we observed dramatic differences in the amount of cooling related to the presence of blocky ejecta material. Comparisons of the rock abundance derived from the eclipse measurements can be made to those derived from the standard Diviner diurnal data [2] in order to constrain the rock size distribution.

At a small nighttime cold spot, we observed brightness temperatures during the eclipse that were more than 10K higher than those observed in surrounding non-cold-spot regions. This seemingly paradoxical result implies that the vertical stratigraphy of the Moon's near-surface regolith may be more complex than has been previously appreciated. We are in the process of evaluating several possible explanations for this phenomenon quantitatively.

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