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Rock Concentration and Thermal Inertia of Selected Lunar Study Regions.

K.E. Bauch and H. Hiesinger
Westfälische Wilhelms-Universität Münster, Institut für Planetologie, Münster, Germany (karin.bauch@uni-muenster.de)

Temperature variations of lunar and planetary surfaces are directly influenced by their surface and subsurface thermophysical properties [1, 2]. These properties, namely bulk density, heat capacity, and thermal conductivity, are represented by thermal inertia, which is the ability of a surface and subsurface to conduct and store heat [2]. Materials with a low thermal inertia, such as dust and other fine-grained material, quickly respond to temperature changes, which results in a large temperature amplitude during the lunar cycle. Surfaces with high thermal inertia material, e.g. rocks or bedrock, take more time to heat up during the lunar day and reradiate the heat over extended periods.

We derived maps of thermal inertia from LRO-Diviner nighttime temperature data [3]. The data was binned in one hour intervals with a minimum spatial resolution of 32 pixels/degree. For each surface facet we generated temperature-to-inertia look-up tables using a thermal model that solves the 1-D heat conduction equation. Model temperatures were then compared to measured data to find the best-fitting thermal inertia value. This approach is similar to martian thermal inertia derivations, as described by Mellon et al. (2000) and Putzig et al. (2005) [2, 4].

Due to the relatively large footprints of the used remote sensing data, anisothermal surfaces are observed within the field of view. Consequently, multiple thermal inertia units having variable temperatures are merged to a single observed temperature. However, the brightness temperature is a function of wavelength - it increases with decreasing wavelength. This nonlinearity of the Planck radiance can be used to determine rock concentrations [e.g., 5-7]. Therefore we used our model surface temperatures calculated with different thermal inertia and rock concentrations and compared these results to the LRO-Diviner temperature data at several wavelengths. The results were also compared to high-resolution Apollo and Lunar Reconnaissance Orbiter Narrow Angle Camera (LROC NAC) images.

Most of the lunar surface is covered by rock-free lunar regolith with low thermal inertia [7]. However, units of high thermal inertia are associated with morphologic features. Young impact craters show elevated rock concentrations, especially at the central peak and the crater walls. However, with increasing age their thermal signature decreases as the regolith cover becomes thicker and/or rocks are fragmented by subsequent impacts. Other morphologic features with elevated rock concentrations are rilles, such as Rimae Hadley and Rimae Aristarchus. The elevated rock concentration of Rimae Hadley is in good agreement to the investigation and observation of the Apollo 15 mission.

References:
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