Abundance and characteristics of impact melt on lunar crater central peaks

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The Moon's crust has been penetrated and modified by impact craters of all sizes over its history, ranging from micron-sized pits to basins thousands of kilometers in diameter. These craters provide a valuable three-dimensional view of the lunar crust by exposing material from depth, making material from throughout the crustal column and perhaps even the lunar mantle accessible to remote sensing observations. However, the same cratering processes that expose subsurface material also act to obscure the true local composition by contributing to extensive mixing of the surface at all scales and by producing impact melt, even on the steep slopes of central peak craters (e.g. Ohtake et al., 2009, Dhingra et al., 2016)

Taking two central peak craters (Jackson and Tycho), we isolate impact melt regions on and off the central peaks using the geologic maps of Dhingra et al. (2016) and analyze their spectral, compositional, and physical properties utilizing datasets from the Kaguya Multiband Imager (MI) and Terrain Camera (TC), the LROC Narrow Angle Camera (NAC), and the Diviner Lunar Radiometer.

Consistent with previous work (Ohtake et al., 2009; Kuriyama et al., 2012), we find that the regions of Jackson's central peak identified as impact melt are compositionally distinct, with higher iron (avg. FeO 5%) and lower modeled plagioclase content (avg. plagioclase 79%) than the rest of the very plagioclase-rich central peak (avg. FeO 2%, avg. plagioclase 90%). This indicates that for central peaks like Jackson with substantial impact melt, it is important to exclude melt from compositional analyses to understand the true local composition. However, the impact melts mapped on Tycho's central peak are not substantially different in iron content than the average central peak (both average 6% FeO).

While detailed geologic maps based on high resolution imagery such as Kaguya Terrain Camera or LROC Narrow Angle Camera are an effective tool for eliminating potentially contaminated regions of central peaks, this approach is time consuming and subjective. For large-scale surveys, a quantitative metric for narrowing data to areas less affected by mixing and contamination is needed in order to ensure only the most reliable spectra are interpreted. We investigated three possible discriminators (LOLA/TC slope, Diviner rock abundance, optical maturity) for identifying fresh and uncontaminated surfaces, and find that rock abundance may be a promising metric.

The rock abundance of the impact melt deposits on Jackson's central peak is very low, with average rock fractions near 0.03, in contrast to the rest of the central peak, which has an average rock abundance of 0.056. The rock abundance distributions for the melt regions both on and off the central peak are also skewed strongly to the right, with skewness values greater than 1, whereas the average central peak and mapped boulder regions have skewness values below 1. The slopes and optical maturity values for the impact melt units vary, and do not appear to provide a diagnostic measure of the presence of melt.

While our analysis suggests that rock abundance is an effective discriminator of impact melt, at least for

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Jackson crater, it may only be applicable to central peak craters within a certain age range, as older craters have much lower rock abundances, and regolith development throughout the central peak might mask the anomalously rock-free signature of melts. Efforts are underway to map impact melt on older central peaks and compare melt rock abundance distributions with average central peak values for these more weathered craters.

Ohtake, M. et al. (2009) *Nature, 461*, 236-241. Kuriyama, Y. et al. (2012) *LPSC 43*rd, Abstract #1395. Dhingra, D. et al. (2016) *Icarus, 000,* 1-14.

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