DISTRIBUTIONS OF IMPACT MELTS WITHIN LUNAR COMPLEX CRATERS JACKSON AND TYCHO.

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Introduction: The formation process of complex impact craters with central peaks has not been understood well [1]. Recent studies suggest that there seems to be smooth surface material not only on the floors but also on the central peaks in several lunar craters, suggesting an impact melt [2, 3]. However, there is no clear evidence that directly indicates impact melts on the central peaks. In this study, we analyzed both occurrences and the composition of impact melts within two relatively fresh lunar complex craters, Jackson and Tycho, by using the spectral data of the Multiband Imager (MI) on SELENE and the image data from the Lunar Reconnaissance Orbiter Camera.

Jackson and Tycho: Jackson (71km in diameter) is located in the far-side highlands (22° N, 197° E). Tycho (85km in diameter) is located in the southern near-side highlands (43° S, 11° W). Both of them are Copernican-age complex craters. In Jackson, there is a central peak whose slopes are brighter and summit is darker in reflectance. The origin of this darker unit is unclear, but it is suggested to be a mega-regolith-layer or impact-melt origin [3]. Tycho also has a central peak, which is suggested the existence of impact melts on it [2, 3].

Method: Each mineral or impact melt exhibits unique spectral absorption depending on their compositions. To estimate the mineralogy, we used the SELENE MI, a spectral imager with spectral bands of 415, 750, 900, 950, and 1000nm (visible), and 1000, 1050, 1250, and 1550nm (near-infrared). Spatial resolution of MI is 20m (visible) or 62m (near-infrared) per pixel at the nominal altitude (100km) [3]. We generated a color-compositional mosaic in which red is assigned to a continuum-removed absorption depth at 950nm; green, to that at 1050nm; and blue, to that at 1250nm. We identified impact melts and other minerals by comparing spectral absorption bands from the MI data and the RELAB Spectral Database (Apollo samples) [4]. Topographic data was also derived from MI, from which we generated a slope map within the craters. In addition to SELENE data, we used Lunar Reconnaissance Orbiter Camera (LROC) image data whose resolution is 0.5m per pixel [5] to identify impact melts with flowing structures or droplets.

Results: The color-compositional images indicate that these primarily have three colors: yellow, blue, and greenish (Fig. 1 a). Comparing the topographic data of these central peaks, the slopes of the blue zones, which have plagioclase spectra, are steeper than those of the yellow zones, but the slopes of the greenish zones, which are in the floors and on the central peaks, are much gentler than those of both the yellow and blue zones. MI spectral data (Fig. 1 b) suggest that yellow areas have pyroxene absorption features, and blue areas exhibit plagioclase patterns, which is consistent with [3]. Spectral data indicate that the greenish zones have impact-melt-glass absorption patterns. There is no clear boundary of absorption patterns between yellow and greenish zones, but they change continuously.

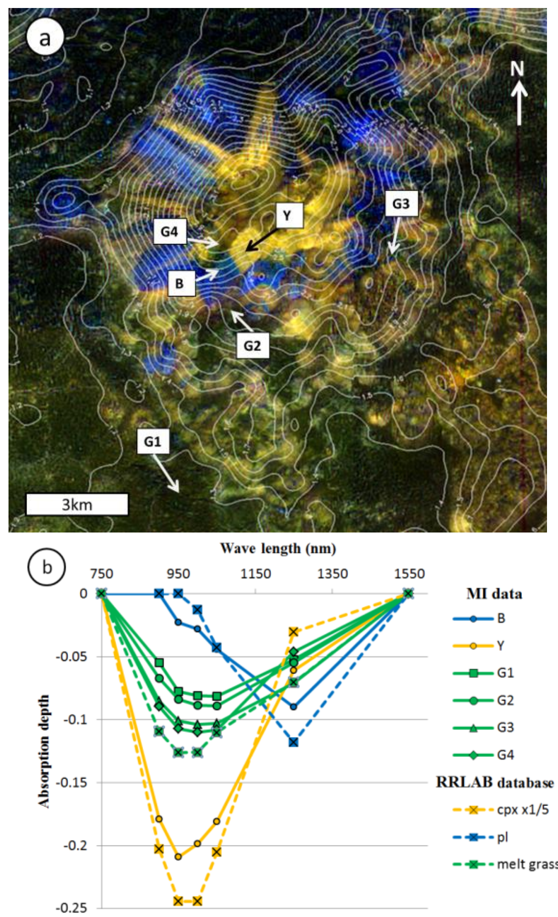

Fig. 1 a) MI color-composite image with contours of the central peak of Jackson. Each contour interval is 100m. **b)** MI spectral absorption data of the central peak of Jackson (B: blue, Y: yellow, and G1-4: greenish zone) and RELAB spectral database data (cpx: clinopyroxene from 12063, pl: plagioclase from 76535, and melt glass: 67095 impact melt glass) [4]. The blue area exhibits a plagioclase pattern (B), and the yellow area, a pyroxene-like pattern (Y). The others have melt-glass-like patterns (G1-4). The point G4 is in the floor and the others are on the central peak.

LROC data reveals smooth surfaced melt patches, melt lobes, and cooling cracks on the central peaks as well as in the floors and on the wall terraces in both of Jackson and Tycho (Fig. 2), and there was no droplet pattern. Many of these melt-related features are found in greenish zone and were observed in the yellow area in the MI color mapping.

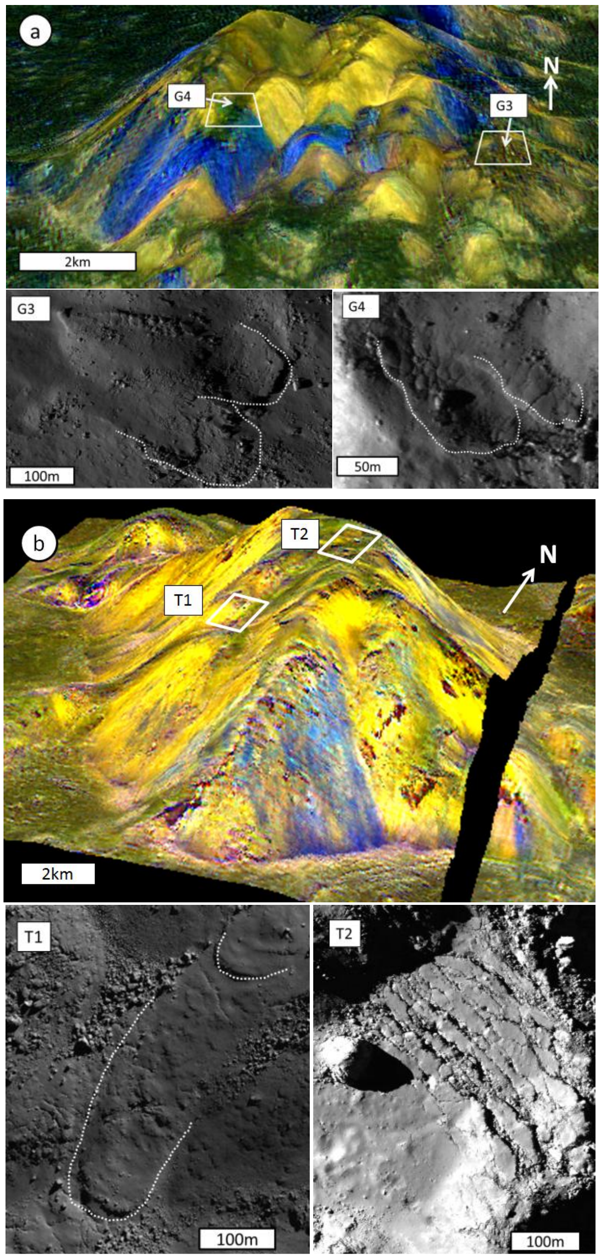

Fig. 2 a) MI color-composite and bird's-eye-view image, and LROC NAC images (G3 extracted from frame ID M115027277LC, and G4, M103223791LC) of the central peak of Jackson. Figure G3 depicts impact melt lobes, and Fig. G4, lobe and levee-like structures. The points G3 and G4 correspond to those of Fig. 1. **b)** MI color image of the central peak of Tycho with a bird's-eye view, and LROC NAC images. Fig. T1 exhibits impact-melt lobes, and Fig. T2, cooling cracks. Each T1 and T2 are extracted from frame ID M111661378LC and M104584909LC.

Discussion and Conclusions: The extent of the melting features observed by LROC and the MI spectral data of the two craters demonstrate that there are impact melts on the central peaks. There are two possible ways for these impact melts to have formed: central peaks uplifted through the already expanded melt sheets, or ejected impact melts flowed down after peaks uplifted. The greenish zones have spectra of impact melt glass, while yellow zones have pyroxene absorption patterns. However, they change continuously. These spectral similarities and occurrences of melting morphologies suggest that yellow zones are also of impact melt origin. Therefore, the central peaks uplifted from under the impact melt sheets because massive, homogenous melts covered the peaks, and there are no droplet features. This assumption is consistent with the possibility suggested by [1]. Furthermore, we believe these yellow zones were generated by crystallization of impact melt or that they are partially melted material. Considering the distributions of yellow and greenish zones, it is possible that surfaces of the melts flowed down from steeper sloped areas, while the underlying crystallized or partially crystallized melt, which has high viscosity, remained on the relatively steeper slopes corresponding to yellow zones. The impact melts remained at the greenish, shallowest sloped area, and the surface became quenched glass.

We think that more investigation of the distribution or cooling rate of the impact melt can constrain the time scale of uplift of central peaks and the formation process of complex craters.

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