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Timescale of the cetral peak formation suggested by impact melt distributions within lunar complex craters

KURIYAMA, Yutaro[1*], OHTAKE, Makiko[2], HARUYAMA, Junichi[2], IWATA, Takahiro[2]

[1]Earth & Planet. Sci.,Univ. of Tokyo / ISAS, JAXA, [2]ISAS, JAXA

Introduction: There have been many studies on impact cratering, but the formation process of complex craters with central peaks has not been understood well. The timescale for the rise of central peaks has been discussed on the base of observation of the terrestrial impact structures whose impact melt sheets surround the central uplift [1, 2]. However, 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 [3, 4]. But there is little description that how impact melts extend on the central peaks. In this study, we analyzed both occurrences and the composition of impact melts on the central peaks of two relatively fresh lunar complex craters, Jackson (22N, 197E, 71km diameter) and Tycho (43S, 11W, 85km diameter), in attempt to constrain cratering formation.

Method: Each mineral or impact melt exhibits unique spectral absorption depending on their compositions. We used the nine spectral bands data (415-1550nm) of the Multiband Imager (MI) on SELENE [4] to estimate mineralogy by comparing with the data from the RELAB Spectral Database (Apollo samples) [5]. Topographic data was also derived from MI. In addition, we used Lunar Reconnaissance Orbiter Camera (LROC) image data whose resolution is 0.5m per pixel [6] to identify impact melts with flowing structures or droplets.

Results: Based on the MI spectral and topographic data, there are primarily three zones on the central peaks: the steepest slope zones with the plagioclase spectral absorption pattern, the intermediate slope zones with the pyroxene pattern, and the gentler zones with the impact-melt-glass pattern like floor-melt pattern. There is no clear boundary of absorption patterns between pyroxene and melt-glass zones, but they change continuously.

LROC data revealed 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, and there was no droplet pattern. Many of these melt-related features were found in the zones which have melt-glass spectral pattern and were also observed in the pyroxene zones.

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. Since impact-melt-glass zones and pyroxene zones exhibit spectral continuities and melting morphologies, we consider that both of these zones are 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.

Melosh and Ivanov (1999) explained that central peaks had formed before impact melt sheets solidified, since melt sheets extend around the peaks [2]. This study, however, exhibits the impact melts on the top of the central peaks. Therefore, we consider that central peak formation of craters of these size are not before melts solidification but almost same timescale within a few minutes.

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