Ejecta distributions and secondary craters of Tycho crater: effects of an oblique impact

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We have undertaken a new analysis on a lunar crater Tycho using remote sensing data in an attempt to verify the recent results of theoretical and experimental studies We have undertaken a new analysis on a lunar crater Tycho using remote sensing data in an attempt to verify the recent results of theoretical and experimental studies on oblique impact. Tycho is one of the most typical craters formed by an oblique impact.

We used a Clementine UVVIS multi-spectral mosaic image, a UVVIS optical maturity parameter (OMAT) image, and data taken by an earth-based imaging spectrometer named as 'Akita Lunar Imaging Spectrometer (ALIS)'.

We divide Tycho ejecta and related features into the following units: blocky ejecta, continuous ejecta, dark ring, fresh ejecta, and glassy ejecta at downrange.

The continuous ejecta extends outward 50 to 110 km, which are corresponding to 1.2 to 2.6 crater radius from the crater rim. The most extensive directions of the continuous ejecta are northeast and southeast. The dark ring extends 50 to 70 km, corresponding to 1.2 to 1.6 crater radius from the rim.

There is a ring of mature halo of glassy melt material just outside of the rim. Based on the OMAT image analysis, the dark ring extends 50 to 70 km, corresponding to 1.2 to 1.6 crater radius from the rim.

The OMAT image shows a bright fan-shape fresh ejecta distribution. The extents of the fresh ejecta are 140 km in west, 200 km in east, and 260 km in northeast and southeast from the rim, corresponding to 3.3, 4.7 and 6.1 crater radius respectively. Laboratory experimental results are consistent with our observational results that the distributions of the ejecta farther from the crater rim are more asymmetric. Secondary craters are more dense and more elliptical in shape in downrange. This result also agrees well with the experimental results.

In addition to the dark ring around the crater rim, another low OMAT unit with a fun-shape is distributed on the eastern area of Tycho. The five-point spectra of the UVVIS image and the ALIS spectra of this unit are identical to those of the dark ring, especially the east half of the ring. It is suggested that a glassy material is extensively distributed to the downrange direction, even beyond the continuous ejecta region. A numerical modeling on a terrestrial crater, Ries in southern Germany shows a fan like distribution of impact melts in the downrange direction of oblique impact. The observed trend of the material transportation is in good agreement with the result of the numerical simulation.