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Distribution and model ages of impact melt pools at the lunar crater Tycho

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Abstract

In addition to producing a new, more detailed geological map of the lunar crater Tycho, we made a map of all melt pools within our study area. The mapped distribution of meltpools is consistent with the formation of Tycho as an oblique impact from the southwest, as proposed by [1,2]. The melt pool map allows a detailed look at the spatial and surface area distributions of melt pools. Our melt pool map also confirms that pre-existing topography is an important control on the spatial distribution of melt pools, as suggested by Hawke and Head [3]. Crater size-frequency distribution (CFSD) model ages show discrepancies between absolute model ages of the ejecta blanket and the melt pools [4,5]. The apparent absolute model ages measured for melt pools at Tycho crater are younger than the ejecta blanket. However, the impact melt pools and ejecta blanket should have formed at about the same time [e.g.,6].

1. Introduction

Using data collected by recent lunar missions, we produced a new detailed geological map of the young Copernican crater Tycho (Fig.1) to improve and refine the Apollo-era map of Pohn (1972) [7]. We used high-resolution Lunar Reconnaissance Orbiter Camera (LROC) and Selenological and Engineering Explorer (SELENE) Terrain Camera (TC) images for detailed mapping, stratigraphic investigations, and dating of geological units with crater size-frequency distribution (CFSD) measurements [8]. One aspect of our mapping campaign involved generating a detailed geological map showing the distribution of melt pools in the study area (Fig.2).

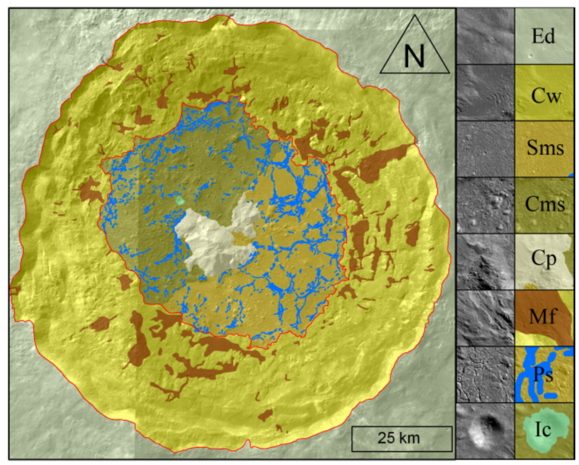

Fig.1: Geological map of Tycho crater superposed on SELENE-TC mosaic.

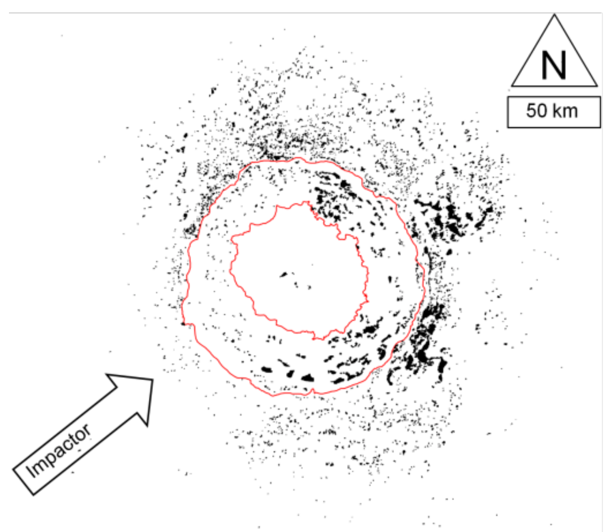

Fig.2: Map of distribution of impact melt pools at Tycho crater.

2. Geological Map

As shown in Figure 1, Tycho crater is surrounded by Ejecta deposits (Ed). The crater walls (Cw) are terraced and display most of the melt flows (Mf) associated with Tycho. The melt flows are associated with the impact melt, rather than remnant volcanic features [4]. The polygonal structures (Ps) show less maturity on false-color images then the rest of the melt sheet, possibly due to less space-weathered material visible through the cracks. The cracks may be the result of the cooling process of the melt sheet or relief features due to underlying morphology [e.g., 9]. The melt sheet on the crater floor is divided into two units. One unit shows a smooth surface (Sms), whereas the other unit exhibits a chaotic surface (Cms), with bulges and wrinkles. A few larger impact craters (Ic) superpose Tycho.

3. Melt Pool Distribution

The majority of the impact melt pools at Tycho are found outside the crater rim and show surface areas of less than 1 km². These small melt pools are mostly homogeneously distributed around the crater, with the exception of the zone of avoidance related to the impactor path from the SW (Fig.2) [1,2]. With increasing distance from the crater center, the melt pools tend to get smaller in size (Fig.3). In addition, the total surface area of impact melt pools declines with distance from the crater (Fig.3). Melt pools with larger overall surface areas are clustered in the ENE and ESE of Tycho crater, likely influenced by preexisting topography. The occurrence of an oblique impact often shows, that the most extensive melt deposits are in the inferred downrange direction. Although the angle of incidence is important for the distribution, other factors may be important as well. Melt pools at large distance from the crater rim suggest a major pre-existing topographic low in that direction. This shows that pre-existing topography and obliquity of impact are both important for the melt pool distribution [3].

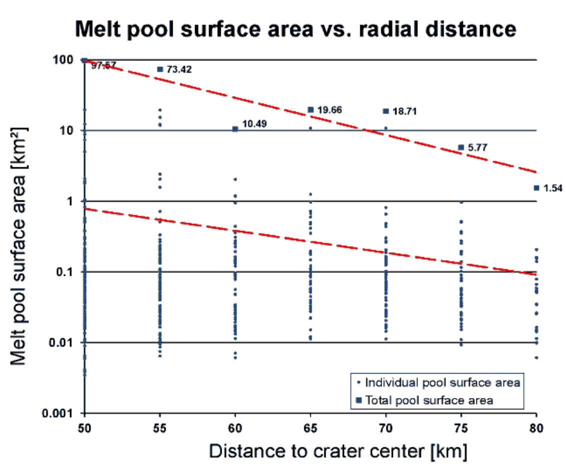

Fig.3: Melt pool surface area versus distance from crater center. Trendlines are shown in red.

4. Melt Pool Model Ages

CSFD measurements at young lunar craters are important for helping us better understand the impact rate over the last billion years [4]. Absolute model ages derived from CFSD measurements of different melt pools give ages between 24.2 ± 5.6 Ma and 80.0 ± 14.7 Ma, whereas our model age for the ejecta blanket is 119 ± 12 Ma [e.g.,4,5]. One interpretation of different model ages between ejecta blanket and melt pools is, that they have different target properties, i.e., the melt pools could be less porous and stronger [4,5]. Self-secondary cratering might also cause differences in CSFDs [10,11,12].

5. Conclusions

Based on our new melt pool map, we find that the distribution of impact melt pools is consistent with an oblique impact from the southwest, as proposed by [1,2], and confirm that the largest melt pools occur in preexisting topographic lows as observed by [3]. We also find that melt pools decrease in size and total area with increasing distance from Tycho. The derived model ages of the melt pools are 30% younger in age than the model age for the ejecta blanket [4] of Tycho crater.

References

[1] Schultz, P.H. (1976), Moon Morphology, p. 641.
[2] Morris, A.R. et al. (2000), LPSC XXXI, #1828.
[3] Hawke, B.R., & Head, J.W., (1977), Impact melt on lunar crater rims, pp. 815-841.
[4] van der Bogert, C.H. et al. (2010), LPSC XLI, #2165.
[5] Hiesinger, H. et al. (2012), JGR, doi:10.1029/2011JE003935.
[6] Osinski, G.R. (2004), EPSL, vol. 226, p. 529-543.
[7] Pohn, H.A. (1972), Geologic map of the Tycho Quadrangle of the Moon, Miscellaneous Investigations Series - U. S. Geological Survey.
[8] Krüger, T. et al (2012), EGU, Vol.14, EGU2012-10988.
[9] Ashley, J.W. et al. (2012), JGR, in press.
[10] Shoemaker, E.M. et al. (1968), Surveyor 7 Mission Report. Part 2 - Science Results, Tech. Rep. 32–1264, pp. 9–76.
[11] Plescia, J.B. et al. (2011), LPSC XLII, #1839.
[12] Zanetti, M. et al. (2012), LPSC XLIII, #2131.