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Tycho Crater Distal Impact Melt-Flow Candidates

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Abstract

In this preliminary study, we identified a total of 144 candidates for distal Tycho crater impact melt flow deposits. 143 of the candidate regions were between 2.8 and 10.9 crater radii from the center of Tycho crater, with one outlier feature at a distance of 25 crater radii. These impact melt features are characterized by raised, block-rich margins and cracks generally perpendicular to the interpreted direction of flow—often back along the radial direction to the parent crater, down Tycho-facing slopes. The majority of candidate impact melt deposits were accompanied by nearby secondary craters clusters, identifiable as belonging to Tycho crater by the radial direction of the chains, herringbone dunes, and downrange braided textures.

1. Introduction

Tycho crater (diameter ~85 km) is among the largest of the young, bright-rayed craters on the Moon.[1] Analysis of Tycho crater rays has played an important role in our understanding of distal ejecta facies, as well as the emplacement and persistence of high-albedo lunar rays.[2,3] Of particular recent interest is the role impact melt plays in the ejecta process.[4-9] The presence of impact melt in proximal regions, such as within the parent crater and in its continuous ejecta blanket is well-documented.[4-5,7-8] Recent work by Krüger et al. (2016) mapped Tycho impact melt in these proximal regions, finding a concentration of melts in the continuous ejecta blanket to the northeast and southeast, consistent with a moderately oblique Tycho impact direction from the west-southwest.[5]

Impact melt ponds have also been reported in craters roughly antipodal to Tycho.[6,10] Bray et al. (2018) also examined the impact melt distribution from the lunar crater Pierazzo (diameter ~9 km), reporting the presence of impact melt deposits scattered among other ejecta facies—also for distances of approximately 10 crater radii from the parent.[9]

2. Data and Methods

We present results of a survey of the presence of impact melt deposits along the main albedo-bright Tycho crater rays identified by Krüger et al. (2016).[5] Candidate Tycho impact melt flow deposits were identified in LROC NAC mosaics, using the web-based LRO Quickmaps tool. The LRO Diviner Rock Abundance map was used to identify regions in which melt flow deposit candidates might be found. Not all candidates reported here had elevated rock abundance values, but those that did not were located near other melt flow candidates that did exhibit rock abundance values elevated relative to the background. Our preliminary studies identified 144 melt deposits, strongly concentrated along the northwestern and the southeastern Tycho rays. The lack of distal melt deposits along the other rays supports Krüger et al. (2016)'s interpretation of an impact direction for Tycho crater from the southwest, as well as the moderately oblique angle of impact.[5]

We also examined the presence of three categories of morphologies (raised margins, blocky material, and cracks) by distance from the center of Tycho crater (e.g., Figure 1). 19 candidate impact melt flow deposits were identified between 2.8 and 4 crater radii. 63% had distinct margins; 95% had blocky material; 68% exhibited cracks. 91 candidate impact melt flow deposits were identified between 4 and 8 crater radii from the center of Tycho. 80% had distinct margins; 92% had blocky material; 80% exhibited cracks. 34 candidate impact melt flow deposits were identified beyond 8 crater radii from the center of Tycho. 79% had distinct margins; 97% had blocky material; 91% exhibited cracks.

3. Summary and Conclusions

The relationship of these melt flow deposits to other ejecta facies within the Tycho rays are also of interest. Martin-Wells et al. (2017) investigated the geomorphology of regions of high radar Circular Polarization Ration (CPR) features, oriented radially to Tycho crater, interpreting the associated deposits as blocky material on the radar wavelength scale (13 cm) that had been ejected during the formation of Tycho secondary craters and swept asymmetrically downrange by dry debris flows.[11] Our work supports the interpretation of deposition of mixed debris and melt, often in complex stratigraphic relationships with the secondary craters themselves. Future work will include an examination of the extent of self-secondary cratering on this melt deposits, as reported by Plescia and Robinson (2019).[4]

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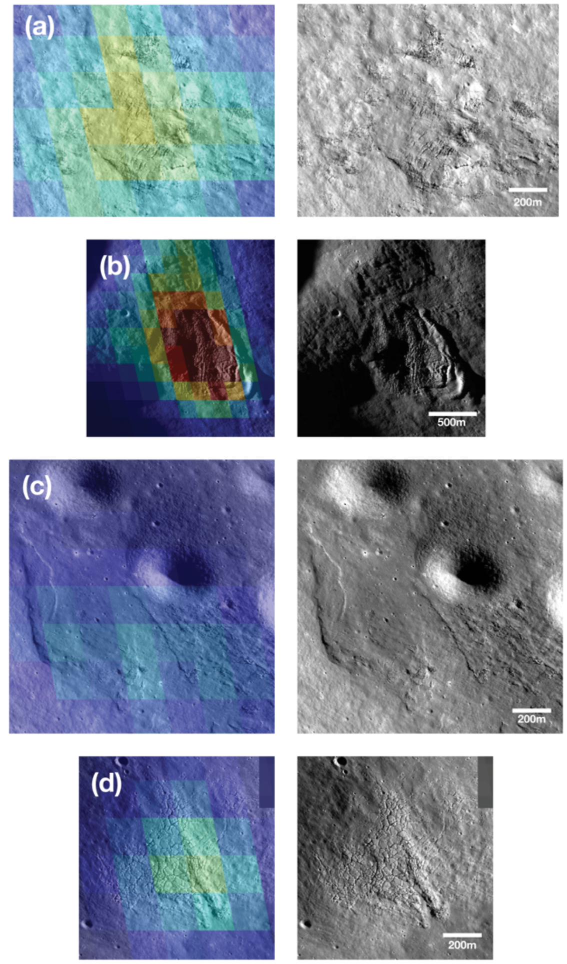

Figure 1: LRO Quickmap images of four candidate impact melt deposits. Right column is mosaiced LROC NAC imagery; left column is overlain by the LRO Diviner Rock Abundance map. All four candidate melt deposits pictured exhibit raised margins, blocky material, and cracks, and are located on the interior, Tycho-facing walls of Wurzelbauer (c-d) or Wurzelbauer D craters (a-b). (a) 36.27953 S, 341.82532 E; 6.252 Tycho radii from the center of Tycho crater. (b) 36.37009S, 341.90087E; 6.174 Tycho radii from the center of Tycho crater. (c) 32.95282 S, 343.19037 E; 7.996 (d) 33.3856 S, 342.91926 E; 7.769 Tycho radii from the center of Tycho crater.