**Distal Impact Melt Flow Contacts with Tycho Secondary Crater Chains.** K. S. Martin-Wells¹, J. Partee¹, and J. Nebel-Crosson¹ Ursinus College (Pfahler Hall, 601 E. Main Street, Collegeville, PA 19426, kmartinwells@ursinus.edu).

**Introduction:** Tycho crater (diameter ~85 km) is among the largest of the young, bright-rayed craters on the Moon.

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. Of particular recent interest is the role that impact melt plays in the ejecta process. The presence of impact melt within parent craters and in their continuous ejecta blanket is well-documented.

Krüger et al. (2016) reported a concentration of Tycho impact melts in its continuous ejecta blanket to the northeast and southeast, consistent with a moderately oblique Tycho impact direction from the west-southwest. Impact melt ponds have also been reported in craters roughly antipodal to Tycho.

Bray et al. (2018) reported impact melt deposits from the lunar crater Pierazzo (diameter ~ 9 km) among its other ejecta facies out to distances of approximately 10 crater radii.

We present results of a survey of impact melt deposits along the main albedo-bright Tycho crater rays identified by Krüger et al. (2016). This investigation revealed a total of 143 regions with impact melt morphologies, located at distances between 2.8 and 10.9 crater radii from the center of Tycho crater. Among the melt flow morphologies identified were blocky margins, as well as cracks or wrinkles oriented perpendicular to the interpreted direction of flow. Observed flow directions were typically down Tycho-facing slopes. The majority of melt features were located in proximity to Tycho secondary crater clusters—identified by their herringbone dunes, downrange braided textures, and the orientation of the crater chains, radially to Tycho. Due to the location of these melts and their spatial relationship to these secondary facies, we associate them with the Tycho impact.

**Data Collection:** Impact melt flow deposits were first identified in LROC NAC mosaics, using the web-based LROC Quickmaps tool. The LRO Diviner Rock Abundance map was used as a proxy for regions in which melt flow features might be found. However, some of the 143 regions identified have no obvious signature in the Rock Abundance map. Our preliminary studies identified 144 melt deposits, strongly concentrated along the northwestern and southeastern Tycho rays. More detailed analysis of these impact melt deposits was undertaken with the JMars desktop software program. The presence of three categories of melt morphology (raised margins, blocky material, and cracks) was catalogued and sorted by distance from the center of Tycho crater. 19 impact melt flow deposits were identified between 2.8 and 4 crater radii.

**Figure 1.** Detail of LROC NAC product M165945369, showing the southeastern extent of a flow of Tycho impact melt down the center of a narrow valley west of Heinsius G crater.

63% had distinct margins; 95% had blocky material; 68% exhibited cracks. 91 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 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.

**Analysis:** Of the impact melts identified in our survey, nineteen regions were located on the Tycho-facing slopes of Heinsuis Q crater and slightly further to the north, on the terrain to the west of Heinsuis G. These regions are straddled between two prominent chains of Tycho secondary craters. Numerous examples of close contact between flow facies and secondary craters can be found in a long, narrow valley located just west of Heinsuis G crater. A long melt flow deposit (~13 km) runs down the center of the valley, which is roughly parallel to the Tycho secondary chains located to the east and west (Figure 1). From the northwestern to southeastern ends of this flow, the underlying terrain drops...
approximately 1800 m in elevation. The morphology of the flow changes with the slope down the valley. The slopes are relatively flat at the top and bottom of the flow and steeper in between. On the steeper slopes, the observed morphologies are blockier, with arcuate ridges running perpendicular to the direction of the flow. These resemble ogive pressure ridges in terrestrial lava flows. We interpret these features as evidence that the flow was still moving downslope after its crust had begun to form.

The southeastern end of the flow fans out slightly at the furthest margin, following a contour of roughly constant elevation. Its lobate margins are blocky, with associated elevated Rock Abundance levels. Further inward from the margins, long lineations run parallel to the direction of the flow. An elevation cross-section taken near the southeastern extent of the flow shows that it is roughly 7 m in height at its thickest point.

In total, eleven elevation profiles were taken perpendicular to the flow direction. Along the three profiles nearest to the top of the flow, the flow margins lie on the side of the western valley wall. However, by re-framing these profiles as running along the flow in these regions, rather than perpendicular to it, the interpretation becomes one in which the melt has flowed down the western valley wall and halted upon reaching the flat plateau of the valley floor, stretching to the east. In the remaining eight profiles, the flow is centered in the middle of the deepest part of the valley, consistent with a flow direction from northwest to southeast.

In contrast to observations along this 13 km flow deposit, morphologies in the region at the crest of the western valley wall don’t include cracks, blocks or distinctive margins. However, numerous craters in the area appear completely flooded with smooth material. In general, elevated Rock Abundance levels in this region correspond well with steep, Tycho-facing slopes.

We interpret the features observed west of Heinsuis G as the result of two separate melt deposits originating from the Tycho impact (Figure 2). One landed near the crest of the western valley wall and spread from there. Where it encountered steep slopes, the impact melt continued to flow as it cooled, resulting in distinctive flow morphologies (arcuate ridges and lobate, blocky margins). Where the slopes were shallower, cracks formed in the melt deposits, but not arcuate ridges or well-defined flow margins. The shallowest slopes do not exhibit flow morphologies at all. The presence of melt is inferred on shallow slopes by craters that have been wholly or partially filled with smooth material.

Conclusions: The impact melt flows reported here are commonly observed on steep, Tycho-facing slopes. The morphology of impact melt deposits seems to be strongly controlled by slope. Unambiguous flow morphologies (arcuate ridges and lobate, blocky margins) are observed on steep slopes.

Cracks, ponds, and smooth surfaces are more common in nearby regions with shallower slopes. Based on these morphological trends, we hypothesize that on gentle slopes, melt may be present in subtle, smooth veneers rather than distinctive, blocky flows.