THE ROLE OF PRE-IMPACT TOPOGRAPHY IN IMPACT MELT EMPLACEMENT ON TERRESTRIAL PLANETS. C. D. Neish[1], R. R. Herrick[2], R. Ripper[3], and J. Lashley[3], [1]The University of Western Ontario, London, ON (cneish@uwo.ca), [2]The University of Alaska Fairbanks, Fairbanks, AK, [3]The Florida Institute of Technology, Melbourne, FL.

Introduction: Flow-like deposits of impact melt are commonly observed on terrestrial planets, typically around young fresh craters [1] (Figure 1). Hawke and Head [2] noted that the melt distribution patterns on lunar crater exteriors tend to be asymmetric, and may relate to the pre-impact topography or the impact direction. On the Moon, most complex craters have melt directions that are coincident with the lowest point on the crater rim, implying that pre-existing topography plays a dominant role in melt emplacement on that world [3]. This may be a result of movement during the modification stage of crater formation, as the central uplift imparts an outward-directed flow to the melt, pushing it over a topographically low portion of the crater rim [1,2].

On Venus, high-resolution topography data is scarce, so the effect of pre-impact topography has never been assessed for melt emplacement around its craters. New stereo topography of Venus [4] allows us to investigate the role of pre-impact topography in melt emplacement on that world for the first time. Previous studies were only able to consider the importance of impact direction [5], since the available global scale topography was not of sufficient resolution to determine rim crest elevation.

In this work, we compare the results from Venus to those previously published for the Moon, to determine the primary mechanism for impact melt emplacement on two worlds with very different kilometer scale roughness (i.e., the heavily cratered lunar highlands versus the smooth Venusian plains). Models of impact crater formation typically assume an initially flat surface, although 3D models could allow for the inclusion of a target slope or a large obstacle. Impact crater modelers should consider including topographic variations in their initial conditions, to better replicate impact melt emplacement on terrestrial planets.

Observations: Of the 909 impact craters identified on Venus, 260 have exterior deposits of impact melt [6], and 36 of these have overlapping high-resolution stereo topography. The craters in this data set range in diameter from 12 to 97 km, and thus are all classified as complex craters. Craters with diameters between ~10 and 50 km are classified as central peak craters, while craters with diameters between ~50 and 100 km are classified as peak ring craters [6]. Most of these craters should have been minimally affected by Venus' dense atmosphere, which primarily disrupts impactors that produce craters < 10 km in diameter [7].

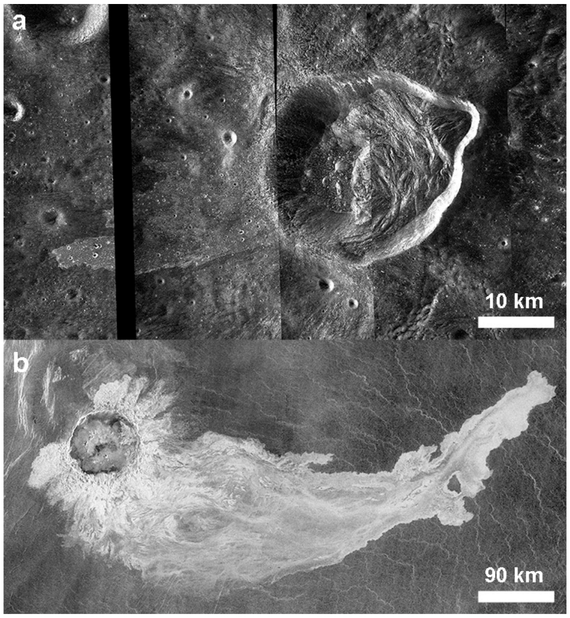

Figure 1: Synthetic aperture radar images of impact melt flows on (a) the Moon and (b) Venus. The images were acquired by the Mini-RF instrument on the Lunar Reconnaissance Orbiter and the Magellan mission, respectively.

For each crater with overlapping stereo topography, we noted the direction of the impact melt flow and the direction of the rim crest low. Unlike the craters on the Moon, we found no correlation between the direction of the exterior impact melt deposits and the direction of the rim crest low on Venus. Half of the complex craters on Venus have melt flow directions that are ≥ 90° from the rim crest low, and only 19% coincide exactly with the flow direction (Figure 2). In comparison, 53% of complex craters on the Moon have melt directions that are coincident with the lowest point in their rim, and 80% are within 45° of the rim crest low [3].

One reason for the difference in melt directions on the Moon and Venus could be the relative roughness of these two worlds at the kilometer scale. The root-mean-square topography of the Moon is about an order of magnitude higher than that of Venus at this scale [8]. Thus, there is likely more variation in rim crest height on the Moon, where impactors hit an already heavily cratered surface, than Venus, which is dominated by large plains of relatively smooth basalt. If there is more variation in rim crest topography, it may be energetically favourable for impact melt to be pushed up and over the crater rim at its lowest point during the modification stage.

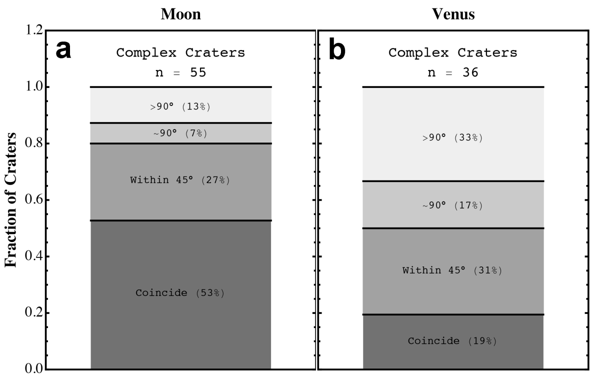

Figure 2: The correlation of the direction of the exterior impact melt deposits with the direction of the rim crest low for complex craters on (a) the Moon and (b) Venus. The lunar data is from [3].

To investigate this hypothesis, we calculated the elevation difference between the highest and lowest points on the crater rim. We used the Magellan stereo topography data set to determine elevations on Venus [4] and the Lunar Reconnaissance Orbiter Wide Angle Camera Digital Terrain Model to determine elevations on the Moon [9]. We then divided the elevation difference by the depth of the crater. We used crater depths reported for Venusian craters in Herrick *et al.* [6], and crater depths reported for lunar craters in Kalynn *et al.* [10] (Figure 3).

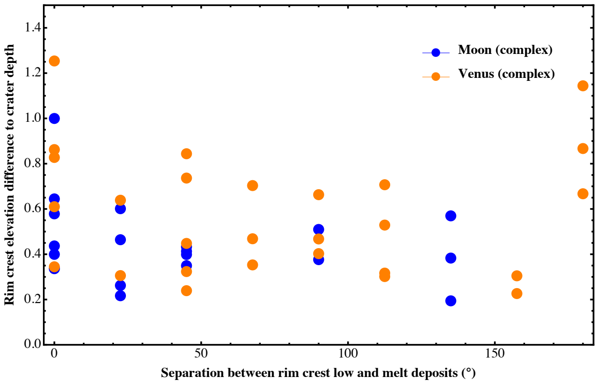

Figure 3: The ratio of the rim crest elevation difference to the crater depth for complex craters on the Moon (blue) and Venus (orange). Those craters with large variations in their crater rims are more likely to have impact melt flows that align with the rim crest low.

Presently, our sample includes 27 venusian complex craters and 20 lunar complex craters. From this initial sample, we calculated the average ratio of rim crest elevation difference to crater depth for two types of craters: (1) those with melt flows aligned with the rim crest low (0° separation), and (2) those with melt flows not aligned with the rim crest low (> 90° separation). For 'aligned' melt flows, the average ratios are 0.78 ± 0.34 for Venusian complex craters and 0.53 ± 0.24 for lunar complex craters. For 'not aligned' melt flows, the ratios are 0.40 ± 0.18 and 0.38 ± 0.19, respectively. (These ratios do not include the unusual behavior observed at a separation distance of 180°.) Thus, craters with larger variations in rim crest topography are more likely to have impact melt flows that align with the rim crest low, on both Venus and the Moon.

Conclusions: For small differences in rim crest elevation, there is no correlation between the direction of impact melt flow and rim crest low. However, if the variation in rim crest elevation approaches the depth of the crater, impact melt flows are more likely to coincide with the rim crest low. In these cases, it is energetically favourable for melt to flow out of crater, and so pre-impact topography dominates over other factors, such as impact direction. Since the Moon has more topographic variation than Venus at the kilometer scale, this process is more common on that world. Models of impact crater formation should therefore consider initial conditions that include a variety of pre-impact topographies when studying the emplacement of impact melt on terrestrial planets.

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