Mapping Sinuous Rilles: a comparison of slope and length

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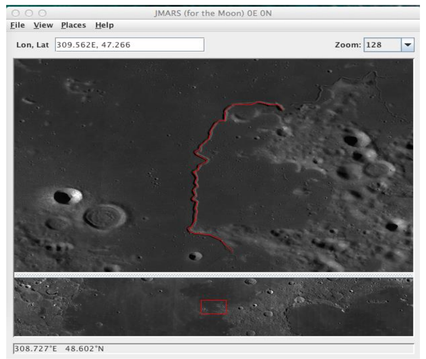
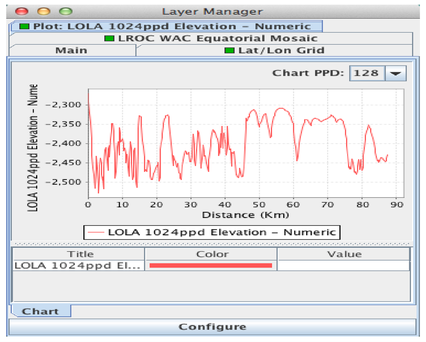
Introduction

We were interested in investigating the relationship between the slope of a sinuous rille and other physical characteristics of the rille, such as length, depth, and width. We chose to start with looking at the relationship between the slope and the length of the rille. Our hypothesis was that there is a linear correlation between these two variables; we thought that longer rilles would have greater downhill slopes. We used an updated catalog of sinuous rille coordinates, found in the Hurwitz et al. (2012) accepted manuscript, to narrow down the number of rilles we measured. We chose 53 sinuous rilles that are between 20-120 kilometers in length located in Orientale, Procellarum and Imbrium basins.

Materials and Methods

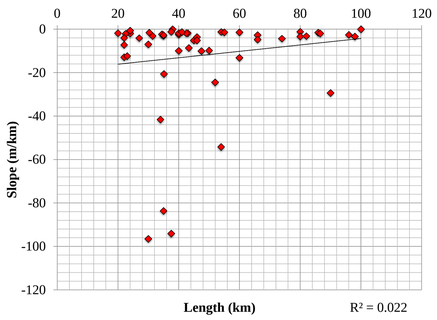
JMARS is a Geospatial Information System developed by ASU's Mars Space Flight Facility that is available to the public. We used JMARS to locate and measure the sinuous rilles. We used the LROC WAC Equatorial layer, and the LOLA 1024 ppd elevation layer. The equatorial layer provided the best images for seeing the sinuous rilles. The elevation layer allowed us to mark and record the elevation along each rille. We sampled each rille every 10 kilometers. We calculated the average slope over the length of the rille.



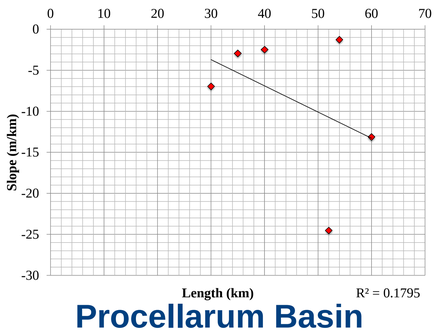


Data

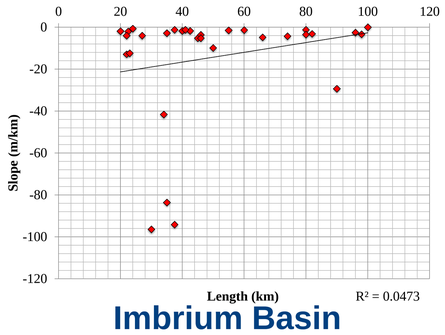
All 3 Basins



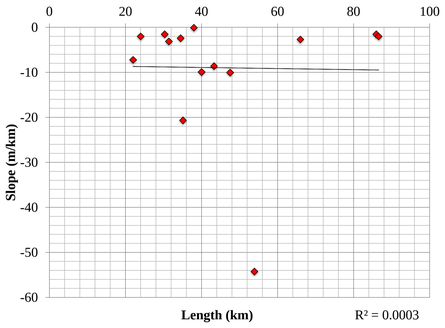
Orientale Basin



Procellarum Basin



Imbrium Basin



Discussion

We wanted to know if the characteristics of a sinuous rille were correlated with the slope. Also, some of the papers we read indicated that there are two mechanisms for sinuous rille formation: thermal and mechanical. Thermal erosion dominates in lower slope areas; this is when the heat of the lava actually melts a path. Mechanical erosion dominates in areas with higher slopes, as then gravity is also pulling the lava along and the lava physically carves a path (like water in a river). We were curious to see what the slopes of the lunar rilles indicated, and also wondered if the sinuous rilles with greater slopes would be longer. Hurwitz et al. (in an accepted manuscript) mapped more than 200 of the sinuous rilles on the moon. We narrowed down that number by filtering and looking at rilles between 20-120 km in length. We ended up with close to 50 mapped sinuous rilles in our data set. We had difficulty clearly identifying the beginning of many rilles, so we assumed the rilles had to follow a downhill (negative) slope from beginning to end. We do know that there is a possibility for uplift in the region to occur after the sinuous rille had formed. We assumed the number of uplifts would be smaller than the number of rilles that still followed the original topography. For this study, we calculated the average slope over measured length of the rille. We did sample the elevation every 10 km, as we hope to use this data set again to look at depth and width along the rilles. First, we graphed all 53 rilles on one graph, added a line of best fit and calculated the r-squared value. As is shown on the first graph, the correlation between length and slope is very small (0.022). We then graphed each basin separately, and also found no clear linear relationship between the variables:

Orientale Basin	r-squared = 0.1795
Procellarum Basin	r-squared = 0.0473
Imbrium Basin	r-squared = 0.0003

Conclusions

We showed that there is no correlation between the length and slope of the sinuous rilles located in these 3 lunar basins. We would like to look at both the width and the depth in correlation with the length and the slope of the rilles. We think the r-squared values may approach 1.0 if more characteristics are included in the analysis. We also note that most of the sinuous rilles we measured have a shallow slope of 10m/km (~1%). This supports the theory we have read (Hurwitz et al., *JGR*, 2012) that sinuous rille formation on the moon is primarily due to thermal erosion when the slope is less than ~3.5%.

Citations

Hurwitz, Debra M., James W. Head and Harald Hiesinger, Lunar sinuous rilles: Distribution, characteristics, and implications for their origin, *Planetary and Space Science*, http:dx.doi.org/10.1016/j.pss.2012.10.019

Hurwitz, Debra M., James W. Head, Lionel Wilson and Harald Hiesinger, Origin of lunar sinuous rilles: Modeling effects of gravity, surface slope and lava composition on erosion rates during the formation of Rima Prinz, *Journal of Geophysical Research*, 117.

Spudis Paul D., Gordon A. Swann and Ronald Greeley, The Formation of Hadley Rille and Implications for the Geology of the Apollo 15 Region, *Proceedings of the 18th Lunar and Planetary Science Conference (reprint)*, LPI, 1988.

Acknowledgements

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