QUANTITATIVE COMPARISONS OF LUNAR SINUOUS RILLES IN THE MARIUS HILLS AND ARISTARCHUS PLATEAU REGIONS: INSIGHTS INTO FORMATION AND EVOLUTION. C. E. Roberts[1] and T. K. P. Gregg[1], [1]Department of Geology, 411 Cooke Hall, University at Buffalo, Buffalo, NY 14260, carolynr@buffalo.edu.

Introduction: Lunar sinuous rilles are prominent volcanic channels typically located in lunar maria. These channels are interpreted to be collapsed lava tubes and/or lava channels that formed during eruptions of mare lavas [1, 2], and commonly originate from irregular depressions. They typically shallow and narrow distally, are tens to hundreds of meters in depth, and can be up to 4 km wide and 350 km long [3]. Although investigations of lunar sinuous rilles span five decades, their formation is not well understood; specifically, the relative roles of constructional and erosional processes remain unconstrained [1, 2, 4, 5]. An improved comprehension of sinuous rille formation would provide limits on emplacement styles and durations, for example, which would in turn illuminate magma behavior.

Quantifying lunar sinuous rille morphologies may help to reveal correlations between rille formation and observed characteristics. Furthermore, comparisons and contrasts of sinuous rilles from different geologic settings facilitate identification of one or more controls on rille morphology. The Marius Hills (MH) (centered at 12.9°N, 52.7°W) and Aristarchus plateau (AP) (centered at 26.7°N, 50.9°W) regions have the most dense concentrations of sinuous rilles on the Moon [6]. Furthermore, these two regions display diverse geology and stratigraphy: the MH consists of volcanic domes on a broad topographic rise [7, 8] and AP contains an uplifted block of highland crust embayed by lunar maria [9, 10]. Here, we present preliminary results from our analyses and comparison of rille morphometry in both regions.

Method: Sinuous rille length, width and sinuosity measurements were performed in ArcGIS 10 on a Lunar Orbiter IV and V frame mosaic base map (~20–1000 m/pixel), because it provided total coverage of both regions. Local gradients were derived from elevation measurements obtained from a Lunar Orbiter Laser Altimeter DEM (~240 m/pixel), also performed in ArcGIS 10. All parameters were measured repeatedly until at least 3 consecutive values within 5% of each other were obtained. Rille lengths were measured along central axes from visible origins (irregular depressions, or the first location rilles become visible on relative topographic highs) to visible termini (last location both rille walls are discernible). Where available, Lunar Reconnaissance Orbiter-Narrow Angle Camera (LRO-NAC) frames (0.5 m/pixel [11]) were consulted for enhanced clarity along certain rille segments. A rille was considered sinuous (rather than arcuate or linear) if it exhibited a turn or bend over a distance equal to or less than 10% of its total length. Sinuosity measurements were obtained from the ratio of total rille length to the straight-line length connecting the origin and the terminus of a rille [12]. Width measurements were taken every 1.3–9.0% of total rille length to obtain average width values. The exact percentage was dependent on the length of each rille to best capture slight changes in width. The elevation of areas surrounding the interpreted origin and terminus of each rille were used to calculate gradient. From the above measurements, basic histograms and scatter plots were created to compare/contrast the different rille parameters.

Results: We measured 20 rilles in Aristarchus plateau and 17 rilles in the Marius Hills regions. Both regions exhibited at least 1 branching rille, and in such cases the branches constituted separate measurements, resulting in 2-3 sub-rilles for each branching rille. The range, average value and standard deviation of each parameter are listed by region in Table 1. These measurements partially confirm the trend observed by [12]: sinuosity generally increases with increasing rille length (Figure 1). The slight correlation between AP rille length and sinuosity and the lack of correlation between MH rille length and sinuosity is suggestive of a greater gradient variation in the AP region. However, when gradient is plotted against length, width, and sinuosity, there are no observable trends for the AP rilles and only slight trends for MH rilles. The histogram in Figure 2 shows little variation in gradient values across the two rille populations. When atypical rilles Vallis Schröteri (the largest lunar rille) and its remarkably sinuous inner rille are removed from the data set, the length-sinuosity correlation is no longer observed. Similarly, there is no observable correlation when the lengths of all rilles from MH and AP are plotted together against sinuosity.

Discussion: Although basic parameters (such as length, width, sinuosity, and gradient) vary greatly among the rilles in Aristarchus and the Marius Hills, there is no single measurement that distinguishes the two rille populations from each other. The lack of defined MH or AP rille grouping with any parameter plotted against gradient suggests that underlying slope is not a main control at these separate volcanic centers.

The geology and stratigraphy of Aristarchus Plateau differ considerable from those of the Marius Hills region [7–10], which would suggest that these factors do not exert strong control over final rille morphology. Instead, some parameter(s) inherent to sinuous rille eruptions and/or emplacement must be a primary control over final rille morphology at these separate locations.

Future Work: The next set of morphometric parameters that will be measured are average radius of curvature, wave amplitude, and meander wavelength for different rille bins based on similar lengths and sinuosity groupings. Possible correlations may be revealed when these new parameters are plotted against sinuosity, width, length and gradient. Also, as additional LRO-NAC coverage becomes available, refined measurements can be obtained for all parameters.

References: [1] Oberbeck V. R. et al. (1969) *Mod. Geology*, *1*, 75-81. [2] Greeley R. (1971), *Science*, *172*, 722-725. [3] Schubert G. (1970) *Rev. Geophys. & Space Phys*., *8*, 199-224. [4] Hulme G. (1973), *Mod. Geology*, *4*, 107-117. [5] Carr M. H. (1974) *Icarus*, *22*, 1-23. [6] Hiesinger H. and Head J. W. (2006) *Rev. Min. & Geochem., 60,* 1-81. [7] Weitz C. W. and Head, J. W. (1999) *JGR*, *104*, 18933-18956. [8] Heather D. J. and Dunkin S. K. (2002) *Planet. Space Sci., 50*, 1299-1309. [9] Zisk S. H. et al. (1977) *Moon, 17,* 59. [10] Chevrel, S. D. et al. (2009), *Icarus*, *199*, 9-24. [11] Robinson M. S. et al. (2010) *Space Sci. Rev.*, *150*, 81-124. [12] Chen L. J. (2008) *LPS XXXIX,* Abstract #1713.

Table 1. Parameters measured for 20 sinuous rilles in the Aristarchus Plateau region, and 17 sinuous rilles in the Marius Hills region.

Aristarchus Plateau (n = 20)

Parameter	**Minimum**	**Maximum**	**Average**	**Standard Deviation**
Length (m)	8930	297520	59750	69573
Width (m)	340	5610	1040	1132
Sinuosity	1.18	2.26	1.44	0.254
Gradient	4.37E-05	7.90E-04	3.50E-04	2.26E-04

Marius Hills (n = 17)

Parameter	**Minimum**	**Maximum**	**Average**	**Standard Deviation**
Length (m)	16220	336890	97810	103424
Width (m)	330	1340	535	227
Sinuosity	1.09	2.01	1.49	0.226
Gradient	6.38E-06	7.15E-04	2.01E-04	2.26E-04

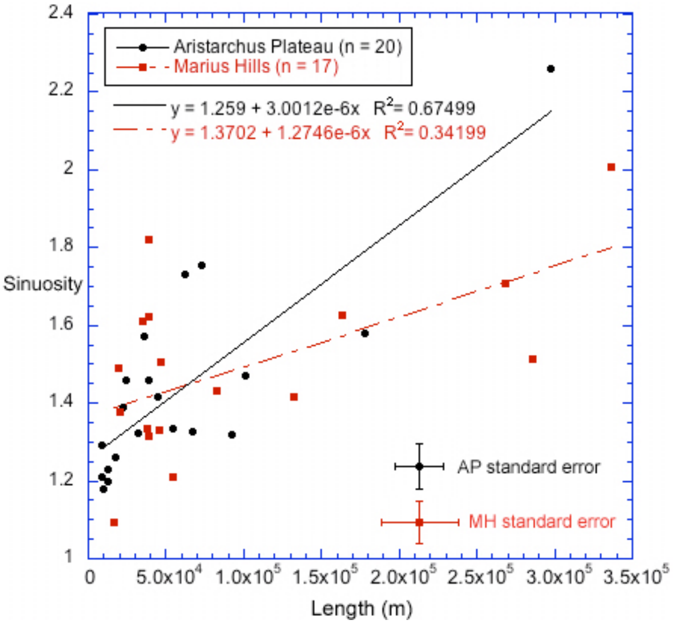

Figure 1. Rille length and sinuosity for each region. Rille values, standard error and R^2 values are shown in black for Aristarchus Plateau (AP) and red for the Marius Hills (MH). Error bars are based on available image resolution.

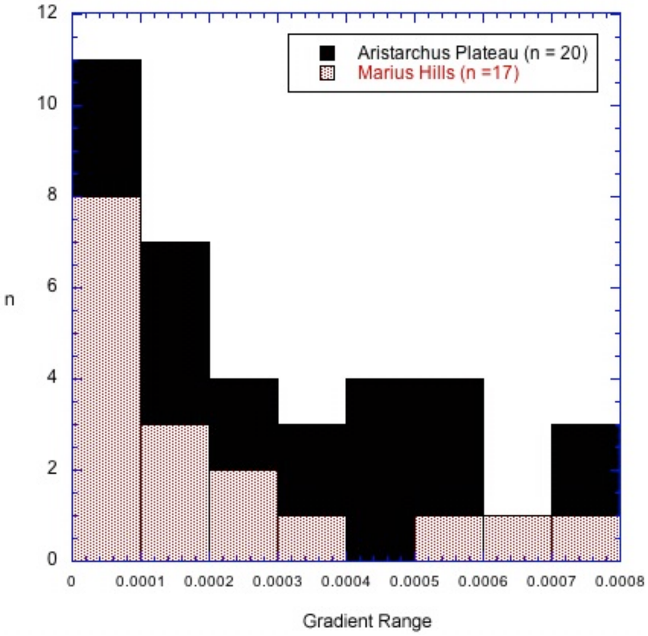

Figure 2. Histogram of gradient ranges for sinuous rilles in the Aristarchus Plateau region (solid black pattern) and the Marius Hills region (dotted red pattern).