VISUALIZING THE TOPOGRAPHY OF THE MARIUS HILLS COMPLEX. H. M. Brown[1], M. S. Robinson[1], J. D. Stopar[1], S. J. Lawrence[1], [1]School of Earth and Space Exploration, Arizona State University, 1100 S. Cady Mall, Interdisciplinary A, Tempe, AZ 85287-3603; (hbrown6@asu.edu)

Introduction: The Marius Hills Complex (13.4°N, 304.6°E) is known for its geologic complexity and abundant concentration of volcanic features [1]. Domes, cones, sinuous rilles, and pyroclastic deposits are prominent across the landscape, representing a complex range of various eruption styles and morphologies [e.g., 1]. These volcanic features sit on top of an elongated, elliptical rise about 300 km wide with 1 km of relief. Previous studies found that the topographic rise is compositionally and spectrally similar to the domes and cones, indicating that they could have formed at a similar time period from the same magma source region [1,2]. *Spudis et al.* [3] proposed that the Marius Hills Complex is an example of a giant lunar basaltic shield volcano [3], on the basis of its broad, low relief shape that is comparable to terrestrial shields and, geophysical evidence of large, dense subsurface bodies below the topographic bulge [4].

The purpose of this abstract is to explore the shield volcano hypothesis [3] through a more detailed topographic characterization in relation to the associated free-air gravity anomaly [4].

Background: On Earth, shield constructs are classified as positive-relief, central vent structures with low average positive slopes, made up mostly of effusive basaltic lava flows [5]. It is common for terrestrial shields to have associated pyroclastic activity resulting widespread ash deposits and cone building [5]. Though most terrestrial shields have summit calderas, a construct does not have to exhibit a collapse caldera in order to be classified as a shield [5].

Spudis et al. [2013] calculated the average slope of the topographic rise (0.8º) by taking two elevation profiles from the Lunar Reconnaissance Orbiter Camera (LROC) Wide Angle Camera (WAC) GLD100 terrain model [6]. Slope of the second southernmost dense subsurface body was not calculated [3].

Approach: The principal data source used to investigate the topography of Marius Hills is the GLD100 global map [6]. Both ISIS (Integrated Software for Imagers and Spectrometers) and GDAL (Geospatial Data Abstraction Library) image processing routines were applied to extract topographic information, including slope, elevation, and contours from the GLD100 terrain model. Slope results were derived from ISIS slpmap, by computing the slope of every GLD100 pixel inside the boundary of the proposed shield. The boundary itself was derived from GLD100 elevation profiles taken of the topographic rise, spanning in all cardinal directions. In order to calculate a representative average slope for the topographic rise, cones, domes, rilles, and craters were omitted from the slope average results.

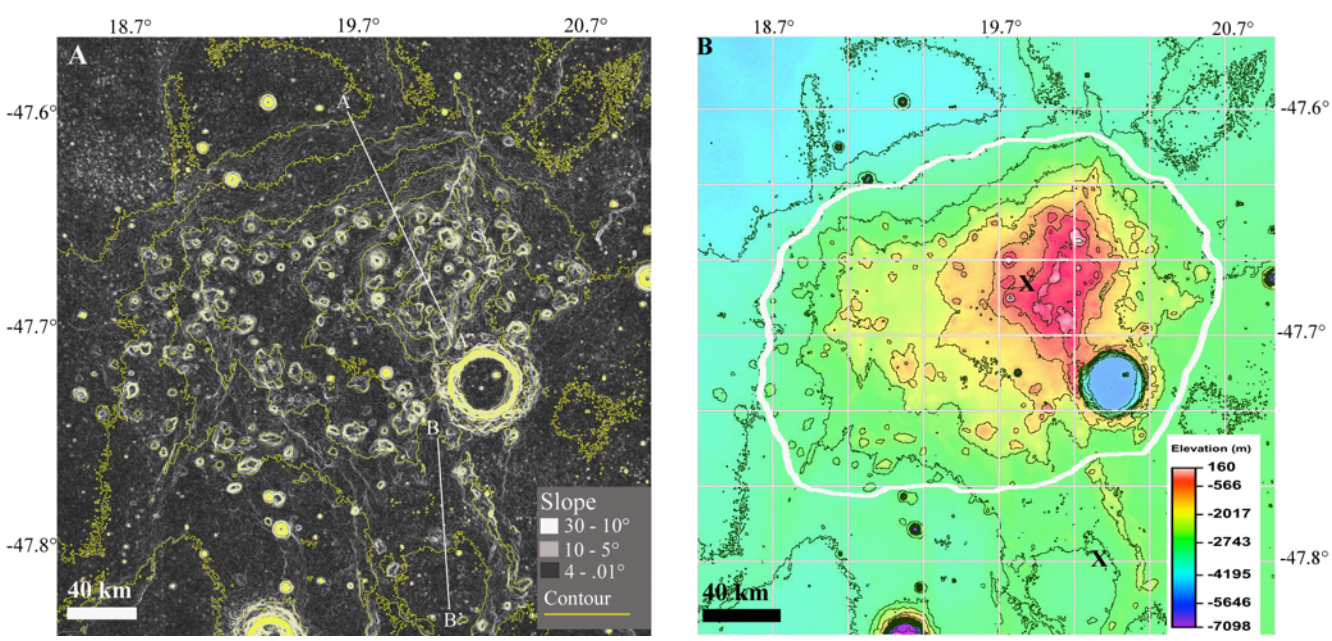

Figure 1. *Marius Hills topography. Left: Slope map with superposed 500-meter interval contours and slope profile examples. Right: Color shaded relief map with superimposed 500-meter interval contours, drawn boundary of proposed shield, and marked free-air gravity-anomalies (centered at 13.6°, -60.3° and 7.2°, -57.5°.*

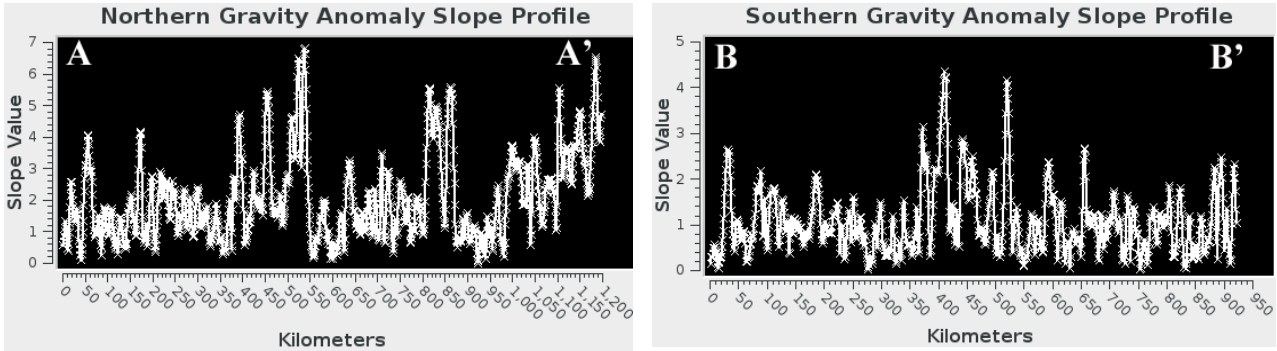

Figure 2. *Slope profiles as depicted in Figure 1A. Derived from GLD100 elevation data. Cones, domes, rilles, and craters were omitted from the final slope average calculation.*

Results and Discussion: Color shaded relief and slope contour maps (Figure 1) reveal the positive relief and gently sloping topography of the rise, but under the southernmost gravity anomaly (7.2°,-57.5°.in Fig.1B) no shield-like formation is apparent. On top of the Marius Hills topographic bulge numerous lava flows extend radially outward from the "summit" of the Marius Hills rise, and dome, cones, and rilles lie along the flanks and even near the summit [7].

From the topography, we estimate the topographic rise is 300 km wide, and exhibits 1 km of relief. Averaging 20 slope profiles over both gravity anomalies from the GLD100 pixels and omitting outliers yielded a different result than *Spudis et al*. [3]. Over the Marius Hills topographic rise and the northern gravity anomaly, a slope of 0.65° was computed, and over the southern most gravity anomaly a slope of 0.8°. *Spudis et al.* [3] results calculated the Marius Hills rise to have a 0.8° slope, and be 330 km in diameter and 2 km in relief.

With an average slope of 0.65° and a height to width ratio of 300 km to 1 km tall, the Marius Hills bulge is consistent with shields found on Earth, that have heights 1/20th of their width, and lower slopes around 2 – 3 ° [8]. A slope of 0.65° makes plausible sense for the lunar environment, where no atmosphere allows for more effusive lava flows [3].

Slopes above the southernmost gravity anomaly are similar to the Marius Hills rise (0.8°), though this does not indicate a second possible shield, which is consistent with previous studies [3,4]. The presence of two dense subsurface features could be an example of magma dispersed throughout the crustal pore space, rather than just being concentrated in a magma chamber [3,4]. The presence of two dense bodies beneath Marius Hills could help to explain the lack of a traditional collapse caldera associated with shields [3].

Summary and Conclusions: Further investigation into the topography of the Marius Hills Complex provides consistency with previous research [3] and terrestrial shield volcano parameters [5]. It is clear that existing topographic data, literature, geophysical data, and satellite imagery paint a colorful story regarding the origin of this geologically complex region on the Moon, though there are no field samples for concrete evidence. Even so, Marius Hills serves as an exciting site for future human exploration to aid in our understanding of lunar geologic dynamics and complexity. By visualizing the topography of the region, it is possible to compare the lunar environment to that of Earth and other bodies in the Solar System. An in depth topographic investigation into the region of Marius Hills provides an increasing amount of evidence that Marius Hills is indeed a giant lunar shield, adding to our knowledge of our fundamental understanding of the Moon.

References:

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