SURFACE TEXTURES OF LINEAR ROUND-TOPPED RIDGES IN THE SOUTHERN HIGHLANDS: EVIDENCE FOR A COLD-BASED GLACIATED LANDSCAPE. Kobe Y. Wang (ycwang430@ucla.edu) and An Yin (yin@epss.ucla.edu), Dept. of Earth, Planet., and Space Sci., UCLA, California 90095-156702, USA

Introduction: Linear round-topped ridges are common features in the southern highlands of Mars (**Fig. 1**). They are up >500 km long and about 10s of km wide. The surface of the ridges are generally smoother than the irregularly shaped ridges and high-elevation regions in the southern highlands (**Fig. 1**). These ridges commonly bound linear troughs radiating from the south polar ice cap. To our knowledge, the origin of the ridge morphology has not been discussed in the literature.

Motivations: It has long been speculated that the southern highlands of Mars were once occupied by a single ice sheet [1]. Debate has been centered on whether the ice-transport process during the inferred glaciation event was wet-based [2] or cold-based ([3], [4]). The two competing models make specific predictions that are testable by photogeologic mapping. Specifically, the wet-based models predict the occurrence of kames, drumlins, sub-glacial channels, lateral and frontal moraine ridges, and water-assisted soft-sediment deformation features such as isoclinal folds [5]. In contrast, the cold-based ice-transport model predicts a pavement of angular boulders along glacial-flow paths, poorly development or complete absence of lateral and frontal moraine ridges, and a lack of water-assisted soft-sediment deformation features [6]. The goal of this study is to (1) establish whether glaciation had occurred across the southern highlands and (2) to determine, if it did occur, whether glacier transport was dominated by wet- or cold-based mechanism.

Data and Methods: MOLA topographic data are used for locating major round-topped ridges (**Fig. 1**). HiRISE images are then used to examine the landforms and textures of the ridge surfaces. The results are compared against the landforms and textures of the surfaces and sedimentary/volcanic deposits in the nearby basins.

Preliminary Results: *Observations* A matrix-support boulder-bearing unit is widely distributed over the ridge tops near the south polar region (**Figs. 2A and 2B**). The boulders have an average size of 2-5 m and the grain size of the matrix material is below the resolution of HiRISE images. The boulders formed semi-circular patterns and the matrix material displays polygonal patterns, which are commonly associated with periglacial landforms on Earth. At the mid-latitude, the surface of the ridges show much lower densities of boulders than those to the south closer to the south pole. Subsurface materials excavated by impact craters are dominated by layered boulder-bearing material (**Fig. 2C**). Closer to the northern rim of the southern highlands but before reaching the north-sloping Arabia terra ramp, the surface of the round-topped ridges contain only scattered and lineated boulder trains (**Fig. 2D**). Directly next to the Arabia terra, however, the surface of the ridges exposes bedrocks only without the presence of overlain boulder-bearing material. Striated surfaces are common and often associated with step-like features perpendicular to the lineation direction (**Fig. 2E**).

Interpretation The boulder-bearing unit could either be generated by deposition of impact ejecta, glaciation, or a combination of both. The close association of the boulder unit with periglacial landforms near the polar region and with striated surfaces near the Arabia terra led us to favor a glaciation origin for the deposition of the boulder unit. However, it is possible that some of the boulders were first generated by impact processes and were later entrained into glacier flows. The lack of subglacial channels (i.e., eskers) and water-assisted soft-sediment deformation features suggests that glaciation is cold-based. This interpretation is further strengthened by the observations that the basins and troughs next to the striated ridges contain boulder-bearing materials interpreted as glacial deposits, but they do not have well-developed moraine ridges. Our work tentatively supports the notion that the southern highlands were occupied by a continuous ice sheet moving across a pre-existing landscape ([4], [7]). The presence of abundant valley networks may have resulted from *in-situ* melting of this ice sheet, as suggested by many earlier researchers ([8], [9]).

References: [1] J.S. Kargel & R.G. Strom (1992) *Geol. 20*, 3-7. [2] J.S. Kargel et al. (1995) *JGR 100*, 5351-5368. [3] B.K. Lucchitta (1980) *LPSC 11*, 634-636. [4] J.L. Fastook & J.W. Head (2014), Planet. Space Sci. 91, 60-76. [5] D. Benn, D., & D.J. Evans (2014). Glaciers and glaciation. Routledge. [6] C.B. Atkins (2013) *Geol. Soc. London Spe. Publ. 381*, 299-318. [7] R. Wordsworth et al. (2013) Ica*rus 222*, 1-19. [8] V.R. Baker (2001) *Nature 412*, 228-236. [9] R.M. Ramirez and R.A. Craddock (2018) *NG. 11*, 230-237.

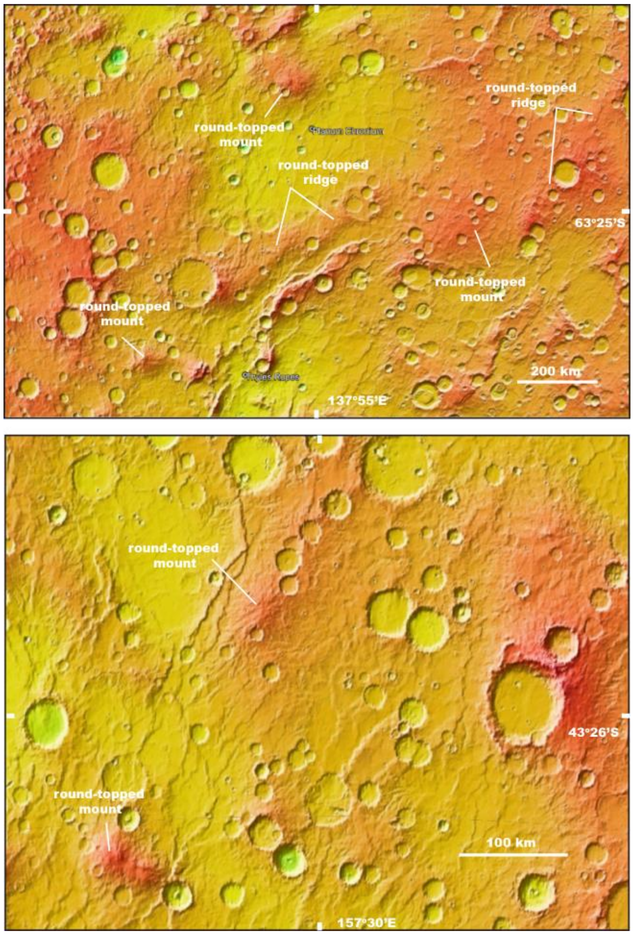

Figure 1 (above). Round-topped ridges and mounts in southern highlands of Mars. Note that the linear ridges bound linear troughs or elongated basins where the density of craters is significantly less than that of the nearby ridges.

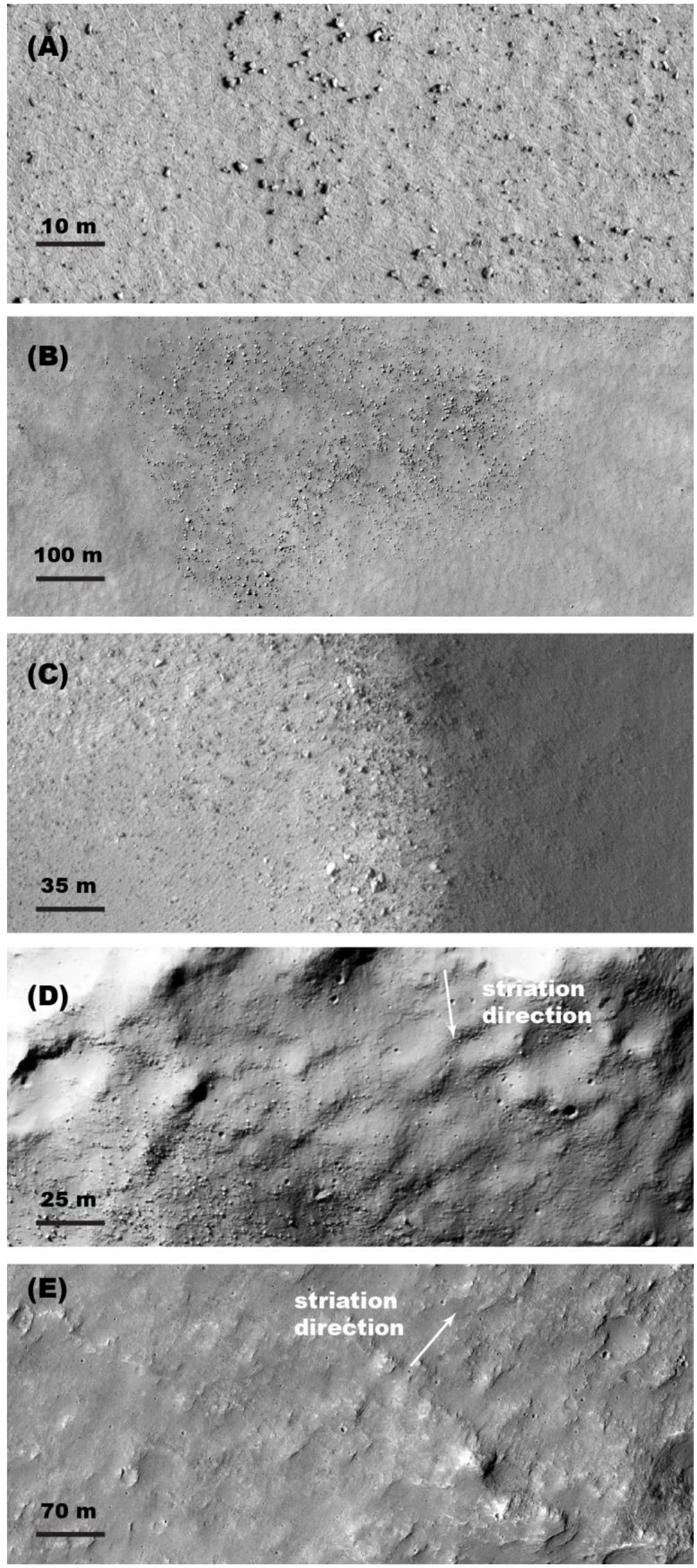

Figure 2 (right). A south-to-north display of surface textures of linear round-topped ridges across southern highlands. (A) smooth polygonal surface dotted by scattered boulders (PSP_005761_1145). (B) Patterned boulder arrangements on a ridge surface (ESP_013989_1185). (C) Boulder material exposed at the wall of an impact crater (ESP_011628_1260). (D) Striated surface with scattered boulders on the ridge surface (ESP_017482_1440). (E) Striated ridge surface without the presence of boulders (ESP_037591_1535).