THE LENGTH OF FLUVIAL SINUOUS RIDGES ON MARS. B. T. Cardenas, J. M. Swartz, and D. Mohrig, Jackson School of Geosciences, University of Texas at Austin, Austin, TX. Contact: benjamin.cardenas@utexas.edu

Introduction: What can be learned by measuring the lengths of exhumed channel belts (fluvial sinuous ridges) on Mars? We commonly treat the length of a sinuous ridge as a proxy for how well preserved the deposit is. For example, a well-preserved sinuous ridge might be traceable over several km, while a poorly-preserved ridge would extend a much shorter distance. Well-preserved channel belts extending km to 10s of km are common in Earth's subsurface (Fig. 1A-B) [1], and, we hypothesize, the channel belts exposed on the surface of Mars as "fluvial sinuous ridges" [2] (Fig. 2). We explore the paleo-environmental conditions necessary to setup this preservation on Earth, and extrapolate to Mars.

In the subsurface Gulf of Mexico, seismically-imaged Plio-Pleistocene channel belts are continuous for significant lengths, often several 10s of km (Fig. 1A-B). The exceptional preservation of the channel belts is setup by a coastal environment experiencing river bed aggradation and multiple avulsions some distance from the shoreline [3-4], the construction of basins bound by aggraded alluvial ridges (Fig. 3), and precipitation to develop drainage networks within basins that move sediment out of these basins to the coastline, creating and maintaining 10s of m of relief [5]. These basins develop into protective, topographically low regions that are later filled by channel belts following river-channel avulsion into these protective zones. Basin length is set by the distance from the avulsion node to the coast. These basins are confined to the net-depositional portion of the coastal zone where topography is dominated by radiating sets of alluvial ridges. They are located along the US Gulf of Mexico and southern Atlantic coasts [5].

We present length measurements of fluvial sinuous ridges exposed at the surface of Mars at Aeolis Dorsa, a region with densely packed sinuous ridges [2]. These lengths are compared to channel belts seismically imaged in the Gulf of Mexico in order to understand how well-preserved the sinuous ridges are, and ultimately to interpret what their preservation state records about the martian paleo-environment.

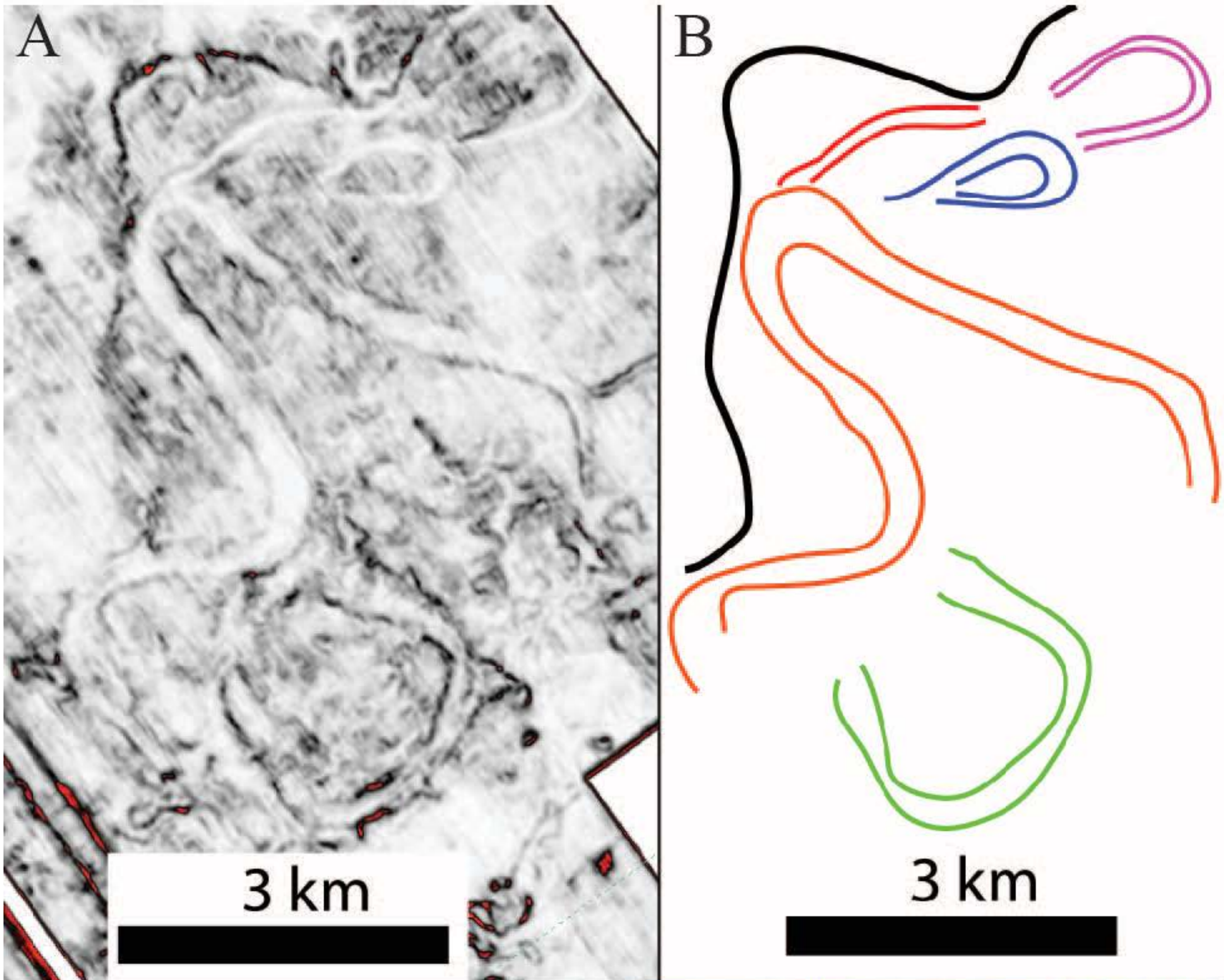
Results: Sinuous ridge lengths at Aeolis Dorsa were measured in a GIS using a mosaic of HiRISE and CTX images. Figure 2 shows an example of a measurement's endpoint. We compare these sinuous ridge measurements to channel belt lengths measured from the subsurface Gulf of Mexico (using some measurements from [6]). The Earth dataset ranges from 4 to 30 km and a mean of 15 km. The high end of this dataset is limited by the extent of seismic surveys, and does not truly represent the upper range of lengths. The Mars dataset is exponential with a significant tail, ranging up to 50 km with a mean of 10 km.

Discussion: Both datasets feature continuous, well-preserved channel belts several 10s of km long. Channel belts extending for 10s of km without being scoured away suggest they have been preserved in extended topographic lows. We emphasize that coastal tributary drainage basins bound by alluvial ridges are required to setup this preservation on Earth, and that these basins are controlled by the nearby shoreline and require precipitation to develop erosional drainage networks. We interpret these drainage basins were present during the Noachian/Hesperian deposition of these channel belts at Aeolis Dorsa, and provided the necessary low relief to preserve channel belts over 10s of km. Significantly, this requires a coastal, aggrading environment at Aeolis Dorsa, and precipitation to maintain inter-ridge drainage basins. This is independently consistent with prior interpretations of a significant, long-lived body of water near Aeolis Dorsa [7-9]. We also point at that interpreted coastal zones on Mars are not always clearly identified geologically, and that these seismic volumes showing Plio-Pleistocene coastal zones on Earth feature channel belts at a similar density as at Aeolis Dorsa.

Conclusion: 3D seismic volumes of Earth's sedimentary subsurface are freely available at https://walrus.wr.usgs.gov/namss/. Channel belts imaged in these volumes should continue to function as valuable planetary analogs, as these deposits represent an overlooked middle step between modern river channels and fluvial sinuous ridges.

References: [1] Paola C. et al. (2018) *Annual Review of Earth and Planetary Sciences, 46,* 409-438. [2] Burr D. M. et al. (2009) *Icarus, 200*, 52-76. [3] Chatanantavet P. et al. (2012) *GRL, 39*, L01402. [4] Ganti, V. et al. (2016) *JGR-Earth Surface, 121,* 1651-1675. [5] Swartz J. M. et al. (2018) *AGU 2018 Meeting*, Abstract EP21B-2230. [6] Armstrong C. P. (2012) UT-Austin MS Thesis [7] DiBiase R. A. et al. (2013) *JGR-Planets, 118,* 1285-1302. [8] Cardenas B. T. et al. (2018) *GSA Bulletin, 130,* 484-498. [9] Hughes C. M. et al. (2019) *Icarus, 317,* 442-453.

Figure 1 (top of next page) – A: Planform seismic image centered on a channel belt continuous for several km, with other less continuous belts. This subsurface volume is from the offshore Brazos River delta in the Gulf of Mexico. B: Initial interpretation of different channel belts in different colors, as well as the wall of an incised valley (bold black line).



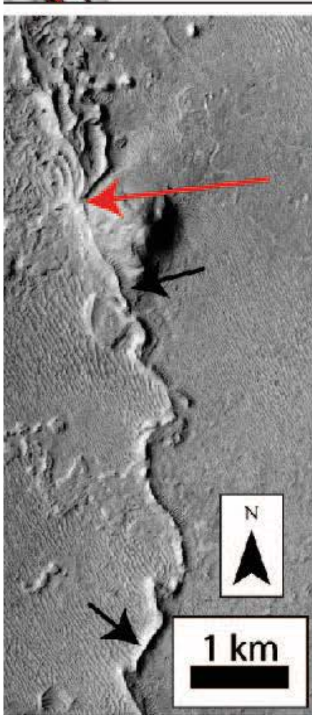


Figure 2 (left) - Black arrows point to an exhumed channel belt (sinuous ridge) at Aeolis Dorsa, Mars. Belt is continuous for several km, but is unclear north of the red arrow, marking an endpoint of the measurement. Centered at 153.60° E, 6.19° S.

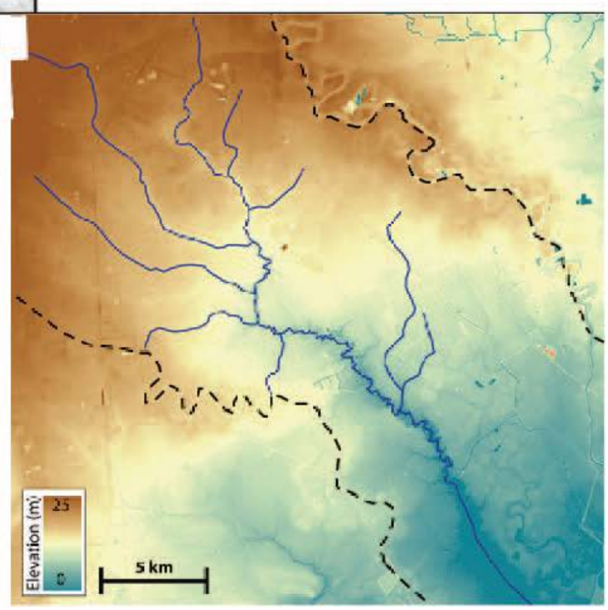


Figure 3 (right) - DEM of a coastal drainage basin near the Brazos River, TX, USA. Black dashed lines mark bounding, topographically high river deposits. Blue lines mark the erosional tributary channels draning this basin.