MAPPING SINUOUS RIDGES IN NORTHWEST HELLAS, MARS. A. L. Gullikson[1], R. B. Anderson[1], R. M. E. Williams[2] [1]U.S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, AZ 86001, [2]Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson, AZ 85719.

Introduction: Evidence for flowing water on the surface of Mars has been recognized since the Mariner 9 mission, when images were returned showing extensive dendritic valley networks [1].With increasingly high resolution images afforded by more recent orbiter missions, numerous potential fluvial features such as stream channels, gullies, and sinuous ridges have been identified. The work presented here focuses on sinuous ridges, which are interpreted to be either inverted fluvial channels or eskers [e.g., 2-6].

Although related to flowing liquid water, sinuous ridges are understudied in comparison to Martian valley networks. Sinuous ridge occurrences were documented on a global scale using data from the Mars Orbital Camera (MOC) and the Thermal Emission Imaging System (THEMIS) by [7], but no large-scale maps tracing the morphology of these features, comparable to the global maps of valley networks [8], exist. We present the results of an ongoing effort to map sinuous ridges in a large region of interest (-15°N to -45°N, 30°E to 75°E) in northwestern Hellas.

Methods: The primary data used in this study are 6 m/pixel images from the Context Camera (CTX), on board the Mars Reconnaissance Orbiter (MRO). CTX has observed ~80% of the surface of Mars at a resolution of 6 m per pixel. This large dataset, with a combination of high resolution and good spatial coverage, permits regional and global mapping of sinuous ridges at a scale that was previously not possible. We will map ridges at a scale of ~1:20,000, using CTX data exclusively to ensure that the threshold for detection of the mapped features is not biased by the availability of multiple datasets with different resolution. We have used the 1:20M scale global geologic map [9] and the 1:5M scale geologic map of Hellas by [10] to provide geologic context and approximate ages for the mapped features.

Although the primary focus of this study is mapping sinuous ridges to be used in future morphometric work, we are also mapping valleys, canyons, and channels, as well as linear ridges interpreted to be tectonic in origin to provide a more comprehensive map of fluvial and ridge-like features within the northwestern portion of Hellas.

Hellas Basin: Hellas basin, centered at 42.4°S, 70.5°E, is located in the southern highlands of Mars. The northwestern portion of this basin and the adjacent highlands were selected for our study because this area incorporates terrain spanning a wide range of ages [9], and contains numerous sinuous ridges identified by [7]. A significant portion of the region of interest is composed of Noachian to Hesperian-aged units [9-11]. Previous studies have suggested that a climate shift on Mars could have occurred during this timeframe. This shift may be preserved in the fluvial features and their morphology within this region.

Much of the earlier work on Martian sinuous ridges has focused on studying such features in the Aeolis Dorsa region, within the Medusae Fossae Formation (MFF) [e.g., 5, 12-13], interpreted to be Amazonian to Hesperian in age [e.g., 9, 14-15]. Our work, which is based primarily in Noachian to Hesperian-aged units, will provide a useful point of comparison with the sinuous ridges that have been studied in the MFF.

Results: We have divided the region of interest into 15 smaller sectors for mapping (**Figure 1**). Initial efforts have been focused primarily on regions without HRSC DTM coverage, so that mapped features can be used to guide the creation of several CTX or HiRISE DTMs in areas of particular interest that are currently lacking moderate- to high-resolution topography. **Figure 2** shows an example of features mapped in the northern portion of sector 10. **Figure 3** shows several examples of features mapped as sinuous ridges.

Preliminary measurements for 15 sinuous ridges mapped thus far in ROI 10 have an average length of 5 km and width of 120 m. Besides the crater shown in **Figure 2**, which has an eroded alluvial fan that is densely populated with sinuous ridges, the majority of ridges that have been mapped are single-thread, and are typically associated with or connected to a negative-relief channel.

Mapping efforts in the floor of Hellas have been complicated by the presence of a strange banded terrain that appears to be related to viscous flow of ice [16]. This terrain contains many ridges that are curved or sinuous, but distinct from the sinuous ridges of interest in our study. Therefore, the banded terrain in Hellas will be excluded from our mapping.

Future Work: Work is ongoing to map sinuous ridges and other fluvial and ridge-like features within the northwestern Hellas region. The completed map will be used to determine whether relationships exist between sinuous ridges and different-aged terrain, mapped geologic units [e.g., 9, 10], the presence of hydrated minerals [e.g., 17-18], and layered deposits [e.g., 19] within the area.

Inverted channels preserve their original channel morphology more effectively than valley networks, and therefore measurements (e.g., width, length, displacement, meander wavelength, radius of curvature, slope) of sinuous ridges interpreted to be fluvial channels can be used to infer discharge rates. When coupled with values for catchment areas, runoff rates can

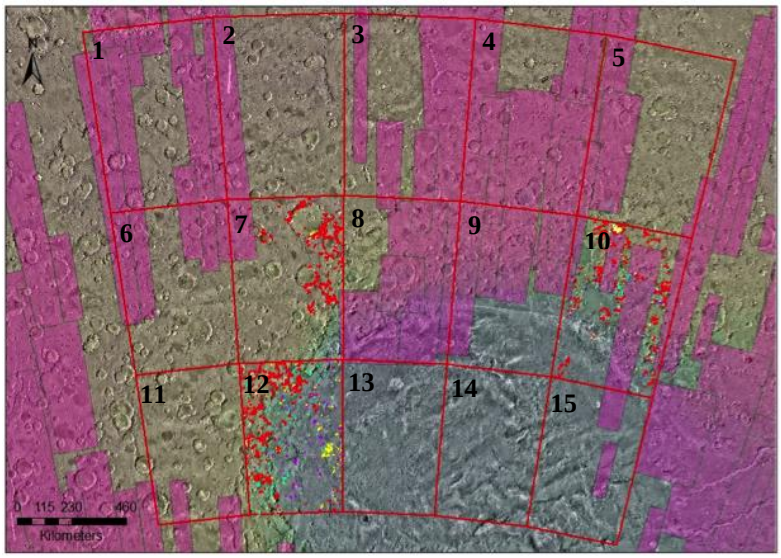


Figure 1. MOLA colorized base map of the northwestern Hellas region. Magenta polygons indicate current HRSC DTM coverage. The ROI for this study is indicated by red polygons, separated into 15 individual sectors, denoted by numbers. Sectors 10 and 12 have been fully mapped and sector 7 has been partially completed.

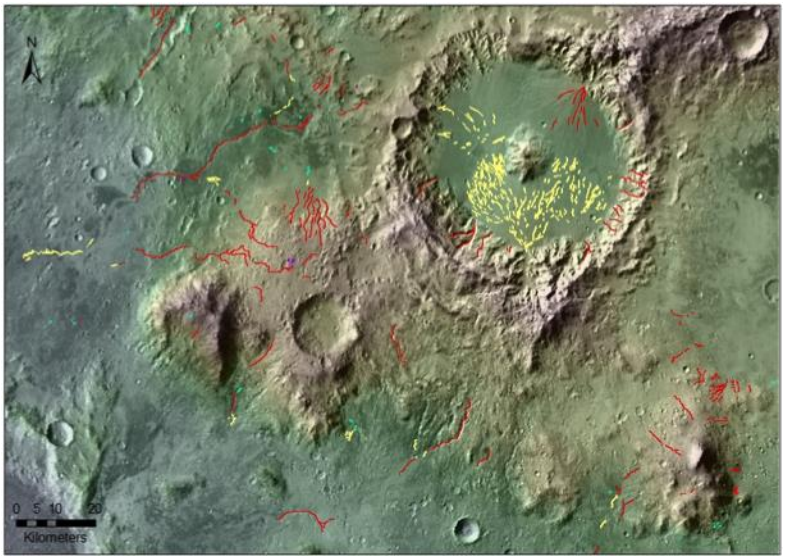
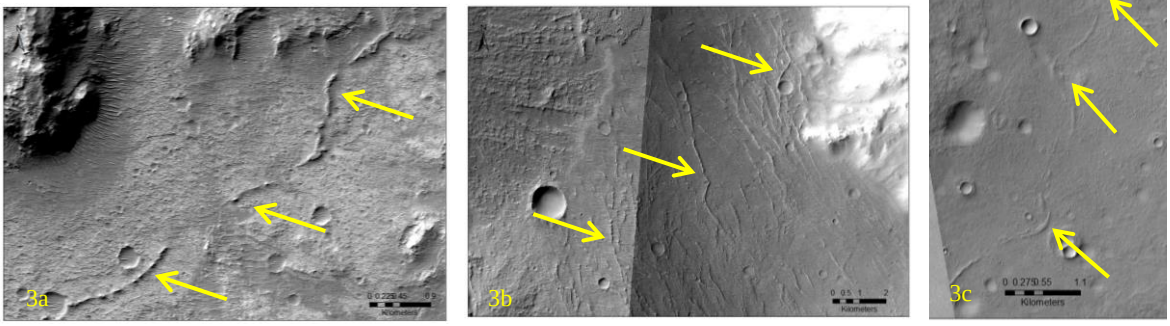


Figure 2. MOLA colorized topography on THEMIS Day IR showing a portion of the northern region in sector 10.

Sinuous ridges
Tectonic-related ridges
Ambiguous ridges
Valleys/Channels/Canyons

Figure 3. CTX images showing several examples of sinuous ridges mapped in the NW Hellas region (yellow arrows point to ridges). **3a** and **3b** are located in sector 10 and **3c** is from sector 12.



then be determined. These data will ultimately assist in placing further constraints on hydrology and climate models for early Mars.

Acknowledgements: This work is supported through NASA through the Mars Data Analysis Program via grant NNH14ZDA001N-MDAP14_2-0108.

References: [1] Masursky, H. (1973) *JGR, 78* (20) pp. 1931-1934. [2] Kargel J.S. and Strom R.G. (1992) *Geology, 20*, pp. 3-7. [3] Head J.W. (2000) *LPSC 31*, #1116. [4] Kolb E. and Tanaka K.L. (2001) *Icarus, 154*, pp. 22-39. [5] Burr et al. (2009) *Icarus, 200*, pp. 52-76. [6] Williams et al. (2009) *Geomorphology, 107*, pp. 300-315. [7] Williams R.M.E (2007) *LPSC 38*, #1821. [8] Hynek et al. (2010) *JGR, 115*. [9] Tanaka et al. (2014) *USGS Investigations Map, 3292*, pamphlet 43. [10] Leonard G.J. and Tanaka K.L. (2001) *USGS Investigation Series, I-2694*. [11] Greely R. and Guest J.E. (1987) *USGS Map, I-1802-B*. [12] Burr et al. (2010) *JGR, 115*, pp. E07011. [13] Williams et al. (2013) *Icarus, 225*, PP. 08-324. [14] Kerber L. and Head J.W. (2010) *Icarus, 206*, pp. 669-684. [15] Tanaka K.L. (1986) *JGR., 91* (B13) pp. E139-E158. [16] Diot, X., et al. (2014) *PSS* 101, 118–134. [17] Bandfield J.L. (2008) *GRL, 35*, L12205. [18] Carter et al. (2011) *EPSC, 6*. [19] Wilson et al. (2007) *JGR. 112*, E08009.