National Aeronautics and Space Administration

FY23 Lew Allen Award

Polygonal Ridge Networks on Mars

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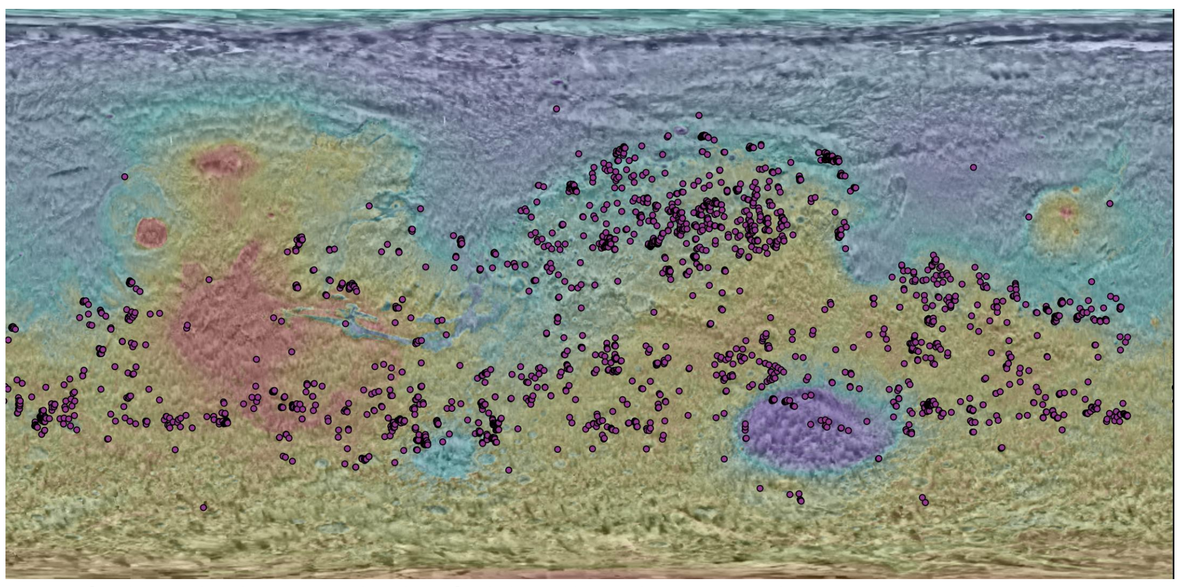
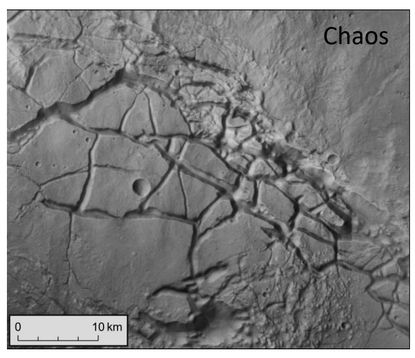
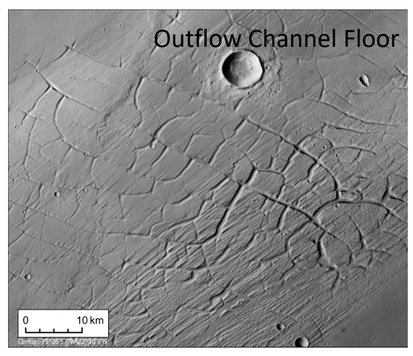
Background: The ancient surface of Mars is marked by evidence for abundant water, including fluvial channels, canyons, lakes, deltas, alluvial fans, and shorelines. However, some of most interesting water-related processes on Mars may have occurred underground, where the environment is temperature-controlled and shielded from UV radiation. In some places, including Jezero Crater, the ancient record of ground-water flow is exposed by erosion, manifesting as networks of interconnected mineralized ridges [1]. In 2017 a Zooniverse Citizen Science Project was developed to map ridges across a portion of Arabia Terra where they are known to be common [2]. A small group of participants decided to take the project further, however, continuing to map well after the original project was finished. After six years, their map, principally populated by Sylvia Beer, now extends across the equatorial regions and includes polygonal ridge networks, polygonal fracture networks, and networks of “dark lines”.

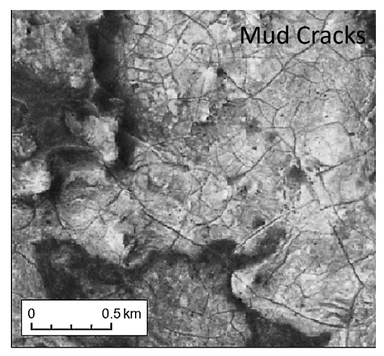
Objective: Go through a catalog of martian polygonal ridge networks and related surface features created by a team of Citizen Scientists and identify future research directions based on the observations made in the catalog.
Tasks: (1) Classify the polygonal ridge networks found by the Citizen Scientists. The ridges were classified into categories: polygonal ridge networks, mud cracks, glacial-related, lava-related, polygonal fractures, dark lines, “unusual”, and unclear. **(2)** Research the nature of the various network types. **(3)** Review the terrestrial literature regarding analog networks on Earth. **(4)** Produce a plan for a research campaign into these features and what each can tell us about the martian subsurface.

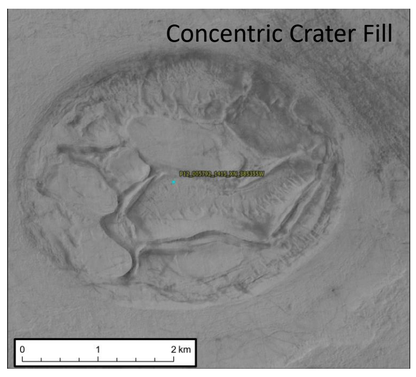


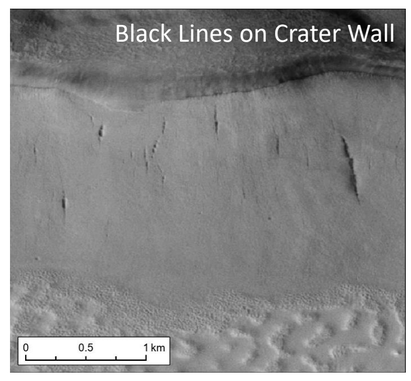
Map of Polygonal Ridge Networks identified throughout the equatorial region.

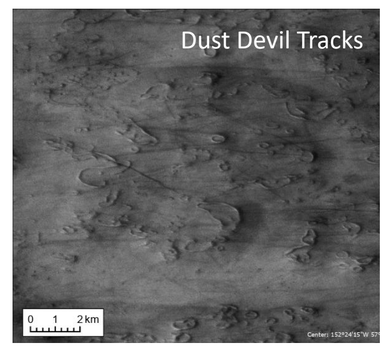


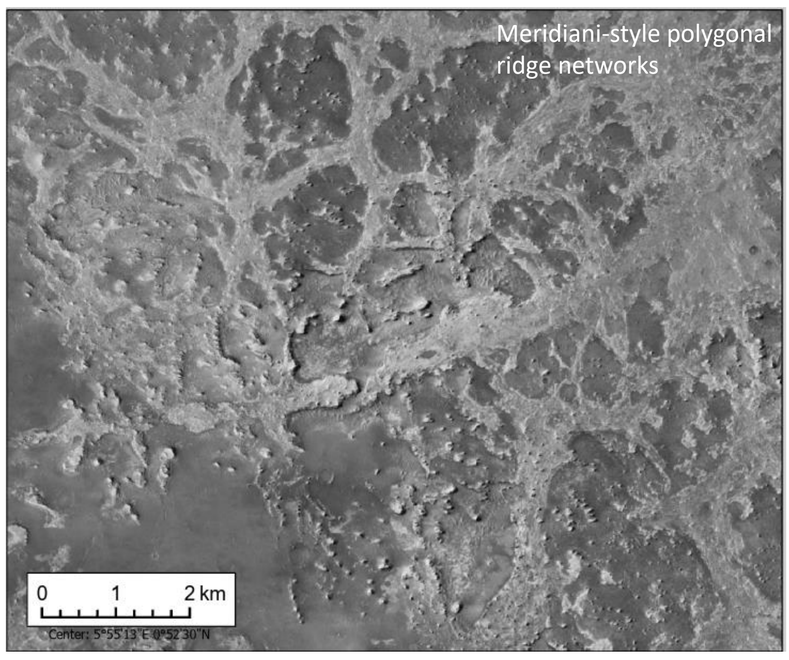


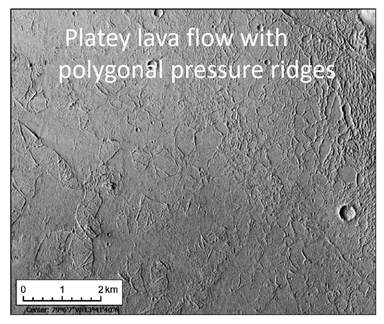


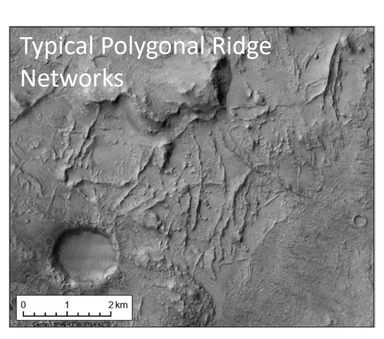












Approach and Results:

Approach: Instances of polygonal features identified by the citizen scientists were investigated using a combination of ArcMap GIS Pro geospatial software, JMARS, and Google Mars. Each instance was evaluated for the quality of the detection and a judgment made on the process that originated it, including the possibility of the origin being “unclear”. The ridges were divided into categories, including polygonal ridge networks, mud cracks, glacial-related, lava-related, polygonal fractures, dark lines, unusual, and unclear. Patterned ground related to normal periglacial processes and dunes were not included in the study, having been thoroughly mapped by other authors.

Results: Polygonal ridge networks, previously only mapped in Arabia Terra and Meridiani Planum, were mapped in hundreds of places across mostly Noachian terrain. Arabia Terra had the most polygonal ridge networks, but concentrations of networks were also found in Noachis Terra and along the dichotomy near Nepenthes Mensae. This was the largest category with 2830 instances. Many instances were extremely subtle, either because of low relief in topography or lack of contrast, making them barely visible except at the greatest resolution of the CTX mosaic. Many instances that would have been otherwise overlooked were identified where black sand had accentuated the pattern against the otherwise grey background. These findings imply that there could be much more patterned ground or polygonal fracturing at a resolution below that which is visible via CTX.

Polygonal fractures were found extensively across the Kasei Valles outflow channels. Tectonic features, between fractures and wrinkle ridges, were found mostly in Bosporous Planum. 284 instances of polygonal fractures were investigated.

Mud cracks were concentrated in two valleys: Ares Vallis and Mawrth Vallis. Those in Ares Valles were more subtle with ridges enclosing less geometric and more regular shapes, while several instances in Mawrth Vallis were true mud crack polygons with geometric shapes and sharp corners. 119 instances were investigated.

Some instances of dark lines turned out to be marginal cracks on inflated lava plateaus. Other instances were found in the walls of polar craters, having to do with the sublimation of ice. In this and other cases, the lines were often black due to a source of black sand nearby that accentuates the pits. The most unusual type of network is found in Meridiani Planum, where connecting ridges are arcuate. The patterns seen here are reminiscent of polygonal ridge networks found on Egypt’s carbonate plateau [3].

Significance/Benefits to JPL and NASA:

The time spent going through the database compiled by the Citizen Scientists yielded many new insights about various parts of Mars and the diversity of processes that can create polygonal forms. The various polygonal ridge and fracture network types will provide the seeds for future proposals to the Mars Data Analysis Program (MDAP) and Solar System Workings (SSW) for analog studies in Egypt.

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