EPSC Abstracts
Vol. 11, EPSC2017-555, 2017
European Planetary Science Congress 2017

ESKER-LIKE RING-SHAPED RIDGES IN PETA, NOVARA AND TWO OTHER UNNAMED CRATERS ON MARS: EVIDENCES OF ANCIENT GLACIERS?

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Abstract

We found in Peta, Novara and two other unnamed craters south Meridiani Planum (Mars) ring-shaped ridges that shows morphology and morphometry possibly consistent with terrestrial eskers. On Earth, these latter are deposited by fluvio-glacial systems and are exposed when ices retreat. Further analyses are in progress.

1. Introduction

1.1 Background

Argyre Planitia and Dorsa Argentea Formation (early Hesperian) are in the southern emisphere of Mars, respectively in mid-latitudes and close to polar regions. Their terrains show well-developed and elongated ridges by the most interpreted as eskers ([1], [2], [3], [4]). On Earth, it is well known that these morphologic features (composed by poorly sorted consolidated sediments) are deposited by glaciers and are exposed when ices retreat. Their length follows the direction of movement of the ancient ice-tongues, and gives us an idea of their maximum extension during glaciations. However, on Mars similar ridges are not exclusive of mid-high latitudes, but can be found in some topographic basins, also close to the equator. In the present work, we focus on the Paraná/Loire Valles and Erythraeum Chaos quadrangle (south Meridiani Planum). We analyzed Peta Crater (Lat 21°S, Lon 351°E; Fig.1a), where sinuous ridges have been previously observed by [5]. We found that also Novara crater (Lat 24°S, Lon 350°E; Fig. 1b) and two other unnamed craters (UC1; Fig.1C, Lat 19°S, Lon 346°E and UC2; Fig. 1d, Lat 19°S, Lon 347°E) contain similar features.

1.2 Methodology

The region has been analyzed using high-resolution visible images (MRO CTX, 6.0 m/pix and HiRISE, 0.25 m/pix). Topographic basemaps are from HiRISE DEMs, obtained by stereo-pairs (1.0 m/pix). Images have been processed using the USGS ISIS 3 and georeferenced into ArcGIS 10.x. HiRISE DEMs have been obtained using NASA Stereo Pipeline and Bae Systems © Socet Set.

2. Observations

The studied craters have diameters comprised between ~40 and ~90 km. Peta crater, UC1 and UC2 are all characterized by one main impact basin plus a secondary crater. This latter is superimposed on the main one. Crater basins contains one or more circular ridges, following almost continuously (in the case of Peta) or discontinuously (in the case of UC1 and UC2) the crater perimeter. Radial ridges are also exposed in UC1. On the contrary, Novara crater has an elliptical shape and contains ridges only close to its south-western borders and in its middle toward northeast. In plan-view, ridges are occasionally branched and anastomosing. In cross-section view, ridges are up to several hundreds of meters wide and some tens of meters high. Their shape is usually asymmetric, characterized by one steep side toward the crater interior and one gentle side toward the crater exterior (Fig. 1e). The crest of the ridges is sharp or rounded and in several cases split in two parts by a trough (multiple crested; Fig. 2). Analyzing THEMIS-IR day and night images [6], the thermal inertia of these ridges is generally higher than surrounding terrains, suggesting they are well consolidated.

3. Preliminary Discussion and Conclusions

The ridges in all the considered craters do not appear to have any possible fluvial source channel. Thus, they probably formed by other mechanisms [5]. According to [5] one possibility is that the ridges in Peta crater are push moraines and barrier ridges that form and are modified as the ice cover freezes to the shore in colder months, then melts and moves around with changing winds in warmer months. A similar hypothesis could be extended to all the other observed craters in the present study. On the other hand, the progressive retreat/advance of the ice-sheets should make more than one order of moraines (i.e. cirque moraines). However, in the crater basins we observe only one main ring of ridges. Based on our preliminary analysis, we propose an alternative hypothesis to simple moraines. In fact, the branched/anastomosing plan-view elongation of the ridges and their occasional extension in the interior of the basins (as for example in Novara and UC1 craters) suggest that they could be related to fluvio-glacial processes. This hypothesis seems to be sup-ported by the morphology and morphometry of the ridges, that is consistent with terrestrial eskers (e.g. [7], [8]) and with the ones observed in the Dorsa Argentea and Argyre regions. Ring-shaped eskers in the craters could form by the progressive melting of the glaciers starting mainly from their thinner outer borders and creating water flows moving in function of the local topography. At the same time, the forming eskers are radially pushed outwards by the flowing/sliding ice.

Acknowledgements

Support from Swiss NCCR PlanetS is gratefully acknowledged.

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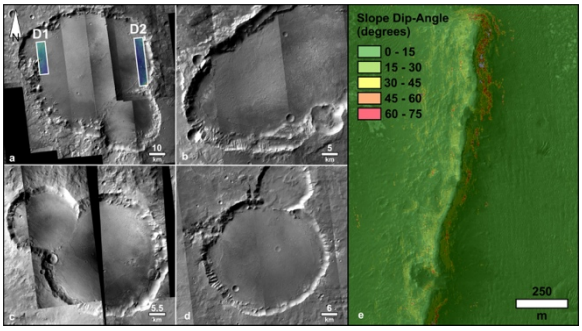

Figure 1. CTX images of Peta crater (a), Novara crater (b), UC1 (c) and UC2 (d). D1 and D2 are HiRISE stereo-pairs. In figure (e) is represented the slope dip-angle of one sample of the ridges inside Peta crater (calculated from HiRISE DEM D2). The crater center is toward left in the image.

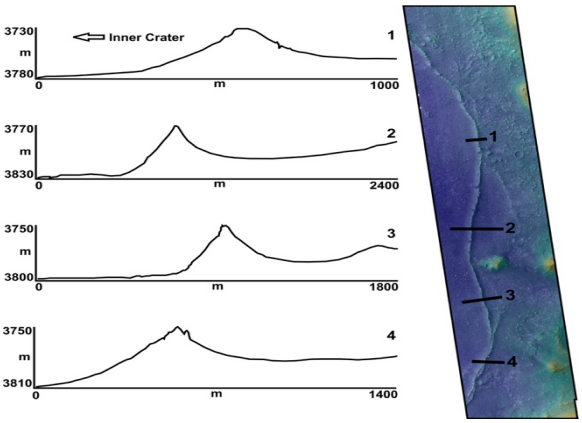

Figure 2. Cross-section profiles of one sample of the ridges inside Peta crater (calculated from HiRISE DEM D2).