

SCALLOPED TERRAINS IN UTOPIA PLANITIA, INSIGHT FROM HiRISE. A. Lefort¹, P. Russell¹, N. Thomas¹ and the HiRISE Team, ¹Physikalisches Institute, University of Bern, CH-3012 Bern, Switzerland, Alexandra.lefort@phim.unibe.ch.

Introduction: The mid and high latitudes of Mars are covered by a smooth meter-thick mantle, first discovered by Mariner 9 and Viking. Mars Orbiter Camera images show various types of dissection features, similar to Earth periglacial landforms. This mantle has been postulated to be a thin layer of an ice-dust mixture, formed as airfall deposition related to an extended decrease in the planet's obliquity 4.5-3 bya [1] [2] [3].

Milliken et al. [1] have studied the various types of landforms in the mid-latitude mantle deposits. They notice a latitude gradation in landform morphology that they relate to the progressive erosion of the mid-latitude mantle as the planet comes back to low obliquity. Among these landforms, they identify a "scalloped terrain" (40-60°), characterized by large depressions. These depressions are reminiscent of south polar "Swiss cheese" terrain, which are presumably formed by interstitial ice sublimation [4]. According to [1], the regions of large "scallops" (centered at ~ ±55°) are the areas of the mantle where erosion is currently the most active because of higher ground ice instability. Some of these scalloped terrains may still be evolving [6]. We are studying the scallop formation processes to better understand near-surface ground ice stability and potentially improve age estimates of mid-latitude mantle.

Two types of formation processes have been proposed. In the region of Peneus Patera (60° S, 65°E), [6] [7] and [8] propose that these scallops may have been created by sublimation of interstitial ice. Other studies ([9] [10] [11]) in the region of Utopia Planitia (45°N , 85°E) have interpreted the scallops to be thermokarst lakes, created by melting of a permafrost and collapse of the dry surface layer.

Recent data from the HiRISE camera onboard Mars Revolution Orbiter provides us with greater insight on the scalloped terrains in Utopia Planitia and on their possible formation process, owing to the high resolution of the image data.

Scallops in Utopia Planitia: Scalloped terrain is found between 45 and 50°N where the mantle is highly discontinuous. Previous studies using MOC and MOLA data show that their southern slopes are generally steeper with more recent scarps, while the northern slopes are shallower and gentler. They are 4 - 20 m deep

and include internal layers about 100 meters thick, which seem to be made of thin material, such as sand or dust. The scallops are also crossed by a series of parallel cracks, indicating a strong, cemented surface. These fractures are similar to ice-wedge polygons in terrestrial permafrost regions. This area also displays lobate mounds and debris aprons which [6] interpret as stemming from an icy permafrost assemblage.

Some of the depressions have apparently coalesced together. MOC images reveal features consistent with different stages of a scalloping evolution, from what appear to be initial 100-meter long depressions later extended to regions of fretted terrain over several kilometers wide. These areas of fretted terrains may originate from the coalescing of several scallops as thin, residual ridges can be often be found in-between.

Small-scale features seen by HiRISE: 30-cm resolution HiRISE images allow identification of small-scale features that were barely, if at all, visible in the previous images. New features include small-scale polygonal cracks (Fig. 1) bright rocks spread all over the surface (Fig. 2), bright dunes, buttes that may be interpreted as pingo or mud volcano, and details on the layers within the scallops. The rocks have a diameter from 0.5 to 2.5 m, with sharp angles. The rocks are widely spread over the images, without any particular pattern. Possible hypothesis for the origin of these rocks are ejecta, since several craters can be seen in the surroundings on the context images, volcanic floods, or boulders emplaced by glaciers or periglacial processes.

It is also possible to identify different types of scarps within scallops, from steep scarps delineating the depression, to gentle scarps corresponding to the top of layers inside of the scallops. There is no color variation from one layer to another and we observe no thinner layering. They seem to be composed of a single type of indurated material. Several dunes aligned in a NW-SE direction are also visible all over the image, mainly located inside of the scallops, maybe composed of sand grains left after disappearance of the interstitial ice.

HiRISE also reveals a large variety of polygonal cracks, whose sizes seem to be partly dependant on their location. We can notably observe small polygons (5 m wide) and knobby terrains within the scallops, and larger polygons

(50 to 100 m wide) outside of the scallops, on the surface of the mantle. Some cracks cut through the side of the scallops, suggesting that they must be at least as deep as the scallops. They are 0.5 m to 4 m wide and seem to be filled by darker material. The polygons may have been there previous to the erosion of the mantle. The polygons would have been eroded during the scallop formation, then smaller, younger polygons would have been created on the floor of the scallops, different in size and shape because of a different type of material (possibly more dusty and less icy), within the scallops.

Conclusions: All these observations point to a formation process more complex than a simple sublimation model. Sublimation may have acted in combination with other processes, such as aeolian or thermokarstic erosion. To constrain the formation process, some particular aspects of these landforms, such as the presence of layers within the depressions, and the relation between polygons and scallops need to be further explored. We are currently working with more

HiRISE images and stereo data to investigate these features and potential formation processes.

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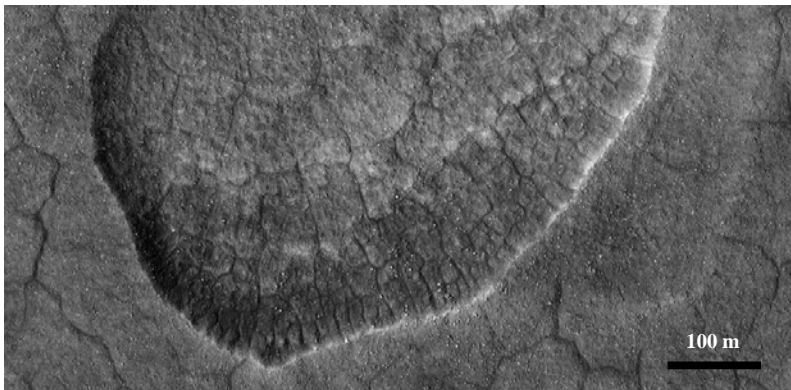


Fig. 1. Scallop and Polygons in Utopia Planitia (HiRISE image TRA_00856_2265)

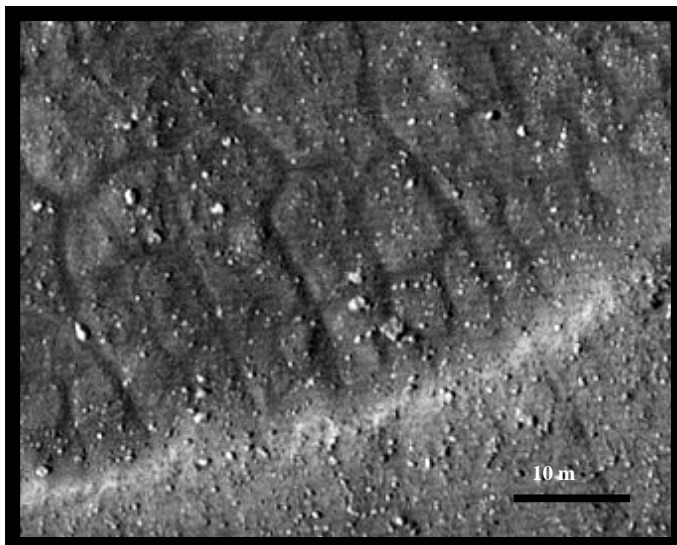


Fig. 2. Boulders and polygons in Utopia Planitia (HiRISE image TRA_00856_2265)