SCALLOP-SHAPED DEPRESSIONS AND MANTLE SUBLIMATION IN THE MID-LATITUDES OF MARS. A. Lefort[1], P. Russell[1], N. Thomas[1], [1] Physikalisches Institute, University of Bern, CH-3012 Bern, Switzerland, Alexandra.lefort@phim.unibe.ch.

Introduction: The mid-latitudes of Mars (between 30 and 60°) typically have a smooth-dissected mantle of apparently thin material. Interestingly, we observe scallops and mesa in certain regions here which are very similar to the "Swiss-Cheese" features of the South Polar Regions. Sublimation of a ice-rich material has been repeatedly proposed to explain the formation of these landforms. The region of Amphitrites-Peneus patera (55 to 65 °S, and that of Utopia Planitia, (45 to 55°N) both display these and other landforms suggestive of interstitial ice, such as patterned ground and fretted terrains.

We use a combination of MOLA altimetry, MOC, Themis and TES data, and ArcGIS analysis to explore what processes may have eroded the mantling unit and whether they are similar in both hemispheres. Answers to these questions will enhance our understanding of the geological history of Mars.

Dissected mantle terrains. First observed in Mariner 9 and Viking images, the smooth mid-latitude mantle terrains over 30° latitude in both hemispheres have been postulated [1] to be a thin layer of an ice-dust mixture, recent airfall deposition during the last periods of high obliquity. Between 30 and 60° of latitude various erosion features can be observed. This is called dissected mantle terrain (DMT) [1] and may, presently, be undergoing erosion. In some regions, features with curvilinear scarps, similar to the morphology of the Martian polar layered deposits can be observed. Such similarity in form suggests a similar mechanism of formation, involving dust and ice deposition, as has been proposed to have occurred in the polar regions. These processes may result from atmospheric cooling at the end of the Noachian Period [2][3][4][5].

Regional morphologies. [1] have denoted three principal types: (i) "localised complete removal" (30-50°) characterized by areas of non-eroded mantle adjacent to zones where that mantle has been completely removed, revealing a rougher unit underneath (ii) "knobby and wavy dissection unit" (30 to 55°), consisting of small bumps or ripples and (iii) "scalloped terrain" (40-60°), characterized by large depressions in the mantle, giving the surface a "scalloped" appearance. These last regions, centered at ~ ±55°, supposedly represent the current maximum area of erosion due to ice instability. At the poleward limit of dissectia and in the Peneus-Amphitrites patera, well developed scallops may still be expanding today.

Amphitrites-Patera. Located on the southern rim of the Hellas basin in Malea Planum it has two circular calderas. These are situated on a volcanic shield purportedly created by episodes of pyroclastic volcanism during the late Noachian period [7]. The mantle terrain covers the local high plains and almost buries craters between 300 and 1000 meters in diameter. This suggests a terrain thickness around 100 meters. Between 50 and 65°, we observe all three erosion morphologies identified by [1]. Below 50°S, the mantle is rare in the plains and highlands of that region, but can be found elsewhere within Hellas basin. At such low altitudes ice may be a component in spite of the high latitude. South of Peneus patera, above 65°S the mantle displays thin layers of dark and bright material. This morphology suggest that it is composed of sand and small particles such as dust and loess possibly cemented by interstitial ice.

Scalloped terrain is found between 55°S and 65°S where the mantle is highly discontinuous. These depressions are reminiscent of south polar "Swiss cheese" terrain, presumably formed by interstitial ice sublimation [4]. Northern slopes bear steep and apparently recent scarps while southern slopes are less steep. Elevation is lowest at the southern ends. Some depressions have apparently coalesced together. MOC images reveal scarps consistent with different stages of a scalloping evolution, from what appear to be initial 100-meter long depressions to 1000 meters wide regions of fretted terrain. These regions may originate from the coalescing of several scallops as thin ridges can be often be found in-between.

Utopia Planitia. Scallops here form between 250-300 meters altitude and are similar to those of Peneus-Amphtrites patera, except for a few differences. Their southern slopes are steeper and more recent scarps with shallower northern slopes. This is a reverse orientation compared with those in the southern hemisphere. They are also shallower (between 4 and 10 m deep) and include layers about 100 meters wide revealing a composition of thin material, such as sand or dust. They are also crossed by a series of parallel cracks, indicating a strong, cemented surface. The

fractures may also result from the removal of ground ice by sublimation. This area also displays lobate mounds and debris aprons which [6] interpret as stemming from an icy permafrost assemblage. In this hypothesis scallops would be lake basins, the mounds, mud volcanoes and the fractures, ice-wedge or mud desiccation polygons. Overall, scallops and associated landform types here correlate somewhat with location and latitude.

Formation process. According to [8] scallop formation should be ongoing at the present time. Sublimation of interstitial ice could induce a collapse of material, initially as a small pit, then growing southward because of greater solar heating on the southern side [8]. Nearby scallops would coalesce together as can be seen to have occurred. Zones of fretted terrain with low curvilinear ridges (visible on the MOC images) probably represent where coalescence was extensive. North of the 55° S the mantle is thinner and even more discontinuous including fretted terrains which may have been scalloped terrains that have eroded totally.

Further modeling. We are building a 2-dimension thermal model to evaluate the rate of sublimation occurring at different positions of the scallops in both hemispheres as well as in other morphological units of the DMT explore contraints and correlations associated with the evolution of these interesting landforms.

References:

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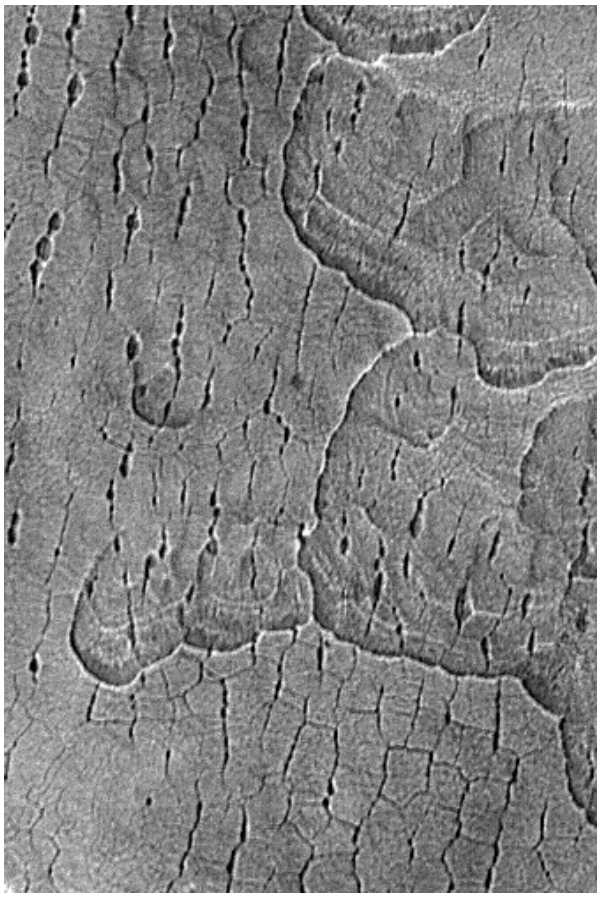
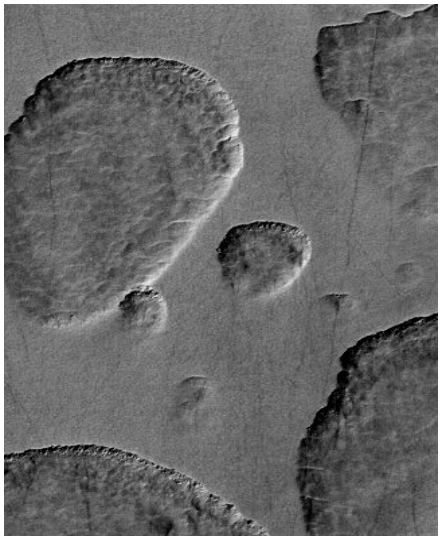


Coalescing scallops and fractures in Utopia planitia (MOC2293, 44.9°N, 274.7°W)



Scallops, NW of Amphitrites Patera (MOC image E1100369, 58.68°S, 294.23°W)