DISTRIBUTION AND GEOMORPHOLOGY OF THE LATITUDE-DEPENDENT MANTLING DEPOSIT IN HELLAS PLANITIA, MARS. M. Voelker, E. Hauber, R. Jaumann, German Aerospace Center, Institute of Planetary Research, Rutherfordstr. 2, 12489 Berlin, Germany (martin.voelker@dlr.de).

Introduction: Located in the southern mid-latitudes of Mars, Hellas Planitia is the second-largest confirmed impact basin on the planet, with a diameter of 2,300 kilometers. The basin also contains the topographically lowest parts of Mars, and hence, the highest atmospheric pressure on the planet of up to 11 millibar. Temperatures vary by season from 150 to 300 K [1, 2]. Thus, this vast depression is one of the atmospherically most active regions of Mars. This is also shown by the seasonal dust storm activity within the basin. This work will help to understand the distribution of landforms caused by water and ice in Hellas, and thus, the geography of potential habitable zones supporting life.

Methods: We applied the newly developed grid-mapping method as described by [3]. This is a useful method for analyzing the geospatial distribution of predefined landforms over a large area, by using high spatial resolution datasets. Using this method, the whole study area is separated into 20,000 grids, each with a size of 20×20 km. Mapping has been carried out in a GIS environment on the basis of CTX images (Context Camera onboard Mars Reconnaissance Orbiter) at a scale of 1:30,000. Because of the huge size of the study area, only every second grid is mapped (approx. 10,000 in total). At the time of writing, ~65% of the study area have been mapped.

Results: According to the roughness map of [4] most parts of the basin's floor are covered with so-called Latitude-Dependent Mantling deposits (LDM) (Figure 1 A and B). It is unclear if the process responsible for depositing LDM is still active on Mars or if it is just temporarily halted [5]. However, according to crater-size frequency distributions, LDMs were deposited in geologically recent times (0.4 – 2.1 Ma) [5]. At certain environmental conditions, like high obliquity or thawing conditions, LDM appears to get deformed or eroded into several morphologies, e.g., scalloped terrain and Layered Remnant Deposits (LRD) in craters (Figure 1 C and D).

Our mapping shows that there is an extensive area (~200 × 800 km) of an elliptical plan-view shape in the NE part of Hellas where LDMs are lacking. This observation is consistent with the roughness map of [4], as this spot shows high roughness values. The rest of the basin is covered with LDM. However, the more south LDMs are observed, the less they are textured and eroded, and they appear to be young and smooth. Scalloped terrain is referred to rimless and often axisymmetric depressions within LDM, formed by subsurficial loss of ice and/or volatiles thought to be contained in the LDMs [6]. It is assumed that their topography and development is linked to solar insolation and latitude [7]. Although there is an almost completely closed LDM cover in Hellas, scalloped terrain only appears in scattered locations south of 35°S. However, there is no other obvious distribution pattern recognizable.

North of 37°S there is an increased prevalence of LRDs within smaller craters (0.1 – 3 km in diameter). They usually occur at the southern parts of the crater interiors, and are hence exposed to the Sun.

Discussion: We hypothesize that the lack of LDMs in NE Hellas may be the result of wind circulations within the basin. According to [8], wind currents rotate clockwise in Hellas. Cold polar winds, possibly catabatic, enter the basin at a gap in the rim in SW Hellas, draining down from the south polar highlands toward the north. When they reach the northern parts of Hellas at a latitude of 30°S, they might warm up and begin to move south again. Thus, they may trigger either enhanced sublimation of LDM material in NE Hellas or prevented an atmospheric deposition as the winds have become too dry at that place. This observation supports theories of a high amount of volatiles within LDM.

The evolution of LRDs remains much more enigmatic. We hypothesize three different scenarios. (1) Eolian processes might have caused sublimation. But wind does not explain the strict location of the CCF in the southern half of the crater bowls over such a huge area. (2) Volcanic ashes, transported over wide distances, like the Medusae Fossae Formation along some equatorial regions on Mars, are also a possibility. They can explain the uniform orientation of the LRDs', caused by eolian and lateral transport of dry volcanic ashes or ballistic transport of pyroclastic material directly from a volcanic vent. However, there is no known volcanic feature northwest of Hellas. On the other hand, climate modeling by [9] suggests that a dispersal of volcanic ashes during the late Noachian or early Hesperian is possible, but only originating from volcanoes northeast and southwest of Hellas. (3) Solar insolation, and hence thermal sublimation, could explain the uniform location of these remnants over a big area. Moreover, this could explain the latitude-dependence of this landform, as they predominantly occur north of 37°. But this does not explain why the LRDlayers consistently “survived” in that part of craters that (currently) receives the most intense solar radiation. This theory would be conclusive if LRDs’ were located in the shaded northern half of a crater. Nevertheless, we assume this scenario as the most likely. Because of Mars’ permanently changing obliquity of up to 47° within the last 20 Ma [10], it is also possible that the northern parts of the crater interiors once received a high amount of solar insolation even at these latitudes. Thus, the volatile-rich material could have been removed there. If LRD is or was rich in volatiles, it is likely that it is composed of the same material like LDM. Another explanation for this paradoxical location might be that the LRDs’ are a result of an inverted relief. So it is possible that today’s LRDs’ were once hollows, that have been refilled by another material poor of ice.

Despite scalloped terrain being latitude-dependent, it does not appear continuously south of 35°S, although there is a complete LDM cover. A possible reason for this scattered pattern might be a varying amount of volatiles within the LDM blanket.

Conclusion: On basis of grid-mapping, it was possible to analyze the geospatial distribution of cold-climate landforms in Hellas. Thereby, an extensive elliptical gap of LDMs in NE Hellas became apparent; probably caused by clockwise wind circulations within the impact basin, causing either prevention of LDM deposition or sublimation of a pre-existing LDM layer. The exact evolution of Layered Remnant Deposits (LRD) is still poorly understood. However, it appears likely that these deposits were eroded by a process controlled by solar insolation (i.e. sublimation), which means they contained, or still contain, certain amounts of volatiles like ice. Hence, our observations support existing theories of a volatile-rich layer in the Martian mid-latitudes, typically termed LDM. Detailed statistical evaluations of our grid map will test, i. a., if there is a correlation between landforms and their elevation, aspect, and slope. Thus we will be able to derive further information about atmospheric conditions and layering within Hellas as well as the influence of obliquity cycles.

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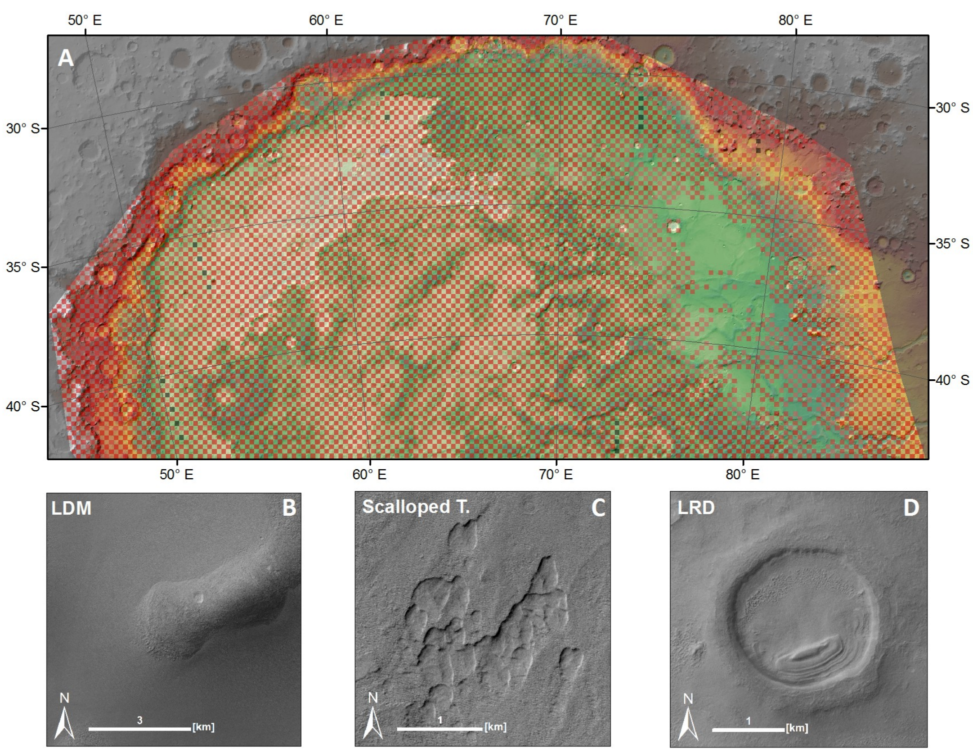

Figure 1.
(*A*) Distribution of LDM. The darker the grid the more prominent LDM occur (Basemap MO-LA).
(*B*) Smooth LDM unit draping a ridge (B19_016971_1346_XN_45S287W).
(*C*) Scalloped Terrain within LDM unit (P13_006133_1394_XN_ 40S305W).
(*D*) LRD and LDM within a crater (P18_008084_1461_XI_33S298W).