4.1.4 Arsinoes Chaos

Arsinoes Chaos (centred 7.5°S/332°E) is situated at the eastern end of Valles Marineris, bounded by Aureum in the north, Aurorae in the west and Pyrrhae Chaos in the south (Fig. 28). This locality is characterised by chaotic terrain and heavily eroded ILD material (Fig. 47).

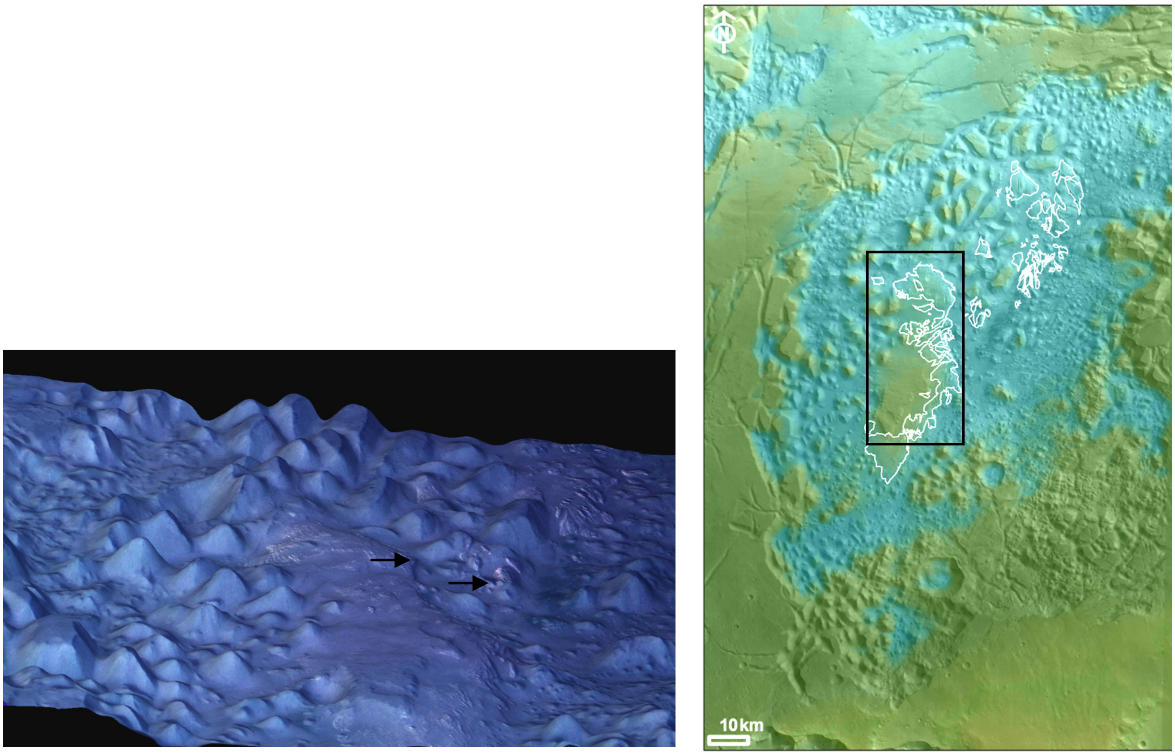


Figure 47: Location of Arsinoes Chaos ILDs. *(left)* HRSC false colour image as perspective view (orbit h0478_0000; 7.7°S/331.7°E). The ILD outcrop stands out from chaotic terrain remnants. Note that the ILD is partially covered by windblown material. Black arrows mark steep heavily eroded regions where ILD material is superimposed on chaotic terrain knobs. For context, see next figure. *(right)* ILDs occur within the enclosed chaotic terrain (HRSC orbit h0478_0000 overlaid by MOLA). Black box indicates the location of the previous figure.

Arsinoes:

The ILD is more or less NS-aligned and features a streamlined shape. Its extent is 92 by 40 km and its elevation ranges between -5200 m to -3800 m. ILD material surrounds or overlies chaotic terrain knobs (Fig. 47). Dark sandy aeolian material on top of the ILD represents the stratigraphically youngest unit (Fig. 49D, 49E). The surface appears rough and littered with fractures and shows a N-S lineated structure, which may indicate that the material was severely affected by unidirectional wind/or water erosion, as shown by the presence of grooves and yardangs (Sect. 2.3.1, Fig. 49D). Erosion probably took place from the north, as only the southern part is frayed.

The ILD is characterised by parameters shown in Table 15.

Overall, the albedo is low. The major part of the surface shows a low albedo as dark aeolian material is deposited there especially within fractures and grooves (Fig. 49E). Scarps and monadnocks on the top are of high albedo and thinly covered by dark material (Fig. 49A, 49D).

One morphological unit was identified (Fig. 49F). The top of the ILD appears massive (Fig. 49D, 49E), being heavily grooved and fractured and exhibiting yardangs which indicate erosion by wind and water (Sect. 2.3.1). Layering is undulated and laminated (49D).

Obviously high albedo cliff-forming material (Fig. 49E) is present whereas interbedded strata indicate material discrepancies and therefore there should be slope-forming materials as well.

The measured thickness was estimated to 1400 m (Fig. 49F). ILDs were assumed more extensive before erosion as shown by fragments of ILD material on chaotic terrain knobs, which is coincident to Iani (Sect. 4.1.3) for instance. Due to the lack of appropriate HiRISE-images, the presence of boulders at the base of scarps is not known but assumed by analogy with other ILDs (Sect. 4.1.1-4.1.3). Dark talus appears on MOC images, indicating that weathering and erosion affected at least incompetent parts of the ILD (Fig. 49E).

The BT of well-exposed ILD material is higher than that of its surroundings (Fig. 49B, Table 15), but there are also parts with a lower BT (Sect. 3.2.2) which are covered by dark aeolian material (Fig. 49B). ILD material appears white to yellow where it is not covered by loose material. Otherwise, it is brownish when covered by dust (Fig. 49C). CRISM observations [*Roach and Mustard*, 2008] of well eroded showed that minerals comprising the ILD are featureless the spectral range of CRISM, i.e. there are no iron-rich or hydrated minerals (Table 8; Sect. 3.1.8).

Layering geometry could not be appointed, as layering is not traceable all around the ILD (Sect. 3.2.3).

Table 15: Parameters of Arsinoes ILD.

Morphology	Albedo	Elevation [m]	Thickness[1] [m]	Consolidation of Materials	Mineralogy	Layer Geometry
Streamlined; dome-like profile	Low[1]	-5200±25 to -3800±25	1400±25	Low TI[2] TI Ø: 359 SI±82 (surrounding: Ø 333±39) BT: 180-203 K (surrounding: 180-195 K)	Featureless in the spectral range of CRISM[3]	-

[1] section 3.2.1
[2] section 3.2.2
[3] *Roach and Mustard* [2008]: no Fe- or hydration absorptions (Sect. 3.2.2)

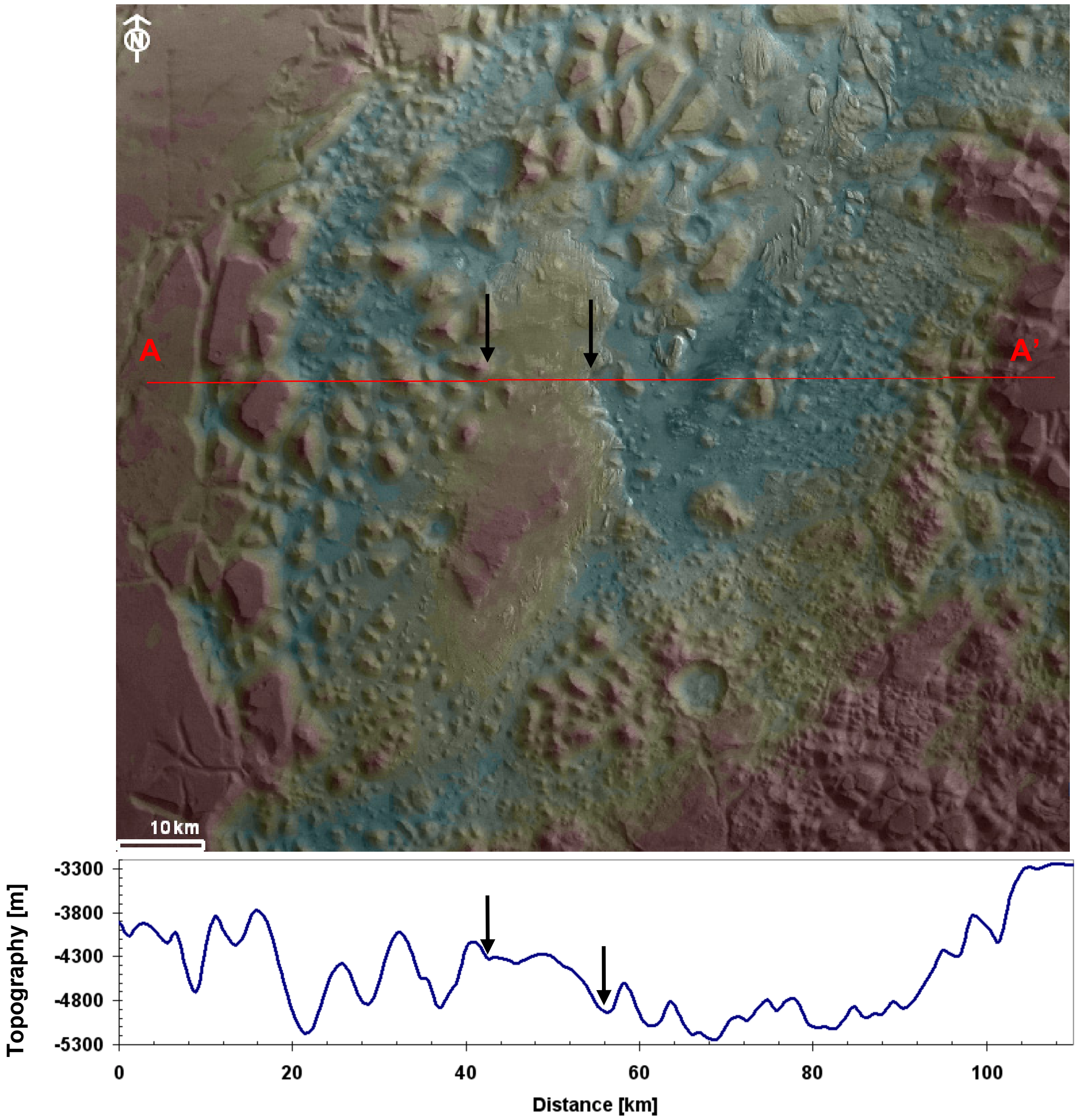


Figure 48: Profile covering Arsinoes ILD. *(top)* The ILD is located in a depression, surrounded, underlain and overtopped by blocks of chaotic terrain. It is bounded by arrows (cf. Fig. *below*; HRSC DTM orbit h0478_0000 overlain on nadir image; 7.1°S/342.4°E). *(bottom)* W-E trending profile showing ILD situated below the plateau and partially overtopped by chaotic terrain blocks. The ILD is marked by arrows (cf. Fig. *above*). Accuracy: Distance ±0.125 km, topography ±25 m (HRSC DTM orbit h0478_0000).

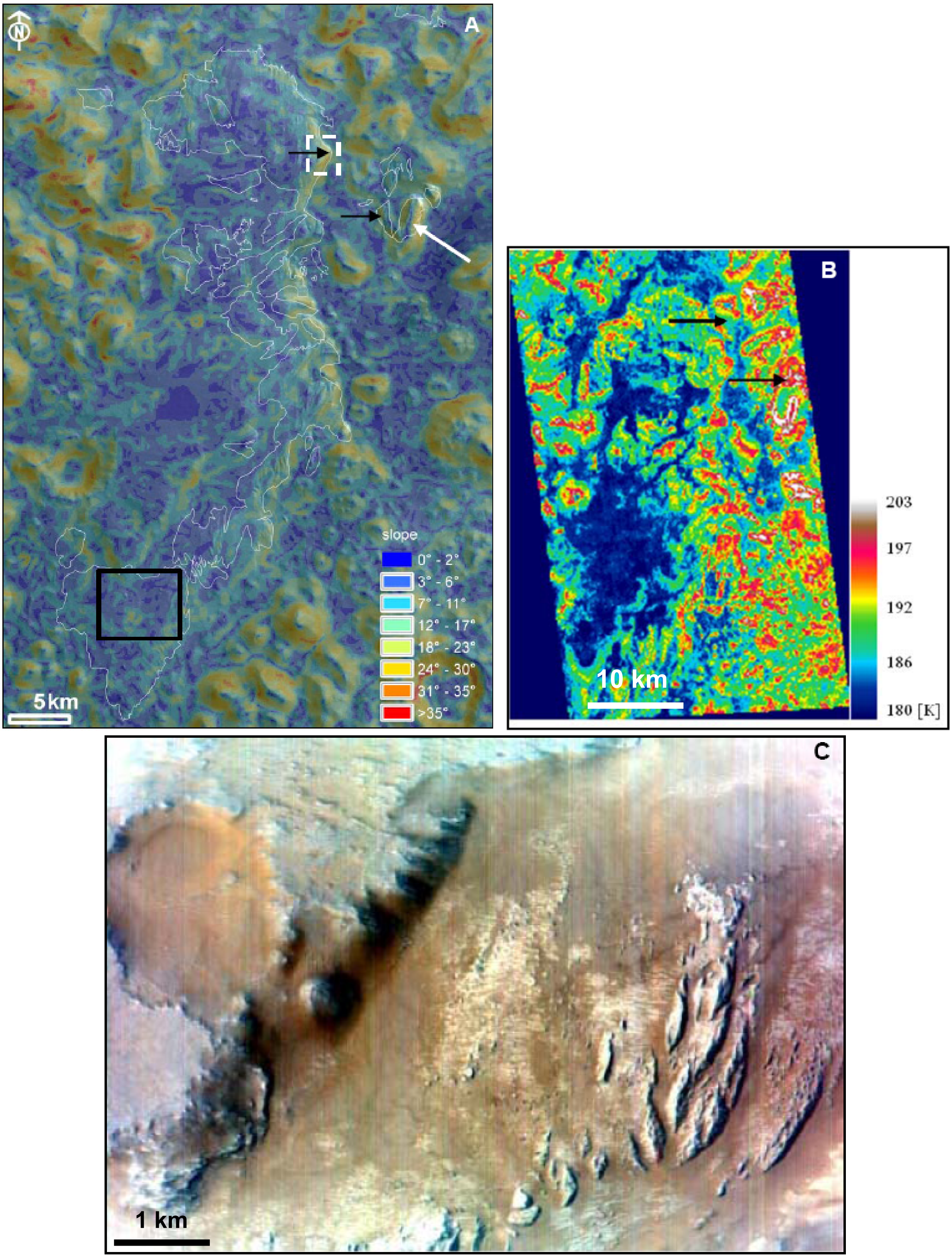
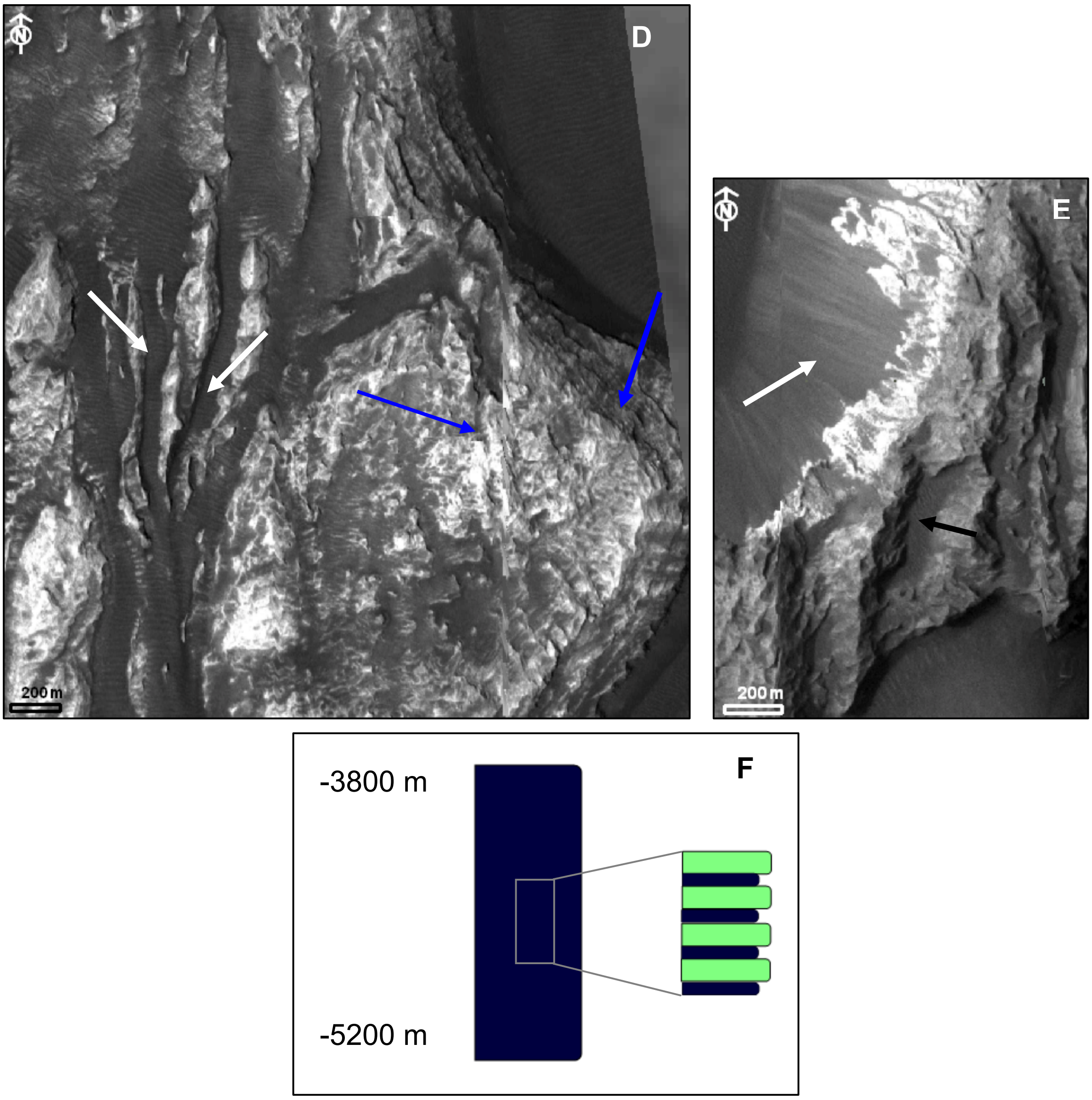


Figure 49: Properties of Arsinoes. (A) HRSC slope map (orbit h0478_0000; 7.1°S/342.4°E). For context, see Fig. 47, 28. The whole ILD features dominantly low slopes (0-10°) but some scarps have gradients of 20-25° in steepness. The white line marks the area where the ILD crops out (cf. Fig. 48), but its course extends to areas that are covered by windblown material as well to the east. Black arrows show areas of steep slopes that mostly correspond to more eroded parts with higher surface temperatures (Fig. 49B). White arrow shows the location of Fig. 49E. Solid black box identifies the region of Fig. 49C. White box shows Fig. 49D. (B) THEMIS BT map (orbit I06374011; L_S = 189.97 →S-spring; 7.1°S/342.4°E). For context, see Fig. 49A. Black arrows show high surface temperatures of 195-203 K in steep (Fig. 49A), more eroded regions. (C) CRISM false colour image (orbit FRT00008233; 7.9°S/331.7°E). On the ILD surface, no water- or Fe-bearing

minerals were detected [*Roach and Mustard*, 2008; Sect. 3.2.2]. Pyroxene was found in ripples surrounding and overlying the ILD. Its material is silhouetted against dark windblown material (below) that appears brownish. Note the friable, heavily eroded ILD material forming yardangs.



(D) Undulating strata observed on the ILD surface (blue arrow). For context, see Fig. 49A. The top is grooved (white arrow) and exhibits surface vales and monadnocks. Steep parts feature a high albedo; less steep parts show a lower albedo due to dark windblown material, mostly ripples, located in depressions (white arrow; MOC orbit E1300822; 7.1°S/342.4°E). (E) Dark talus appears at the base of steep scarps (white arrow). For context, see Fig.49A. Note the massive-looking surface. High-albedo regions are steep scarps with a thin aeolian covering (cf. Fig. 48, 49A). Dark sandy material is deposited in ripples on bedding planes (black arrow; MOC orbit S0300417; 7.1°S/342.4°E). (F) Thickness profile showing alternating strata of possible slope- and cliff-forming materials as observed in figure 50D. The whole thickness is calculated as 1400 m (Table 15). Laminated and undulated strata are observed (Fig. 49D). The ILD does not bear iron-rich or hydrated minerals (Sect. 3.2.2).

4.1.5 Aurorae Chaos

Aurorae Chaos (Fig. 50; centred at 7.5°S/326.7°E) is located east of the Valles Marineris and extends toward Capri and Eos Chasmata to the west (Fig. 28). To the east, it is connected to Aureum Chaos and to the north to Hydraotes Chaos. Several resistant chaotic terrain knobs are exposed on its partially smooth floor. It is a large, low-lying region (~-5000 m) ending in a sharp border with the surrounding plateau (>-600 m). The ILD mounds occur in a region, which appears smooth due thick low-albedo mantling in parts (Fig. 50).

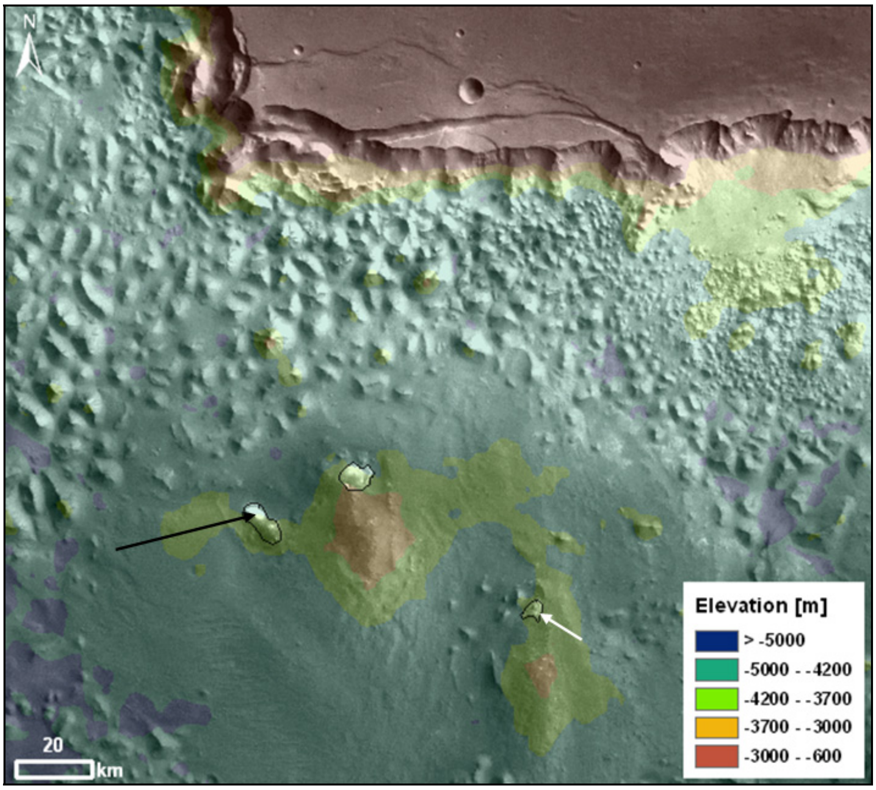


Figure 50: Elevation map of Aurorae Chaos ILDs. ILD exposures are outlined in black. Their elevation ranges between -4200 up to -3900 m. Windblown material covers much of the area under which the light-toned unit extends, appearing in orange to green colours (HRSC nadir image overlain by DTM orbit h0500_0000; 7.3°S/326.3°E). The black arrow corresponds marks the region of high BT shown in Fig. 51B; the white arrow point at the ILD with a dark cover and the CRISM sulphate detections.

Aurorae:

The ILDs (7.2°S/326.2°E) of Aurorae Chaos have been eroded into buttes and knobs. They are exposed at elevations from -4600 m to -3600 m within an area measuring 45 by 22 km. Although the region exhibits many chaotic terrain remnants, the main part surrounding the ILDs looks very smooth; this may be due to thick aeolian material cover confirmed by low BT in the ILD surroundings (Fig. 51B). This feature may be caused by an elongated ILD plateau extending below a thick windblown material coverage, this being the only site where ILD exposures have been observed. Several small-scale ILDs mostly formed by erosion-resistant mounds cover the chaotic terrain, which in turn is exposed on the canyon floor.

The northern part seems eroded, whereas the southern part is frayed, indicating that

erosion was more extensive in the northern direction. This might be explained by the example of the easternmost ILD, which is often called a 'teardrop'-shaped plateau as its north-facing surface looks freshly eroded, unlike the dark material covered southern part of the ILD shown in Fig. 51A, which is covered by dark material.
The ILD is characterised by the parameters shown in Table 16.
Only one morphological unit was identified. Its layering seems homogenous and undulating (Fig. 51C). Its apparent stair-stepped morphology indicates possible material differences within the ILD (Fig. 52C). The elevation-derived thickness is 1000 m (Fig. 51D, Table 16).
The freshly eroded part also shows steeper slopes (Fig. 51A) where exhumation is more effective as loose material is transported downslope, whereas flat areas trap loose material.
Overall, the relative ILD albedo is intermediate (Sect. 3.2.1). The high-albedo light-toned material differs strongly from the low-albedo canyon floor and the chaotic material.
The erosion of ILD material into buttes indicates that it was - or still is - relatively susceptible to erosion (inadequately consolidated), and that there probably has been a much more extensive ILD in the past. This unit is partially covered by windblown material from which ILD material crops out (Fig. 50). The butte morphology is strongly indicated by the slopes seen in Fig. 51A.
Bluish colours correspond to mafic sandy windblown material while brownish colours indicate dustier material; ILD material appears yellow (Fig. 51C). Like other ILD regions, the ILDs of Aurorae contain monohydrated sulphates (Sect. 3.2.2) that were detected by CRISM[1].
Layering geometry was not measured as layering is not distinct and traceable (Sect. 3.2.3).

Table 16: Parameters of Aurorae ILDs.

Morphology	Relative Albedo	Elevation [m]	Thickness [m]	Consolidation of Materials	Mineralogy	Layer geometry
Butte, dome-like profile	Intermediate	-4600±50 to -3600±50	1000±50	Low TI TI Ø: 304 SI±40 (surrounding: 280 SI±33) BT: 185-197 K (surrounding: 178-182 K) talus and boulders present	monohydrated sulphates	-

[1] http://crism.jhuapl.edu/

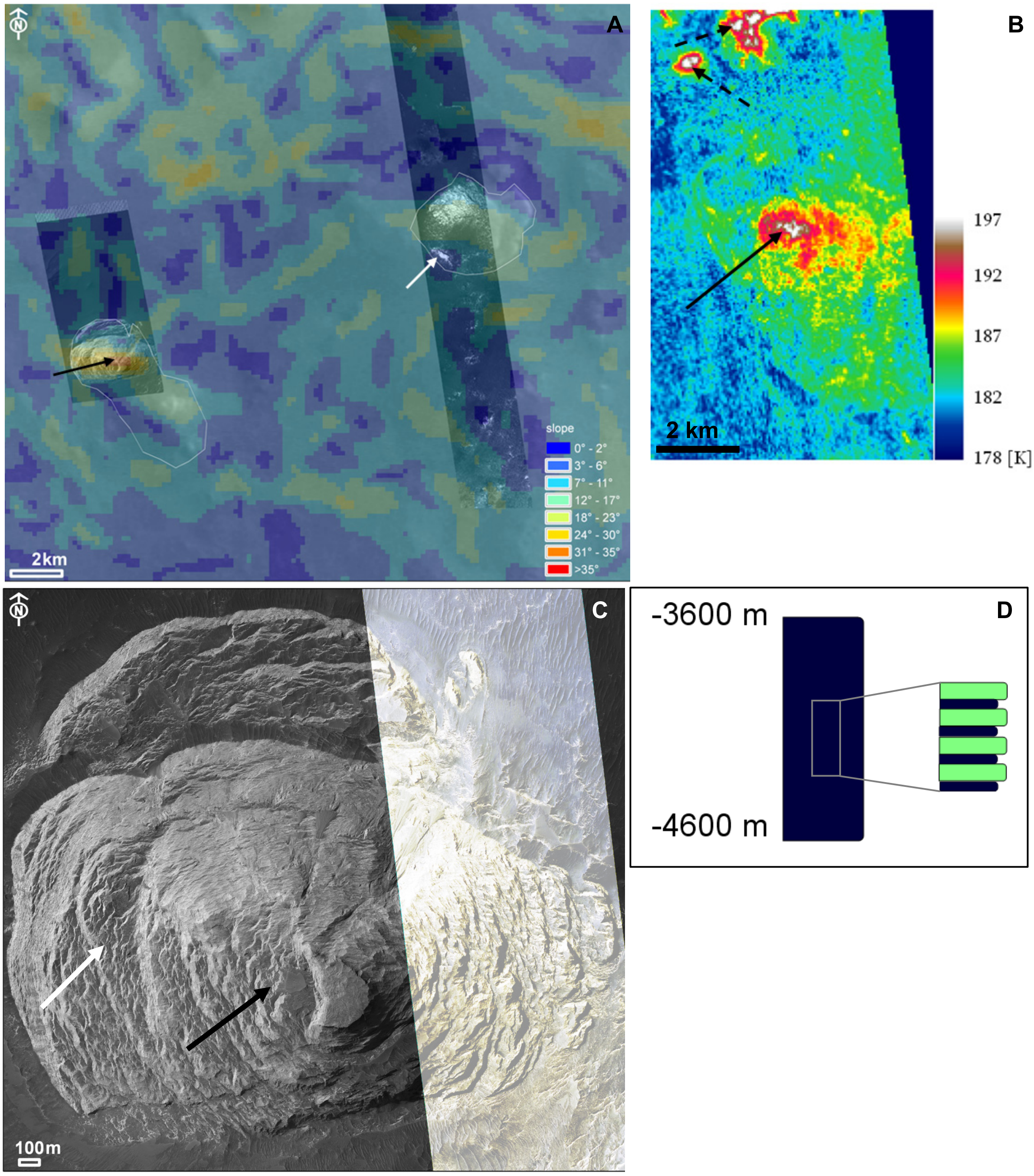
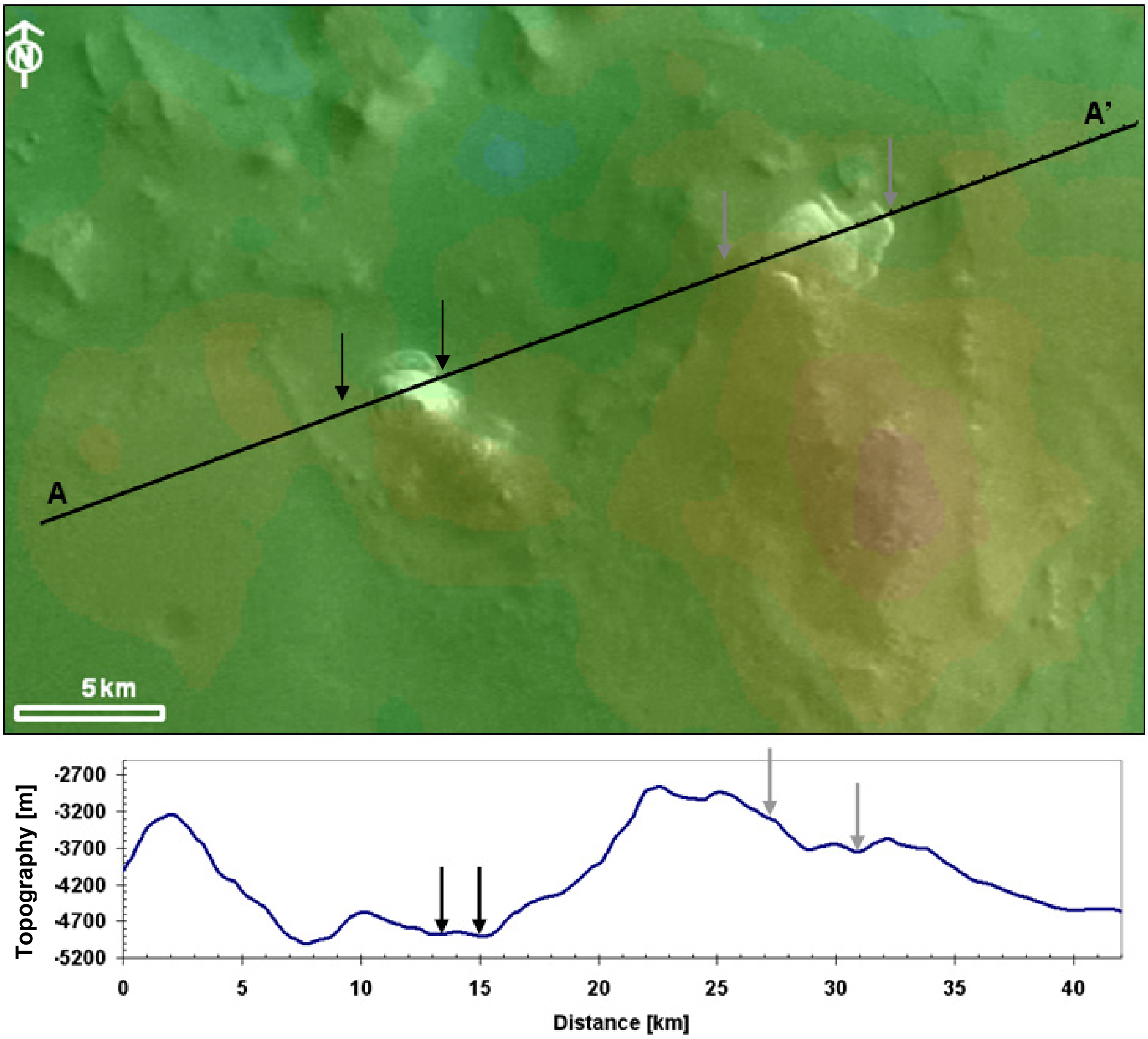


Figure 51: Properties of Aurorae. (A) HRSC slope map (orbit h0500_0000 overlain by MOC orbits E1201671 and R2000806). Note the slope of >5° up to 35° (black arrow; compare Fig. 51B, 51C; 7.1°S/326.2°E). White arrow indicates the location where the ILD crops out from the dark material cover in Fig. 51B. (B) THEMIS-BT map (orbit I22249027; L_S=153.3 →S-winter; 7°S/326.2°E) of the right ILD in Fig. 51A. The ILD's derived surface temperature ranges from 187 K to 197 K and is silhouetted against the lower-BT crater floor. The highest temperatures (black arrow) occur in a freshly eroded surface (Fig. 50, 51A, 51C) at the steepest part and the top of the ILD. Some chaotic terrain remnants nearby (dashed black arrows) show equally high temperatures but no evidence of light-toned material. (C) HiRISE grey-scale image overlain by false colour image (orbit PSP_007415_1730; 7°S/326.2°E) showing the left ILD mound of Fig. 51A. Layering is extensive and undulating up to the top. Its stair-stepped appearance shows several sequences of material. Note the flat top and other plain regions where aeolian material was deposited, and the steep parts (Fig. 51A) exhibiting debris fans at their base. False colour image shows the yellowish appearance of ILD material where it is not covered by bluish (corresponding to dark sandy material in the grey-scale image) and/or brownish material (dusty) material. (D) Thickness profile showing ILD material to be exposed between -4600 m and -3600 m. In the interior, a stair-stepped morphology appears, suggested by alternating strata on the right.



(E) *(top)* HRSC nadir image overlain by DTM showing the SW-NE-trending profile section covering two ILD mounds (7°S/326.2°E). *(bottom)* Profile showing the location of the ILD outcrops indicated by arrows. Compare figure *above* and Fig. 50 for context. Accuracy: Distance ±0.175 km, topography ±50 m (HRSC DTM orbit h0500_0000).