4.1.2 Aureum Chaos

Aureum Chaos is a crater with a diameter of ~295 km (4.4°S/333°E) situated southwest of Aram Chaos (Fig. 28) and east of Valles Marineris (Fig. 2, 10). To the west/southwest, it is bounded by Aurorae and to the south by Arsinoes Chaos (Fig. 28). The chaotic terrain dominating its floor is superimposed by smooth, cliff-forming light-toned material in the north to central part (Fig. 32). There, two different ILD morphologies (Aureum 1 + 2) are observed. Both show a ~NS-alignment (Fig. 32).

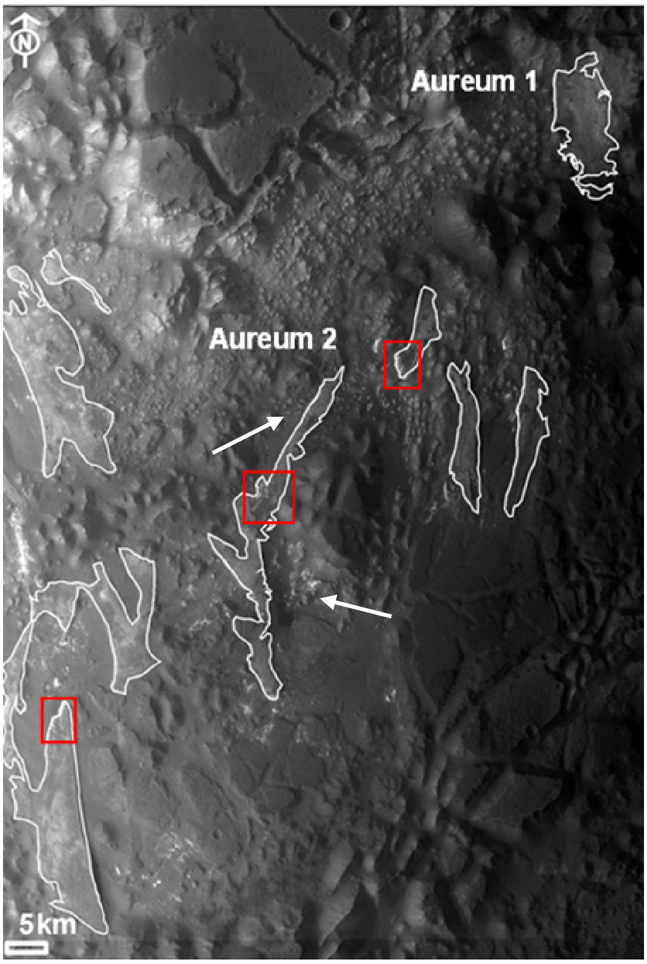


Figure 32: Location of Aureum Chaos ILDs. There are two different ILD morphologies in Aureum (4.1°S/339°E; outlined in white) situated on heavily disrupted chaotic terrain (arrow): Aureum 1 shows a flow-like shape, whereas Aureum 2 is a typical elongated mesa comparable to Aram Chaos (Sect. 4.1.1, 2.4.3). For context, see Fig. 28. These ILDs seem to be part of a lengthy plateau extending through the whole region (and further to the west; not visible here; Fig. 28) partially covered by dark material (HRSC orbit h1936_0000). Red boxes correspond to Fig. 36A (right), 37A (left), 38A (centre).

Aureum 1

Aureum 1 (3.1°S/334.1°E) has an irregular shape (frayed marginal parts; Fig. 33A) and features a mesa-profile (Fig. 34). It is located in the northern part of the crater (Fig. 32, 28) and is 7 by 15 km in extent. The ILD is exposed from -4600 m to -4100 m (Fig. 33D). Its overall albedo is intermediate. The ILD is characterised by the parameters shown in Table 10.

The ILD surrounds and in parts onlaps mounds of chaotic material (Fig.33A) indicating

that the ILD extended further and is younger than chaotic terrain. Erosion is demonstrated by small low-albedo mesas on top (Fig. 33A; cf. Sect. 4.1.1), yardangs located on the top, and friable material. Within depressions – mostly on the top -, dark windblown material is trapped. The flat top (Fig. 33B, 34) exhibits a surface that is characterised by vugs that are bounded by sharp crests and provide insights into lower layers (Fig. 35).
The ILD features just one unit (Fig. 35, Table 10): a high-albedo unit that shows a small-scaled, stair-stepped morphology and a thickness of 500 m (Fig. 33D). In some areas, small low albedo mesas (Fig. 33A) with light-toned scarps appear. On the CTX image (Fig. 33A) indicate similarities to unit 2 observed in Aram (Sect. 4.1.1) with respect to small mesas and the cap unit (Fig. 35; cf. Fig. 31D).
The lack of HiRISE images allows no further description of the surface morphology regarding the presence of rock break-up, boulders and talus.
No mineralogical information is reported from CRISM or OMEGA. Nearby in Aureum 2 sulphates and haematite were found.
Layering is not traceable all around the ILD, so that strike and dip was not measured (Sect. 3.2.3).

Table 10: Parameters of Aureum 1.

Morphology	Relative Albedo	Elevation [m]	Thickness[1] [m]	Consolidation of Materials	Mineralogy	Layer Geometry
Irregular, mesa profile	Intermediate[1]	-4600±12.5 to -4100±12.5	500±12.5	Intermediate TI[2] TI: Ø 401 SI ±43 (surrounding: Ø 354 SI ±46) BT: 198-206°K (surrounding: 190-206°K)	No data	-

[1] section 3.2.1
[2] section 3.2.2

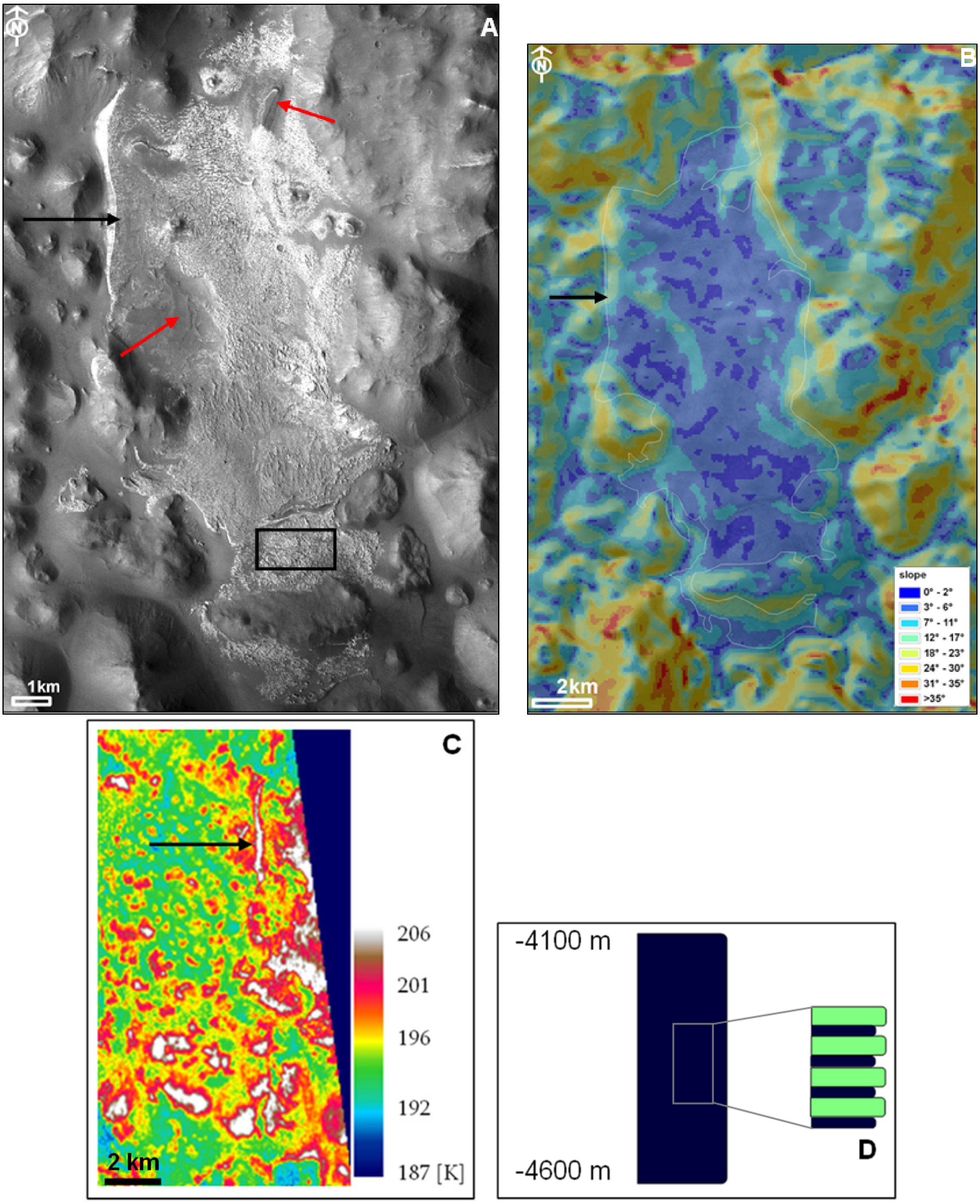


Figure 33: Properties of Aureum 1. (A) CTX image (orbit P06_003248_1755; 3°S/333.8°E) showing the eroded surface. Note ILD material encloses chaotic mounds especially in the southern part and onlap them in the west and north. Black arrow indicates steep (Fig. 33B) low-albedo scarp. Red arrows correspond to small, low-albedo mantled mesas in regions without the cap unit. Box marks the location of Fig. 35. (B) HRSC slope map (orbit h0103_0009) showing a flat top (0-5°) and steep scarps (10-25°; arrow). The ILD is outlined in white. Flat areas exhibit windblown material (Fig. 33A, 35). (C) BT map of the western part of Aureum 1. Surface temperatures are 198-206°K (Table 10). The highest temperatures are observed in steep (Fig. 33B) and high-albedo (Fig. 33A) ILD regions (arrow). (D) Thickness profile of Aureum 1 shows the estimated thickness of 500 m. The ILD is characterised by an intermediate albedo, a high BT (Fig. 33C), an intermediate TI (Table 10) and a rugged wind-affected surface morphology (33A). There are small low-albedo mesas on top. This unit (Fig. 35) shows similarities to the top of Aram (Sect. 4.1.1, cf. Fig. 31D).

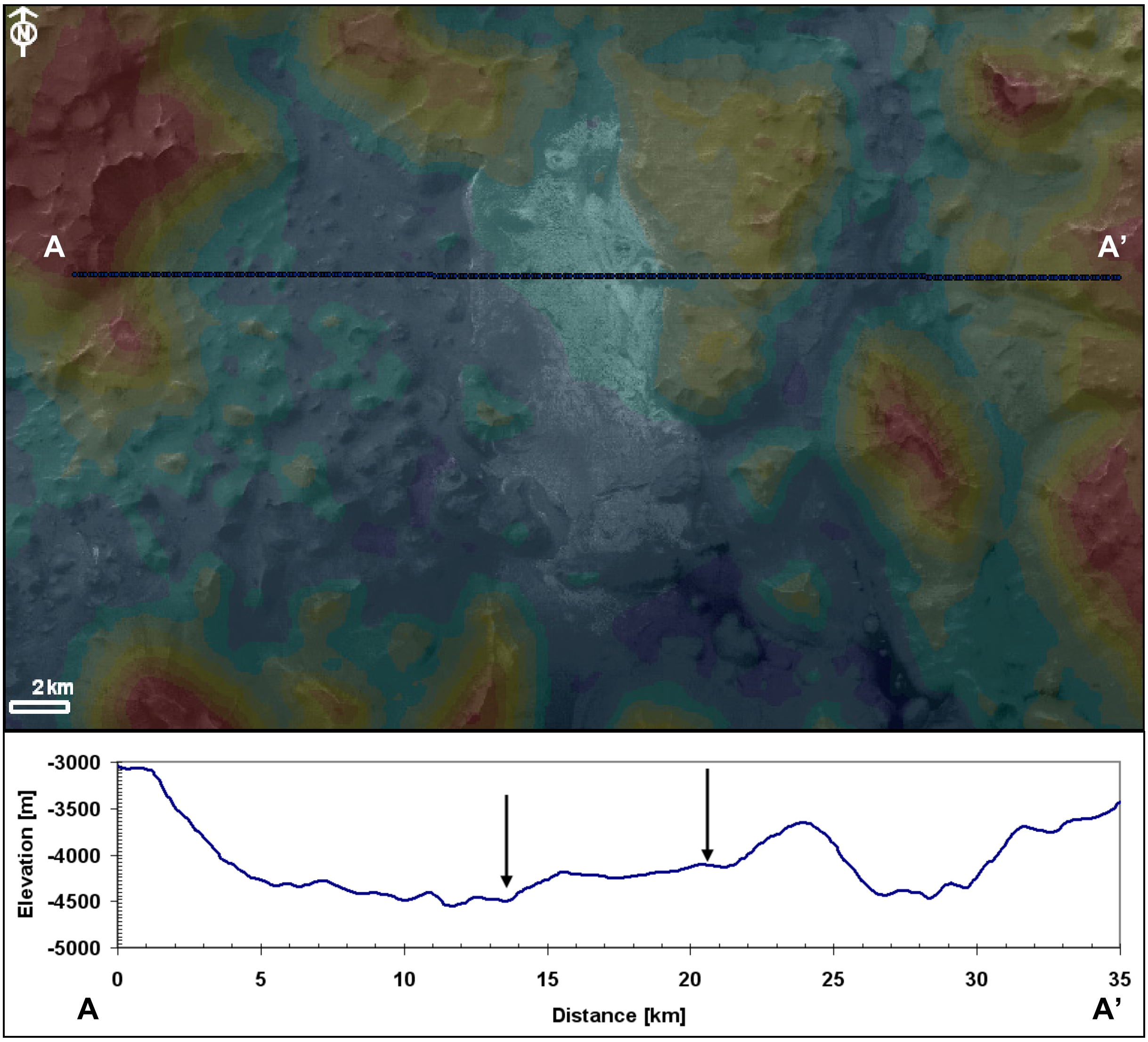


Figure 34: WE-trending profile of Aureum 1. *(top)* Profile course over chaotic terrain, crater floor and ILD shown on HRSC nadir image overlain by DTM. *(bottom)* Profile demonstrating mesa-structure by featuring flat top and steep scarps. Arrows indicate ILD exposure within chaotic terrain. Accuracy: Distance ±0.075 km, topography ±12.5 m (HRSC-DTM orbit h0103_0009).

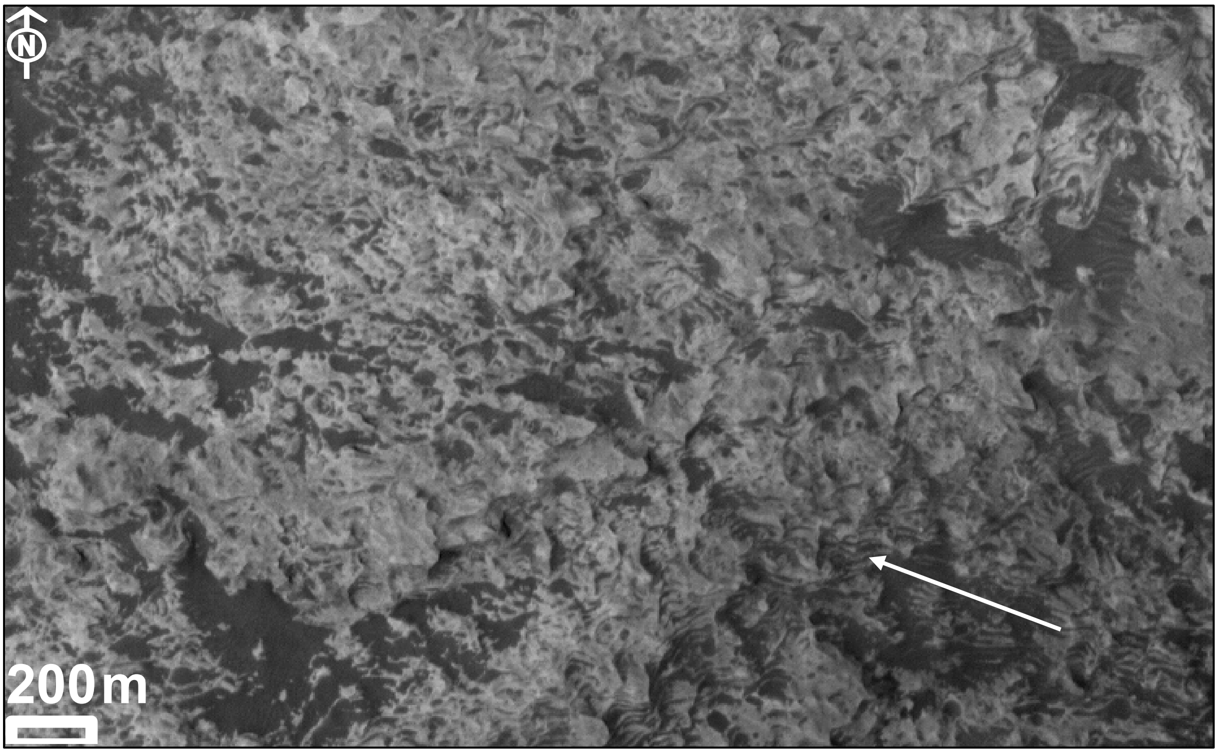


Figure 35: Distinct layering in Aureum 1. For context, see box in Fig. 33A. The surface is characterised by undulating strata. It appears affected by weathering and erosion as it exhibits surface vugs and monadnocks implying materials of different resistance to erosion and weathering. Alternating strata could also explain this small-scale stair-stepped morphology (arrow; MOC orbit S1400266; 3°S/333.8°E). This surface is comparable to unit 2 observed in Aram Chaos (Sect. 4.1.1, cf. Fig. 31D).

Aureum 2:

Aureum 2 (centred 3.8°S /334.4°E) is an accumulation of ILD material featuring an elongated mesa morphology and dome-like knobs (Fig. 32) that is comparable to Aram (Sect. 4.1.1). ILDs are exposed in a 34 by 60 km region. Their elevation varies between -4400 km and -3300 km. The ILD is characterised by the parameters shown in Table 11.
The mesa morphology is indicated by flat tops (0-5°) and steep scarps (10-30°; Table 11; Fig. 36D, 37B). Together, these ILDs (Fig. 32) seem to have had a much greater extent before they were eroded into mesas. Extensive fracturing and erosion may have contributed to the development of several mesas. The northern part of each ILD exposure seems to have a sharp border (side of erosion), whereas the southern part is more frayed, suggesting that erosion is coming from the north. The scarps feature a higher albedo than the top, which in turn is covered by dark windblown material, exhibits dark mantling and/or is topped by cap rock (Fig. 36A, 36F, 38B). At the scarps talus consisting of low albedo material and boulders of high-albedo material is present (Fig. 36F, 37D, 38B). Even on mantled low-albedo mounds, small exposures of light-toned material are present (Fig. 36A).
Two morphological units were distinguished. The lower unit (unit 1, Table 11, Fig. 36B) is thickly bedded and features a high albedo, steep scarps (10-30°; Fig. 36A-C, 37B-D), angular meter-sized fragments of material and angular joints (e.g. Fig. 36F, 36G) on a massive-appearing surface (Fig. 36F). It has a maximum thickness of 850 m (Fig. 36B, Table 11). The upper unit (unit 2) is characterised in parts by a slightly lower albedo and

thin bedding (Fig. 36F). It features a stair-stepped morphology implying alternating strata (Fig. 37D) which, in turn, indicates material differences, meaning that some materials are less resistant to weathering and erosion and is thus of different consistency. It features monadnocks and surface vales (Fig. 36F). Apparently, some materials are less resistant to weathering and erosion, so that the surface ultimately looks rough, sharp-edged and irregular (Fig. 36A). Laminated, undulating and convolute strata alternate with bouldered parts (Fig. 36E, 37D). Unit 2 comprises a maximum thickness of 950 m (Table 11). The thicknesses of the inner strata (from step to step) are below the HRSC-DTM resolution limit. However, 8-10 sequences (steps) were identified within an elevation range of ~50 m (Fig. 36B). A thickness of ~5-6 m per step was measured parallel with the contour lines (Sect. 3.2.2).

Weathering and erosion obviously affected the two units, as shown by their angular joints (Fig. 36G), boulders (Fig. 36F), surface vugs and talus (Fig. 36E). The steepest parts (Fig. 36D, 37B cf. Fig. 36A, 37D) show a high albedo because they are not so extensively covered by windblown material trapped in flat parts, increasing BT (Fig. 36C).

HiRISE false colour images show spectral differences in the material in addition to morphology and consolidation. Extreme fine layering is observed in the upper parts, such as the capping unit (unit 2), whereas the lower part (unit 1) shows clear indications of breakage as material weathers out (Fig. 36E). Meter-sized (cf. Sect. 4.1.1) boulders at the base of the scarps are yellowish, the same tone like ILD material. Conversely, talus appears darker (brownish). Furthermore, windblown dark material appears bluish on the etched surface of ILDs (sometimes rippled). This is dark (unweathered) mafic material that is mostly composed of pyroxene (cf. Sect. 4.1.1).

Along the scarps, minerals were detected (Fig. 37A, 38A) as the ILD material there is freshly eroded, and there is less trapped aeolian material on the flat parts (<5°). Kieserite and PHS were identified by CRISM [*Roach and Mustard*, 2008]. Both detections coincide with unit 1 (Fig. 36B). Haematite (Sect. 3.2.2) was detected by TES [*Glotch and Rogers*, 2007]. Stratigraphically located below unit 1, these haematite findings correspond to a region of low albedo located near the crater centre, whereas sulphates were found on light-toned steep scarps where layering can be best observed. Kieserite is restricted to steep (Fig. 36D, 37A, 38A, 37B), high albedo regions (Fig. 36F, 37D) and often shows angular joints (Fig. 36G), rock debris and boulders (Fig. 36E). It forms cliffs and is interlayered with PHS within unit 1 (Fig. 37D, 38B) or massive. It may even alternate with PHS within unit 2. This is suggested by the cliff-forming nature of kieserite and the high-albedo scarps, which produce boulders and talus similar to unit 1 (cf. Fig. 36F).

However, the cap unit (unit 2) is spectrally neutral (Sect. 3.2.2). These minerals do not show iron or hydration features, carbonates or nitrates in the required spectral range (Table 8; Sect. 3.1.8). Thus, spectrally neutral minerals might be other sulphates (anhydrite), halite or sylvite, or even silica (plagioclase) that show no absorptions in the VNIR. Conversely, in areas where the cap rock unit is eroded, PHS were identified (Fig. 37A) and thus occur within unit 1. PHS are slope-forming and of lower albedo often observed on bedding planes where kieserite is detected on scarps (Fig. 37A, 38A, 37B). They occur within unit 1 (Fig. 36B) and show distinct layering (Fig. 38B).

Strike and dip were not measured as layering is not traceable all around the ILD (Sect. 3.2.3).

Table 11: Parameters of Aureum 2.

Morphology	Relative Albedo	Elevation [m]	Thickness [m]	Consolidation of Materials	Mineralogy	Layer Geometry
Mesa, irregular profile	Low[1]	-5100±25 to -3300±25	Unit 1: 850±25 unit 2: 950±25	Low TI[2] TI: Ø 368 SI ±44 (surrounding: Ø 296 SI ±30) BT: 190-218°K (surrounding: 185-192°K) boulders and talus present	Haematite below unit 1, kieserite + PHS within unit 1, unit 2 is featureless[3]; nontronite within knobs nearby but not associated with ILDs	-

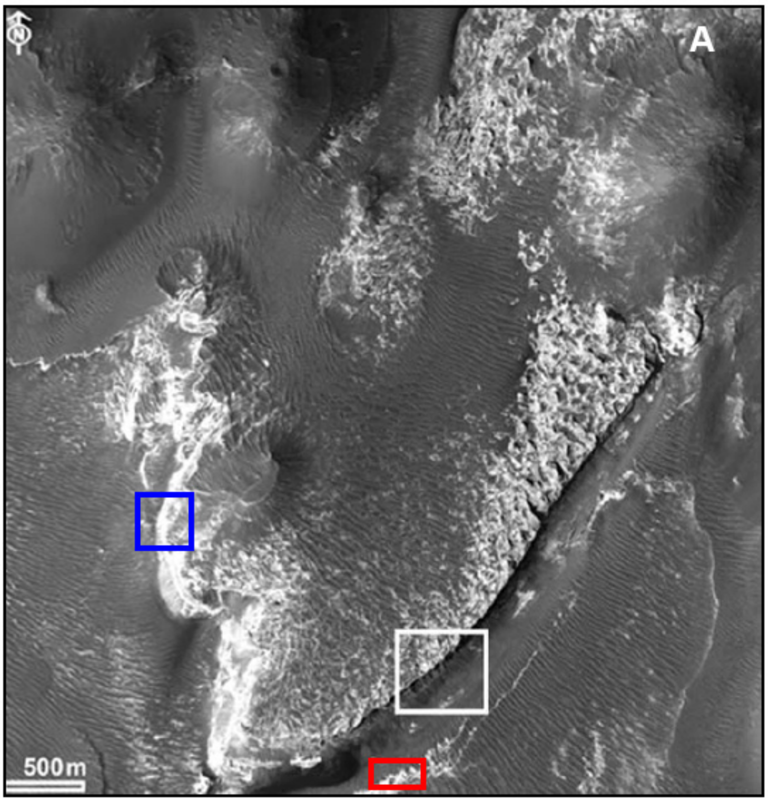
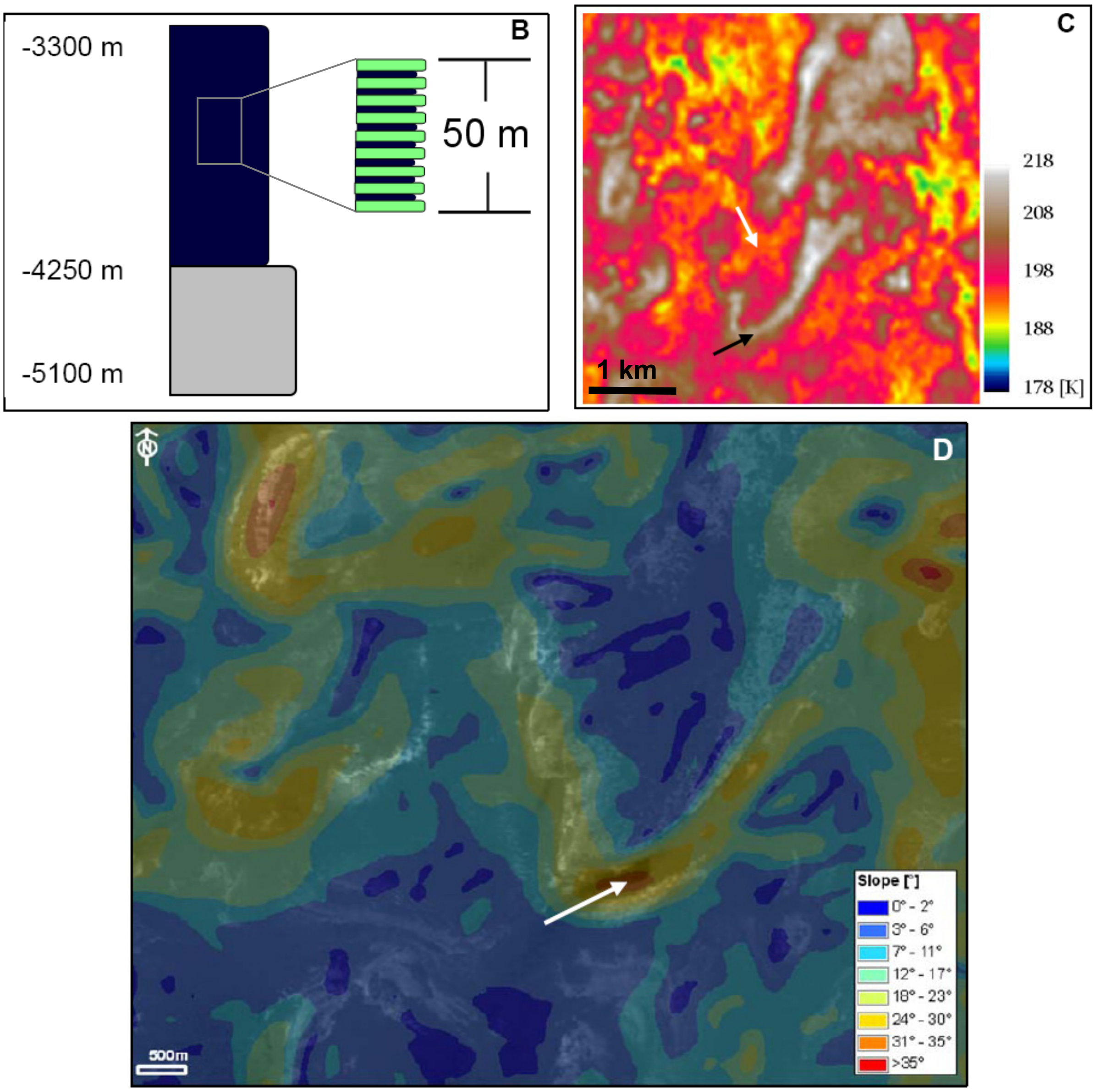
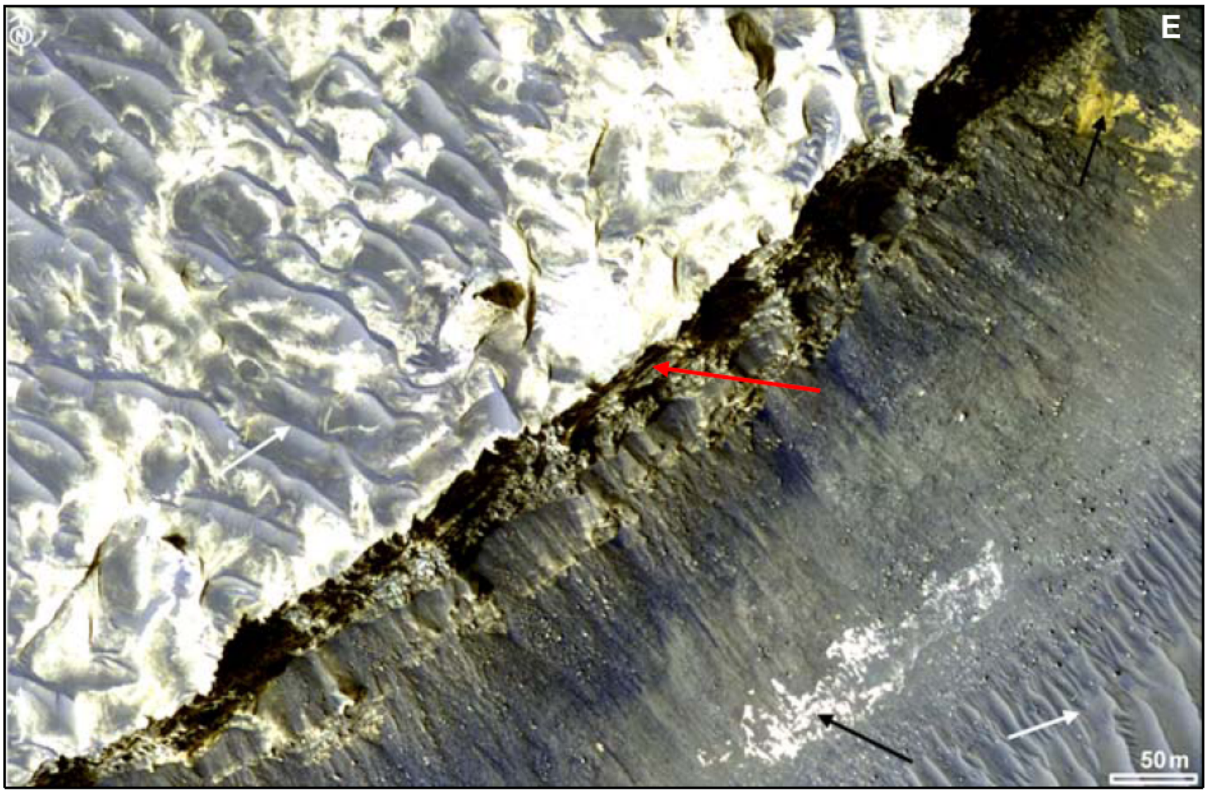


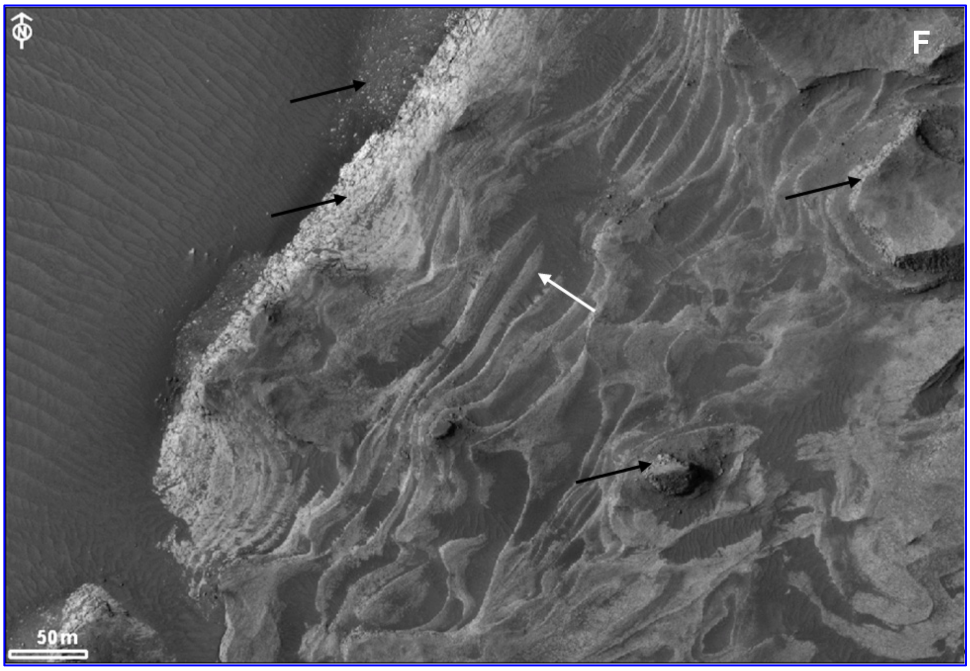
Figure 36: Properties of Aureum 2. (A) HiRISE image (*orbit* PSP_004026_1765; 3.6°S/333.7°E) shows an ILD eroded into mesa morphology. For context, see Fig. 32 (easternmost box). Note the surface is heavily affected by erosion and weathering. White box shows Fig. 36E, blue box shows Fig. 36F and red box Fig. 36G.

[1] section 3.2.1
[2] section 3.2.2
[3] in the spectral range of CRISM i.e. no hydrated- or iron-rich minerals



(B) Thickness profile showing unit 1 and unit 2 (cf. Fig. 32). Width corresponds to Unit 1 has a thickness of 850 m whereas for unit 2 a thickness of 950 m was estimated (compare Fig. 36E). Note within 50 m around 9 sequences are observed. Unit 1 is shows hydrated sulphates and higher albedo than unit 2. Unit 2 has more distinct layering which is convoluted and is spectrally neutral. (C) THEMIS BT map (*orbit* I17756020; L_S =340.8 →S-summer). Note maximum BT of ~218 K indicated by white, which coincides overall with high albedo and more or less uncovered material on the scarps (black arrow; Fig. 36D) and tops of both units. Conversely, regions of low albedo that are covered by dark aeolian material mostly accumulated in ripples feature a lower BT of ~190°K (white arrow; cf. Fig. 36A). (D) HRSC slope map (orbit h0103_0009; 3.6°S/333.7°E) indicating steep (10-30°), high-albedo scarps and flat top (0-5°) exhibiting dark material. Same detail as Fig. 36C. Note the steepest regions (20-30°; white arrow) coincide with high-albedo material, whereas flat regions (0-5°) mostly feature lower BT and albedo (Fig. 36C, 36A). The white arrow indicates same region identified in Fig. 36C by a black arrow.





(E) HiRISE false colour image (orbit PSP_004026_1765) shows both units (Fig. 36B). For context, see Fig. 36A (white box). Spectral differences between ILD material (yellow and white), mafic aeolian material like dark sand (bluish) and dusty material (brownish) appear clearly. Steep slopes (Fig. 36D) display talus and boulders (yellowish) indicating consolidated. ILD material crops out (black arrows) below loose material coverage. Red arrow indicates alternating strata of laminated material in unit 2. Ripples (white arrows) are present on the ILD surfaces and in their surroundings. (F) HiRISE (orbit PSP_002892_1760; 3.6°S/333.6°E) showing a stair-stepped morphology indicating interbedded strata. Context of detail is visible at the western edge of Fig. 36A (blue box). Weathering is evident on scarps with a high albedo. There are signs that breakage (black arrow) produced boulders which accumulated in talus at the base of the ILD. Angular joints are apparent especially in unit 1 (Fig. 36G, 37D). Unit 2 is flatter, looks smoother and shows a lower albedo. Layering (white arrow) is undulated more distinct there (cf. Fig. 37D).