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The erosion rate and previous extent of interior layered deposits on Mars revealed by obstructed landslides

Supplementary Information

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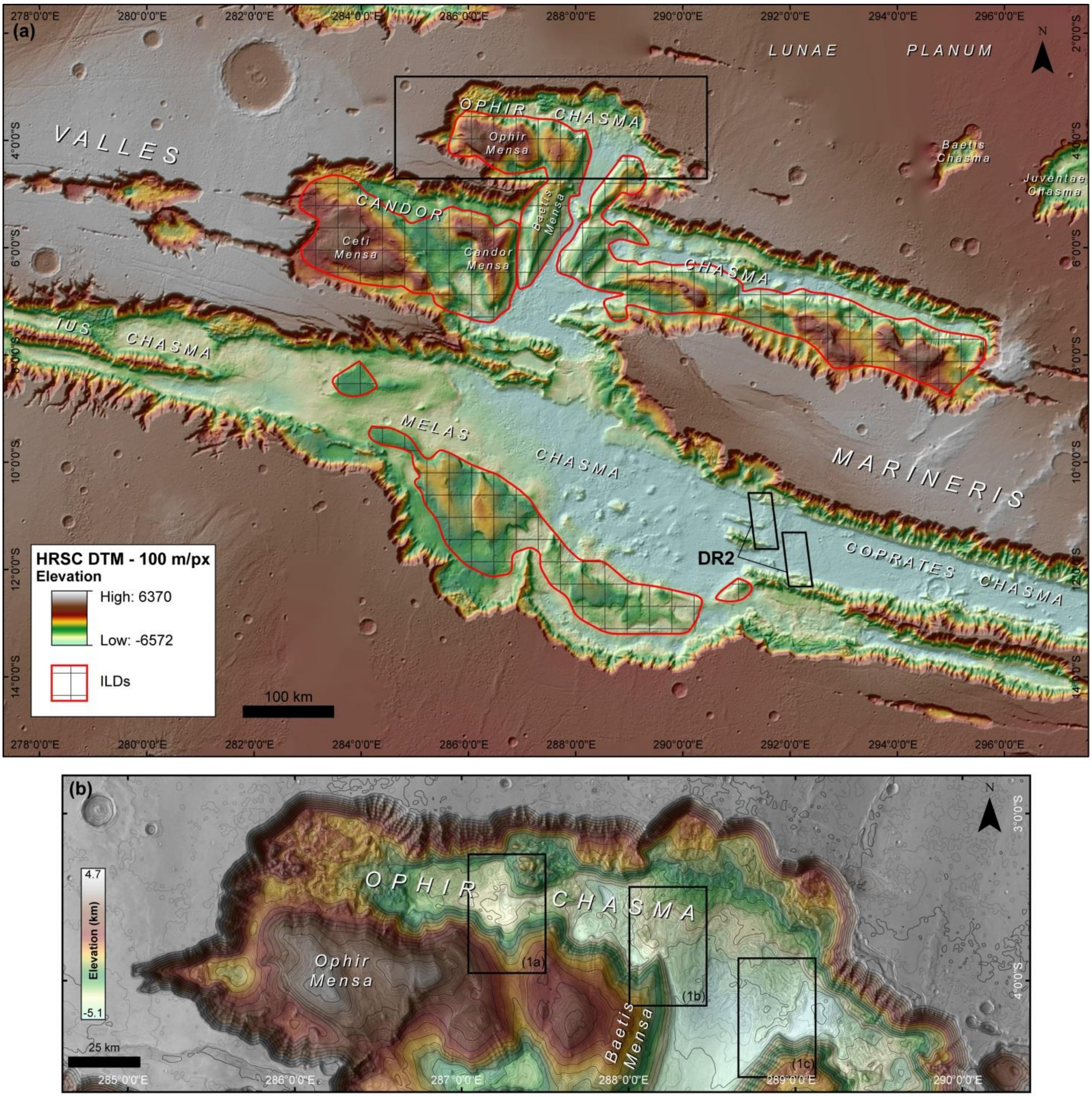

Figure DR1. Context map of the study area in (a) Valles Marineris and (b) Ophir Chasma. Black boxes show the location of figures in the main text and Supplementary Material. Large-scale interior layered deposits (ILDs) are highlighted throughout the wider Valles Marineris region.

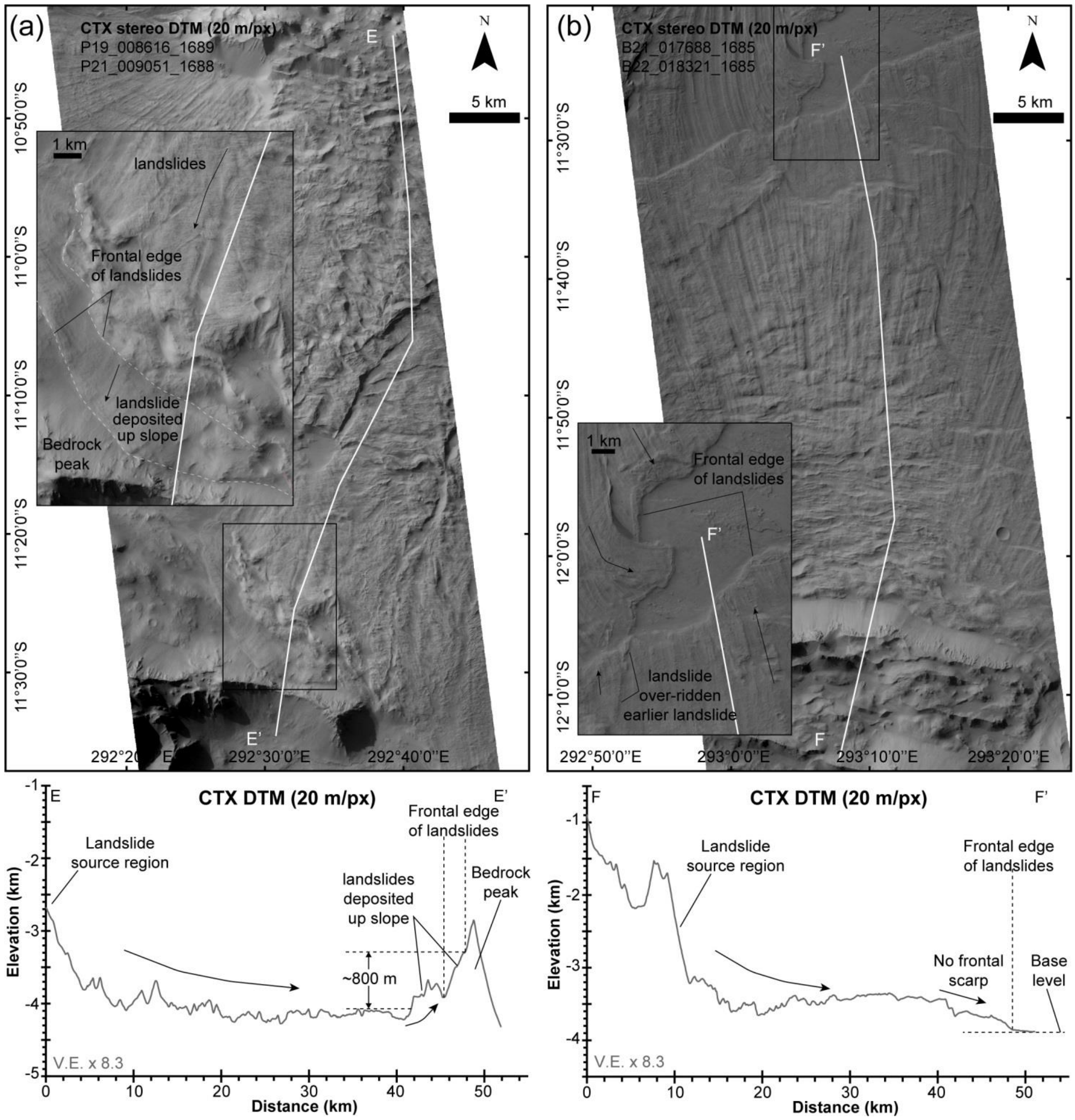

Figure DR2. Typical Valles Marineris landslides (a) with and (b) without obstructions. (a) CTX image of the landslide Ophir Labes and topographic profile showing landslide obstruction by a bedrock peak that has not been removed. (b) CTX image of the landslide Coprates Labes and topographic profile showing landslide frontal region with no obstruction.

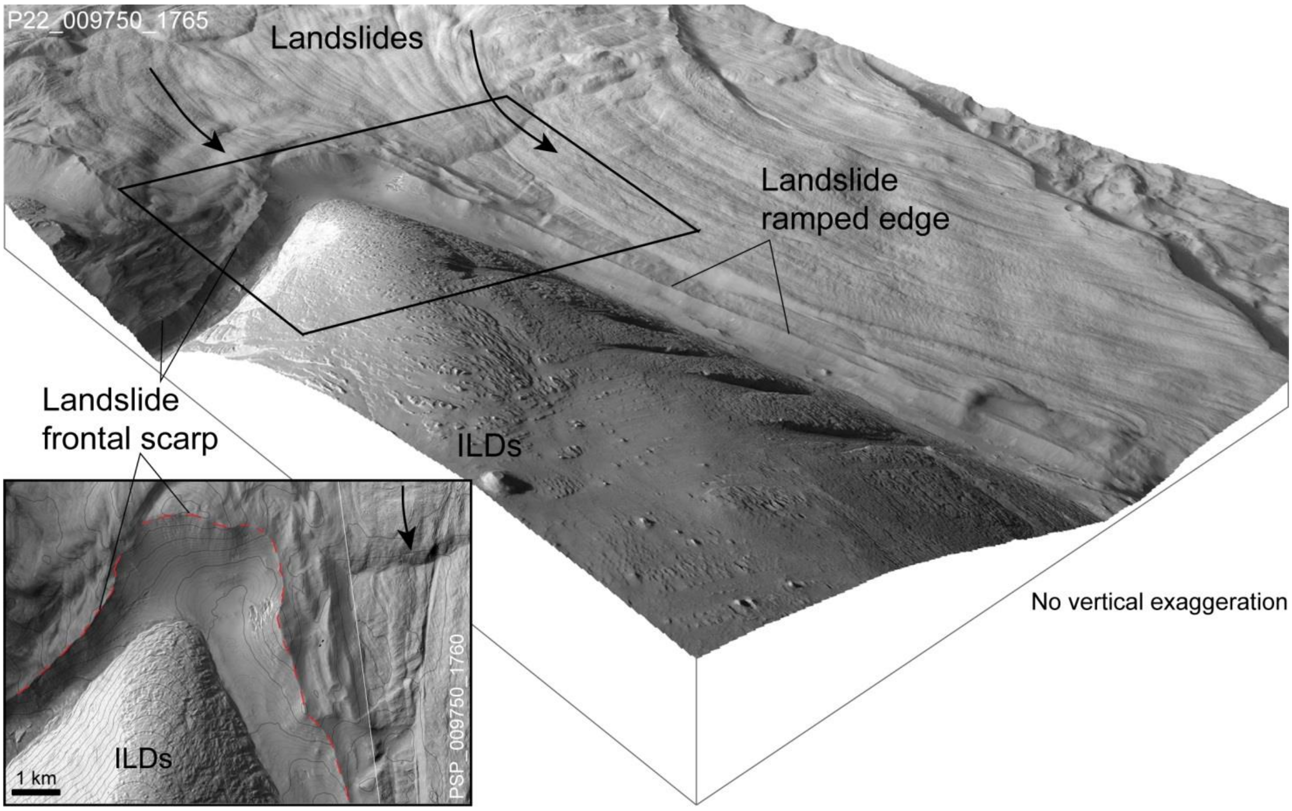

Figure DR3. Perspective view of an obstructed landslide. The frontal scarp is 1 – 2 km from and mimics the shape of the ILD. Perspective view made from a CTX stereo DTM and image. Also shown (inset) is a close-up view of the frontal scarp.

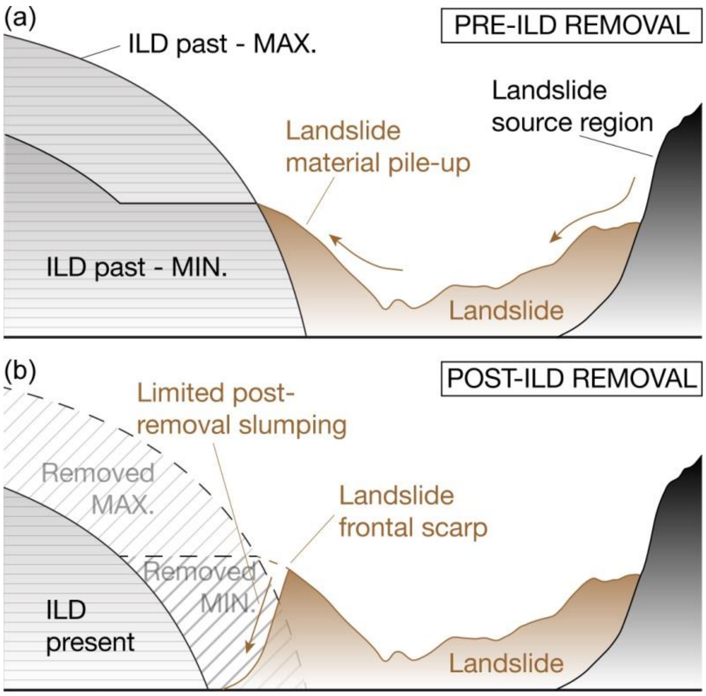

Figure DR4. Schematic diagram, not to scale, showing the proposed formation scenario. (a) Landslide deposits flow away from their source region and are obstructed by the ILDs. Shown are both minimum and maximum representative sizes of ILDs that could have caused such an obstruction. (b) After landslide formation the ILDs have reduced in size, causing limited slumping at the toe of the landslide, but with landslide material volumes being conserved.

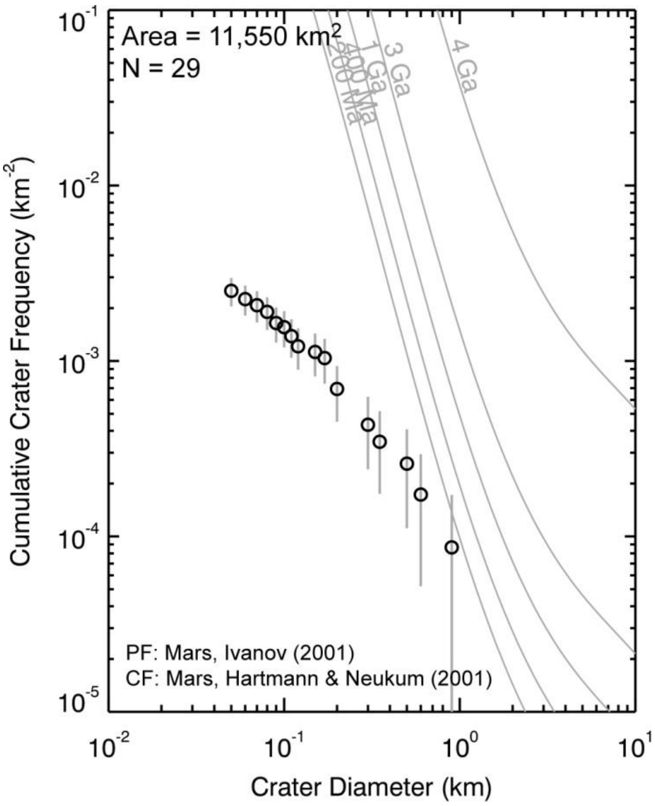

Figure DR5. Crater count results for the ILDs. Plot is binned cumulative crater frequency histogram for all craters greater than 50 m diameter. PF is the production function (Ivanov, 2001) and CF is the chronology function (Hartmann and Neukum, 2001).

Interior Layered Deposits Volume Loss

We estimate the minimum and maximum volume of material lost from the ILDs by assuming that the retreat at the front of the landslides is indicative of volume loss elsewhere. To estimate the minimum volume of ILD material that must have been removed, we calculated the area defined by the current landslide frontal scarp and multiplied by either the path length or circumference of the ILD boundaries. Some of the landslide toe (the highest point) has likely fallen into the void left by the ILD removal, but the overall effect on the results will be small as volume will be conserved. Therefore if material has been lost just from the northern slopes of the two ILDs, then the minimum volume removed is ~0.4 x 10^3 km^3; if however material has been lost from the entire circumference of the two ILDs then the minimum volume removed is ~1.2 x 10^3 km^3. If material has been removed from the entire ILD, rather than just at the base close to the landslide, then we can calculate maximum estimates of material loss. In this case we cropped a 50 m/px

HRSC DTM mosaic to the ILD outline, then added 500 m of elevation and calculated the volume difference. Therefore if material has been lost just from the northern boundary of both ILDs, then the maximum volume removed is ~1.5 x 10^3 km^3; if however material has been lost from the entire circumference of the two ILDs then the maximum volume removed is ~5.8 x 10^3 km^3.

Table DR1. Results of landslide crater counts.

Landslide No.	Area (km^2)	N (craters in age)	Fit Range (km)	N(1)	N(10)	Model Age (Ma)
1	157	130	0.1 – 0.48	2.1 x 10^{-4}	3.0 x10^{-6}	423 +55/-58
2	360	276	0.1 – 0.45	1.8 x10^{-4}	2.6 x10^{-6}	374 +34/-37
3	308	228	0.1 – 0.45	1.4 x10^{-4}	2.8 x10^{-6}	397 +40/-42
4	312	173	0.1 – 0.40	1.5 x10^{-4}	2.1 x10^{-6}	308 +35/-38
5	263	115	0.1 – 0.35	1.1 x10^{-4}	1.6 x10^{-6}	225 +31/-34
6	509	197	0.1 – 0.48	1.1 x10^{-4}	1.5 x10^{-6}	216 +23/-24