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A flooded crater in Cerberus Palus, Mars: Evidence for substantial volatile loss

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Abstract

We investigate a crater in Cerberus Palus, Mars, that has been largely filled by material with the platy-ridged-polygonized (PRP) surface morphology characteristic of the wider area. Subsidence of solidified material within the crater demonstrates volume loss, either of the PRP material or some older material beneath. Possible formation hypotheses include: 1) simple volatile loss (if the PRP material was ice-rich), 2) degassing of lava (if the PRP textures represent lava flows) or 3) the melting of ice-rich material at the crater bottom when lava buried it, leading to magma-ice interaction and the eventual subsidence of the solidified lava crust. An interpretation involving loss of ice or lava-ice interaction seems most likely.

1. Introduction

PRP material, characterized by a very flat surface, covers a wide area in Elysium Planitia. It is interpreted as the remnants of a frozen sea [1] or as lava flows [e.g., 2]. We present morphologic observations of a crater flooded by PRP (Fig. 1a).

2. Data

HRSC, CTX, and HiRISE images were used for morphologic investigation, and MOLA point data for quantitative Topographic information. A HiRISE anaglyph was used for qualitative topography.

3. Observations/Interpretations

A liquid material flowed into the crater through a prominent breach in the eastern crater wall, and perhaps through other inlets in the north and south. Concentric extensional fractures around the inner crater (Fig. 1b) wall indicate brittle failure due to subsidence after the material had solidified into PRP. Grooves behind obstacles indicate flow displacement towards the crater center (Fig. 1c), and rows of small rimmed craters, unlikely to be impact craters, indicate possible explosive activity. At one location in the south of the crater, the concentric extensional fracture transitions into a fractured topographic ridge, which seems to have been the source of material that buries adjacent older terrain (Fig. 1d). By analogy with similar sized craters, the total thickness of the remaining infilling material is >800 m. Assuming the crater was once totally filled with PRP material, there has been ~150 m subsidence (Fig. 1e). Degassing of lava alone seems insufficient to explain such volume change – additional volatile loss through the removal of substantial amounts of ice seems the only solution. A purely icy PRP, or a combined lava/ice interpretation are favored.

Acknowledgements

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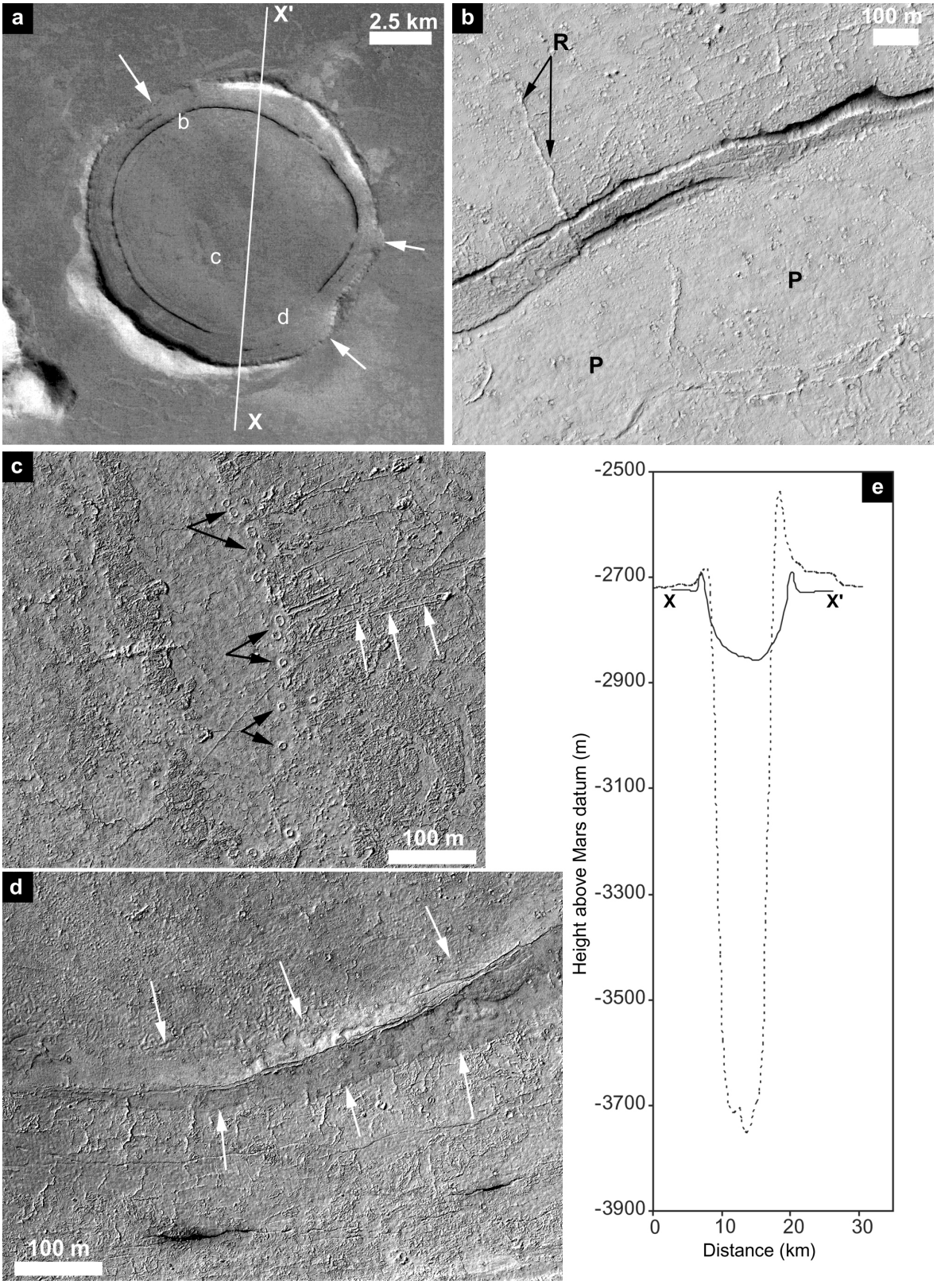
References

[1] Murray, J. et al., Nature, Vol. 434, pp. 352–355, 2005.

[2] Plescia, J., Icarus, Vol. 88, pp. 465–490, 1990.

Figure 1 (next page): Crater in Cerberus Palus at 8°N, 148.6°E. (a) View of crater with locations of images b-d and profile shown in e (white arrows: breaches in crater rim). (b) Detail of the concentric fracture. Note the polygons at “P” and the ridge “R”, which does not continue to the subsided floor, possibly indicating some later burial events. (c) Grooves (white arrows) indicate flow direction, and crater rows (black arrows) indicate cones. (d) A ridge with a summit fracture seems to be the source of material that buried nearby PRP (white arrows mark flow front). (e) Comparison of topographic profiles across the studied crater (solid line) and another nearby unflooded crater of similar diameter, also in PRP terrain (dashed line).


a
X'
2.5 km
b
c
d
X
b
100 m
R
P
P
c
100 m
d
100 m
e
-2500
-2700
-2900
-3100
-3300
-3500
-3700
-3900
X
X'
Height above Mars datum (m)
0
10
20
30
Distance (km)