

DISCOVERY OF POTENTIAL CAVE SKYLIGHTS IN HEBRUS VALLES AND HEPHAESTUS FOSSAE, MARS. D. Sulcanese¹, G. Komatsu^{2,1}, G.G. Ori^{2,3}, and J.A.P. Rodriguez⁴, ¹Dipartimento di Ingegneria e Geologia, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy (davide.sulcanese@gmail.com), ²International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy, ³Ibn Battuta Centre, Université Cadi Ayyad, Marrakech, Morocco, ⁴Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719.

Introduction: The downstream reaches of Hebrus Valles, Mars, consist of a broad system of braided channels, which mostly disappear at their contact with an extensive network of pits and troughs [1] (Fig. 1). Some of the channels are cut by or transitioned into pits and troughs indicating that there had been co-evolution of the channels and the pits and troughs that are surface expressions of an extensive cave system. Modeled ages derived from impact crater statistics show that the proposed event of floods being captured by subsurface caves happened during the Early Amazonian [1]. We here report the first set of potential skylights into previously proposed extensive cave systems in the Hebrus Valles region; including the trough systems of Hephaestus Fossae (Fig. 1). Skylights and their possible candidates have been reported on Earth [2, 3], the Moon [4], and also Mars [5, 6]. One skylight on the Moon appears to be underlain by a huge underground void, tentatively hypothesized to be a lava tube [7]. Some investigators have proposed that this region would be of interest for future human exploration [8].

The purported skylight features in Hebrus Valles and Hephaestus Fossae are widely distributed in the terrain full of fluvial and collapsed landforms, and the area is hypothesized to be underlain by an extensive cave system [8]. Therefore, these skylight features may be related to the collapse landforms. We note that these features are not fully proven to be linked to the cave system yet, but if that is the case, they would provide access to caves for future Mars missions.

Geological setting: Hebrus Valles and Hephaestus Fossae are located at the boundary between two geological units, and the boundary can be seen well with the THEMIS daytime infrared image in thermal contrast (Fig. 1). The south unit is the Late Hesperian Transition (lht) unit [9], marked by large mesas and knobby terrain; The north unit is the Late Hesperian Lowland (lhl) unit, marked by buried and variously degraded surface craters, as well as linear chains of pit and troughs organized in polygonal patterns [9].

Geomorphology of the purported skylight features: These probable/possible skylights are located near the system of troughs or pit chains, and appear to be irregular depressions a few hundred meters across

(Figs. 2, 3). The tone of the shadows in these probable/possible skylights seems to be different from that of nearby pit chains. Furthermore the implied dimensions of the caves from the inferred magnitude of catastrophic flooding indicate that [1] these features can be all linked each other.

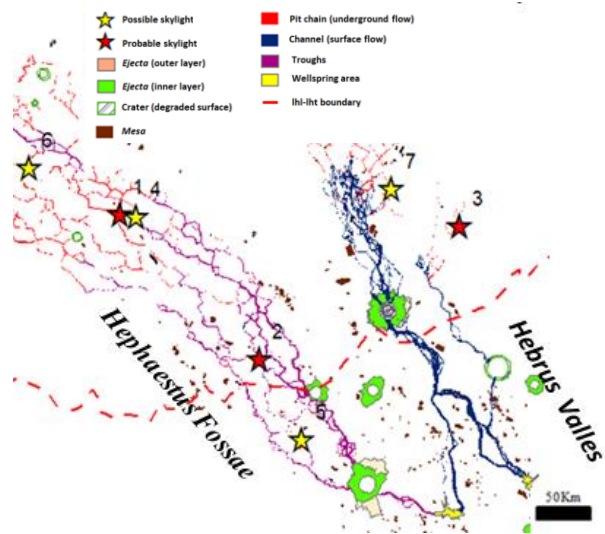


Fig. 1. Location map of 7 skylight candidates identified in Hebrus Valles and Hephaestus Fossae.

No.	Location	Dimensions	Elevation	Probability
1	Hephaestus Fossae	x-140m y-124m	-3802m	Probable
2	Hephaestus Fossae	x-140m y-132m	-3644m	Probable
3	Hebrus Valles	x-160m y-125m	-3664m	Probable
4	Hephaestus Fossae	x-270m y-174m	-3809m	Possible
5	Hephaestus Fossae	x-280m y-290m	-3594m	Possible
6	Hephaestus Fossae	x-370m y-274m	-3828m	Possible
7	Hebrus Valles	x-350m y-100m	-3842m	Possible

Table 1. List of skylight candidates identified in Hebrus Valles and Hephaestus Fossae.

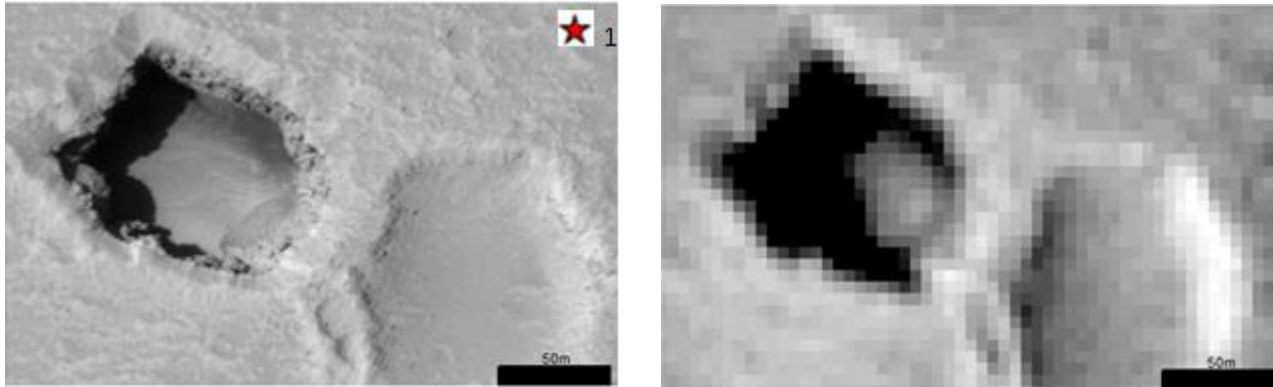


Fig. 2. Comparison between two images of a skylight candidate (this is No. 1 in the Table 1). HiRISE image on the left and CTX image right. HiRISE image (ESP_052638_2020). CTX image (P02_001726_2014_XN_21N238W).

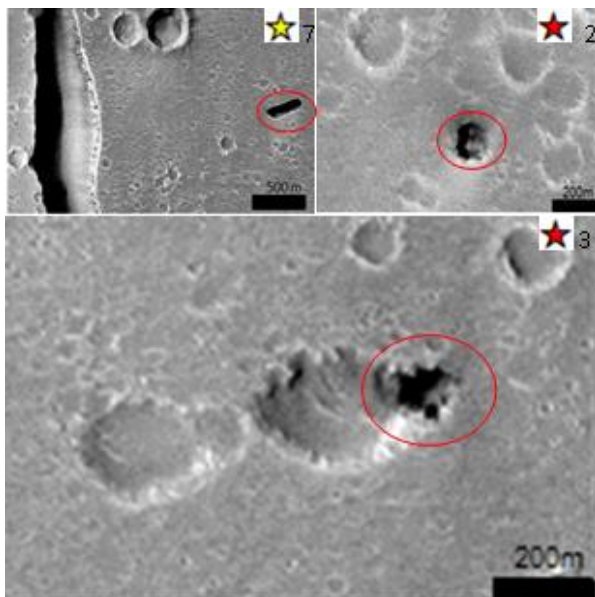


Fig.3. Examples of skylight candidates identified in Hebrus Valles and Hephaestus Fossae.

Future investigations: We suggest an extensive investigation of these features including studies with future missions. For instance, acquisition of different HiRISE images at various solar illumination conditions will be useful to determine their depths [4]. We also suggest a gravimetric mapping [10] or a GPR survey of the area with remote sensing, to explore the possibility of void presence in the subsurface underneath Hebrus Valles and Hephaestus Fossae.

Implications for future Mars missions: These probable skylight features are located in an area with clear evidence for water-carved superficial channel systems with possible subsurface cave, and also many large impact craters with rampart possibly indicating water/ice-rich near surface materials [e.g., 11].

Thanks also the low elevations of the area (from about -3500 m to about -4000 m) and a relatively flat surface, we suggest that these possible skylights can be accessible targets for the Mars subsurface study, which includes the search of subsurface water-ice or traces of life, and eventually for a safe zone to build habitable bases for future human missions [8].

References:

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