

EVIDENCE FOR ICEBERG RAFTING ON HELLAS BASIN, MARS. E. R. Uceda¹, A. G. Fairén^{2,3}, C. Woodworth-Lynas⁴, J. A. P. Rodríguez⁵. ¹Universidad Autónoma, Madrid, Spain (mariae.ruiz@uam.es); ²Centro de Astrobiología, 28850 Madrid, Spain; ³Department of Astronomy, Cornell Univ., Ithaca, 14853 NY, USA; ⁴PETRA International Ltd., Newfoundland & Labrador, Canada A0A 2B0; ⁵NASA Ames, 94035 Moffett Field, CA, USA.

Introduction: We have previously presented evidence for dump structures and chains of craters on Mars that we interpreted as indication for iceberg transport and grounding on very cold oceans early in the planet's history [1]. Here we add the identification on HiRISE images of curvilinear furrows which can be observed in the Hellas Basin (Fig. 1). All this data support the notion of the existence of frigid oceans/lakes on a “cold and wet” early Mars [2,3].

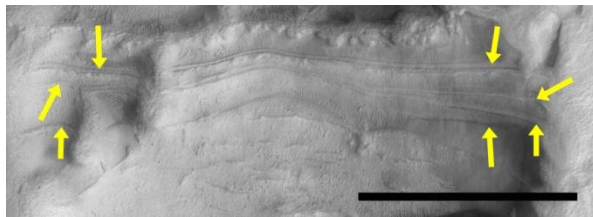


Fig. 1: Scour marks (arrows) in Hellas Basin (HiRISE image PSP_009548_1420). Scale bar = 1 km. HiRISE image credit: NASA/JPL/University of Arizona.

Furrows in Hellas: The furrows in Hellas are located in elevated areas or on local topographic highs. We interpret these features in terms of iceberg rafting and grounding. We propose that the furrows were formed in submerged unconsolidated sediments, when floating ice keels touched down and displaced loose material to the sides as they continued to move forward, possibly driven by both wind and water currents.

Terrestrial sea ice and icebergs form scour marks when draft exceeds water depth and their keels touch and plough forward through unconsolidated ocean- or lake-floor sediments [4,5]. Typical terrestrial scour marks are often several kilometers long, tens of meters wide and 0.5 to 5 meters deep [5] consistent with the dimensions of the furrows we describe here from the Hellas basin on Mars.

Importantly, evidence of upstream glaciation in the form of lateral moraines, terminal moraines, till deposits, and kame and kettle topography is been recently recognized on Mars [6-8]. Therefore, evidence for mountain glacial activity required to feed the system is well preserved.

Alternative interpretations: Alternative formation processes for the curvilinear features on the surface of Hellas include: (1) Faults. Faults tend to maintain preferential orientations reflecting bedrock structural trends, and offsets would be expected where they intersect. Neither of these characteristics are observed in the HiRISE images of interpreted ice scour marks

analyzed so far. (2) Fractures/joints. Like faults, fractures and joints tend to reflect preferential bedrock structural trends, and may occur in linear intersecting groups with little or no offset at the intersection points. The meandering, curvilinear nature of many marks are evidence against bedrock control. (3) Collapsed lava tubes. These are generally long, meandering features that do not usually occur in intersecting groups. They tend to be much wider and deeper than the proposed scour marks, and typically do not have raised rims. (4) Dust devil marks. Meandering dust devil tracks are common features over a wide range of latitudes in both hemispheres of Mars, but they have no morphological surface expression, unlike scour marks.

Previous studies: Using MGS data, Ormö and Komatsu [9] found curvilinear grooves in places in Hellas basin, and they interpret some of them as possible ice keel scour marks. Fossil ice floes up to 45 m thick have been recognized and documented in the Cerberus Fossae region [10]. The floes are not associated with ice scour marks and grounding pits because such features would be hidden from view below the fossil ice canopy. Rice et al. [11] investigated platey and ridged terrain at the mouths of Athabasca and Marte Valles, in Elysium Planitia. They interpret platey terrain as the fossil casts of former ice floes and ridged terrain as ice pressure ridges, emplaced by jökulhlaups (glacial outburst floods). Kettle cratering has also been proposed to have occurred in Athabasca Vallis [12]. Evidence of ice keel scour marks and ice floe grounding pits within the Kasei Valles system and parts of Echus Chasma has been reported [13].

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