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New evidence for equatorial sea ice on Mars from HiRISE images

J.B.Murray (1), M.R.Balme (1), J-P.A.L.Muller (2) & J-R.Kim (2)

(1) Centre for Earth, Planetary and Astronomical Research, The Open University, Milton Keynes MK7 6AA, U.K. Email j.b.murray@open.ac.uk. (2) Mullard Space Science Laboratory, Dept of Space & Climate Physics, University College London, Holmbury St. Mary, Dorking, Surrey RH5 6NT, UK.

The first HiRISE images of Elysium Planitia (Mars) show areas both near the centre and the edges of the 800 x 200 km area of fractured, drifted and rotated rafts up to tens of kilometers across, which have been interpreted as a dust-covered frozen sea a few million years old. Image TRA 000854 1855 is situated near the centre of the sea, encompassing a junction between an area of relatively static ice to the north, and a channel in which rafts have drifted to the west.

These images have a resolution of about 0.3m, and at this scale the large (100m to 3 km) fractured rafts can be seen to have a 10% cover of platy blocks 1m to 6m across, interspersed with a honeycombed pattern of networked aeolian ridges, with cells about 3m wide. The blocky appearance is very similar in metre-scale morphology to broken and re-frozen arctic pack-ice. Between the rafts, particularly in the northern part of the image, is smoother terrain of lower albedo, topographically lower (from shadows) than the rafts at contacts, with prominent patterned ground comprising centrally-domed polygons 5m-10m wide, similar to polygonally-cracked ground on subliming ice in Antarctica. In places these polygons are aligned almost parallel and/or normal to the raft edges, and there are patterns of more pronounced valleys spaced about 30m apart, running longitudinally down each lane. We interpret this terrain as subliming sea ice, now stabilized by surface dust and a sublimation till. A third type of terrain is found only in the southern part of the image, where the pale, smooth lanes between rafts are aligned more east-west. There are still traces of polygons, but these are much fainter and wider (20m - 40m). This terrain much more heavily cratered than the previous two terrain units, and size-frequency crater distributions show that it is about an order

of magnitude older. We believe it to represent the sea bed after the sea ice above had sublimed away.

HiRISE image TRA 000867 1875 includes the southern border of the frozen sea, and is dominated by a series of ridges parallel to the shoreline, there being at least a dozen visible in the 500 metres closest to the edge. They are crossed by transverse dunes spaced about 50m apart. The limits of the sea are marked by a series of three or four cliffs about 5m to 10m high according to MOLA data. MOLA also shows that the surface slopes steadily away from the shoreline by about 10m over 1 km.

The appearance of the entire area covered by the image corresponds to what would be expected after the retreat of the ice-covered sea as the water level lowered. The low cliff was presumably eroded during the first initial catastrophic flooding event, and the undercliffs beneath it are consistent with subsequent erosive cliffs formed as the water retreated. The parallel ridges further down the shore are similar to ice ridges and strand lines in Arctic and Antarctic sea ice, and could be ice rubble piles marking the lowering sea level.