COASTAL-LIKE FEATURES IN NEPENTHES MENSAE, MARS, AS PALEOWATER-LEVEL INDICATORS, AND A TERRESTRIAL ANALOG. Á. García-Arnay[1], F. Gutiérrez[1], and S. Fernández[2], [1]Dpto. de Ciencias de la Tierra. Universidad de Zaragoza, 50009 Zaragoza, Spain (arnay@unizar.es), [2]Dpto. de Geología, Universidad de Oviedo, C/ Jesús Arias de Velasco s/n, 33005 Oviedo, Spain.

Introduction: Nepenthes Mensae is located in the eastern hemisphere of Mars, close to the Equator, north of the Martian dichotomy (upland-lowland boundary), east of Isidis Planitia and southwest of the Elysium rise (Fig. 1). This region is characterized by a belt of interconnected NW-SE trending depressions with a knobby terrain of residual reliefs (mesas, knobs and buttes), created by erosion of the Martian uplands [1], and mapped as unit *HNt* (Hesperian and Noachian transition unit) in the last global geological map of Mars [2]. The uplands adjacent to the study area are dissected by valley networks, whose mouths are located along the dichotomy. Previous works reported a Gilbert-type delta [3][4][5] and possible paleoshorelines [4][6][7], which may record the past existence of a long-lived body of liquid water related to the putative ocean of Mars in Nepenthes Mensae. A detailed geomorphological analysis was carried out in order to (1) identify additional deltas and coastal-like features related to the ancient putative sea in the region; and (2) explore a possible terrestrial analog.

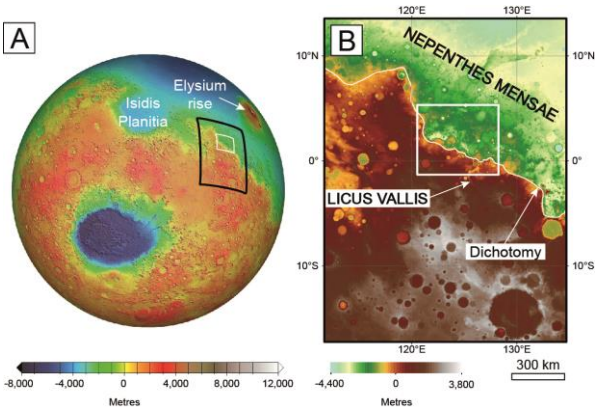

Fig. 1. Geographic setting of study site. (A) MOLA topography of Mars with Nepenthes Mensae region indicated. (B) Regional setting of Nepenthes Mensae (the study area is indicated by the white box).

Data and Methods: The landforms were mapped and analyzed using CTX panchromatic images (6 m/pixel), MOLA and HRSC-derived DEMs (~500 m and 50 m in resolution, respectively), and THEMIS-derived thermal inertia images (100 m/pixel) in a GIS environment. We extracted the elevation values for each delta (plain-front junction; mean highstand) and bench (proximal edge) to infer paleowater levels (see Fig. 2). These values permitted the detection of equipotential surfaces corresponding to possible water levels and their changes. We assume that (1) the present topography is similar to the one that existed during the development of the analyzed landforms; and that (2) the coastal-like landforms formed during that time period.

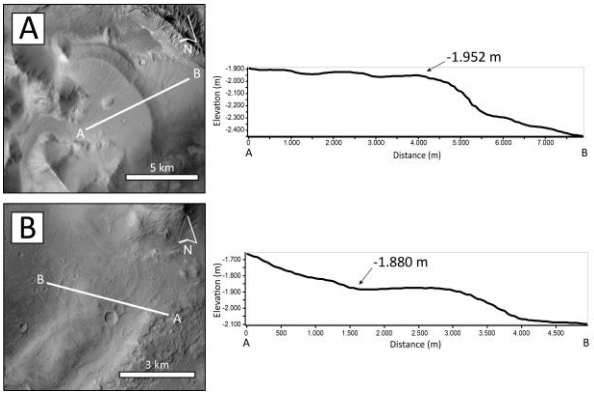

Fig. 2. Panchromatic images illustrating a putative Gilbert-type delta at the mouth of a drainage network (A) and a bench (B). On the right, topographic profiles along the lines indicated in the images. The estimated paleowater levels indicated by arrows.

Lanforms description: We analyzed (1) eight fan-shaped features located on the mouth of the valley networks, seven of them documented in this study for the first time, and (2) numerous benches along the edges of the depressions and around isolated massifs within the depressions. The fan-shaped landforms display steep fronts (~11°) and low-gradient plains (~1°) from 2 to 13 km across. In some cases, the plains are dissected by small and rather subdued distributary channels. The benches are subhorizontal or gently-sloping surfaces hundred of meters across with lateral continuity, and typically bounded by a riser on the outer edge. Elevations extracted from the fan-shaped landforms and benches occur within the ranges -1,186 m to -1,975 m, and -1,880 m to -2,150 m, respectively. Elevation values are rather scattered and as a group do not define a clear equipotential surface. However, around 60% of these landforms (5 fans and 24 benches) occur between -1,900 and -2,000 m. These values yield a mean elevation of -1,959 m (standard deviation of 26 m) for the benches, and a mean elevation of -1,951 m (standard

deviation of 24 m) for the fan-shaped landforms, indicating a consistent equipotential surface.

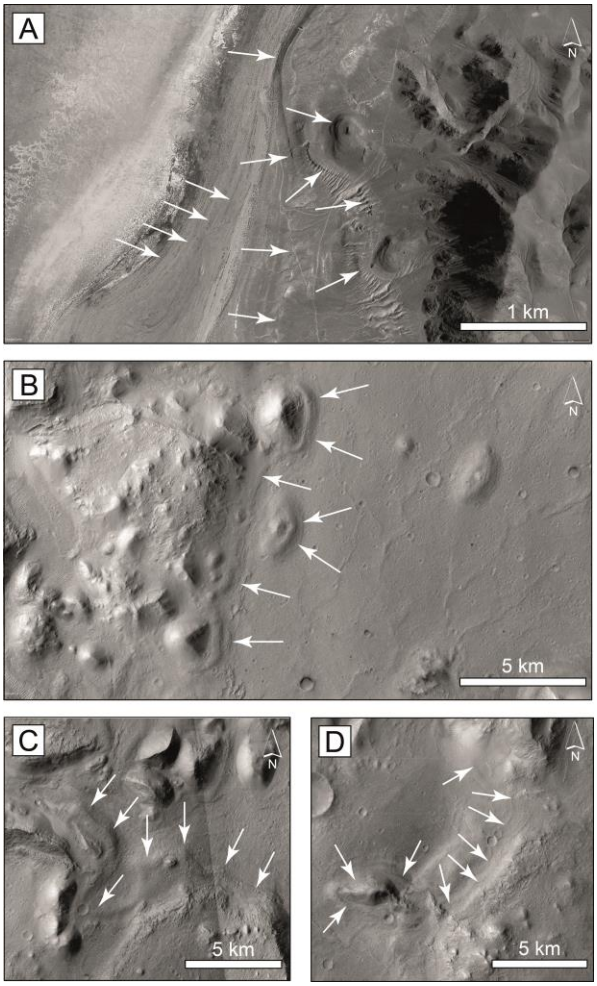

Fig. 3. Comparison between the coastal landforms in Lake Lahontan (Nevada, USA) (Image from Google Earth) (A) and Nepenthes Mensae (B, C, D) (CTX images, NASA). Arrows point to landforms that record paleolevels. (A) Strandlines and terraces in Lake Lahotan. (B, C) Laterally continuous benches with consistent elevation in Nepenthes Mensae. (D) Benches and possible strandlines in Nepenthes Mensae.

Interpretation: Based on their morphology and spatial-altitudinal distribution, we interpret the fan-shaped features as relict Gilbert-type deltas, and the benches as possible shore platforms developed along paleoshorelines. This interpretation is supported by several lines of evidence: (1) cartographic distribution, with deltas linked to drainage networks and benches associated with the margins of the depressions and prominent resisual reliefs; (2) lateral continuity of subhorizontal benches; (3) elevation consistency between the benches and deltas; (4) the detection of hydrated minerals in the surface of the depressions; and (5) the analogy between the putative paleoshorelines in Nepenthes Mensae and the relict coastal landforms documented in terrestrial paleolakes. The estimated equipotential surfaces may correspond to stable water levels with significant geomorphic inprint of an inner sea or a series of interconnected lakes in the region, that became disconnected from the Oceanus Borealis as the water level dropped.

Terrestrial analog: Lake Lahontan (Nevada, USA) used to be a large and deep pluvial lake in the Pleistocene. This paleolake has previously been proposed as a terrestrial analog for putative lakes and oceans in Mars [8][9]. We have selected this paleolake as a possible analog of the putative sea in Nepenthes Mensae because it has (1) well-preserved coastal landforms similar to those mapped in Nepenthes Mensae (Fig. 3); (2) similar surface area considering the corresponding mean highstands, ~18,000 km^2 in Nepenthes Mensae and 22,200 km^2 in Lake Lahontan [10]; and (3) was located within an endorheic basin.

Conclusions: Nepenthes Mensae was occupied by a putative inner sea or a number of interconnected lakes as supported by the presence of putative coastal landforms. These include possible deltas at the mouth of drainage networks and benches attributable to shore platforms or terraces along the margins of the depressions and around isolated massifs. Their elevations permitted approximately inferring the equipotential surface that defines the main water level of the inner sea or paleolakes. The Pleistocene Lake Lahontan (Nevada, USA) is proposed as a possible analog of the putative sea in Nepenthes Mensae, based on its similar coastal landforms, surface area, and endorheic nature.

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