CHAIN OF DEPRESSIONS AND THE WATERSHEET EVOLUTION IN NEPENTHES MENSAE, MARS.

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Introduction: The Nepenthes Mensae region of Mars is located northern ward of the Martian highland-lowland boundary, between Terra Cimmeria and Utopia Planitia, in the eastern hemisphere of Mars. This region was covered by the water of the ancient Oceanus Borealis [1][2], but successively it was exposed to the atmosphere during the later hydrological episodes when the liquid water on the Martian lowlands formed seas and lakes [2][3]. Recently, geomorphological evidence of water level changes in the Nepenthes Mensae region [4] and the important role of water in the geological history of this region were described [5]. Here we present briefly how the topography of the area reveals the existence of a chain of depressions. Some water- and ice-related geomorphological features observed in this area relate these depressions with a possible chain of lakes near the highland-lowlands dichotomy, here firstly described. The study area of Nepenthes Mensae in which we observed the chain of depressions and possible lakes extent between 2.5ºS-7ºN and 120º-135ºE.

Data and Methods: The study of the Nepenthes Mensae region was developed thanks to the use HRSC-derived (~50 m/pixel) and MOLA-derived (~463 m/pixel) digital terrain models. In addition, we also used HiRISE (~0.3 m/pixel), MOC-NA (~2 m/pixel), CTX (~6 m/pixel), HRSC (~12.5 m/pixel), THEMIS-Vis (~18 m/pixel) and daytime THEMIS-IR (~100 m/pixel) images for the geomorphological analysis of the region. We included all these data into a Geographic Information System.

Topography: Nepenthes Mensae, such as other sites of the Martian highlands-lowlands boundary, is characterized by the presence of a topographical scarp. In this area, the scarp is about 2.5000 meters (Figure 1). The higher part of the scarp in this region ranges between 0 and -100 meters in altitude, meanwhile the northern edge of the Nepenthes Mensae (southern Utopia Planitia) is located at -2300 meters in altitude. This difference in altitude occurs along 300 km from South to North. Topographically, Nepenthes Mensae is not characterized by a uniform slope toward the north but from an irregular surface with mesas, hills and knobs. In addition, this sector of Nepenthes Mensae is characterized by a plain with an altitude comprised between those of the southern highlands of Terra Cimmeria and of the northern lowlands of Utopia Planitia. The mean altitude of this plain or plateau is about -1500 meters. The western sector of this plain is connected to the highlands through an gentle slope, without a scarp, meanwhile between the southern sector of the plain and the highlands are separated by a chain of depressions clearly visible on the MOLA-derived topographic map (Figure 1). This map also shows that the plain has a smooth surface (at the MOLA data scale) with eroded not-pristine impact craters. However, the other areas of Nepenthes Mensae outside of this plateau are marked by a rougher surface with frequent hills, knobs and small mesas. The frequency of these hills and knobby terrain is higher in the northern edge of the plateau of Nepenthes Mensae, where they also have smaller size (diameter and height).

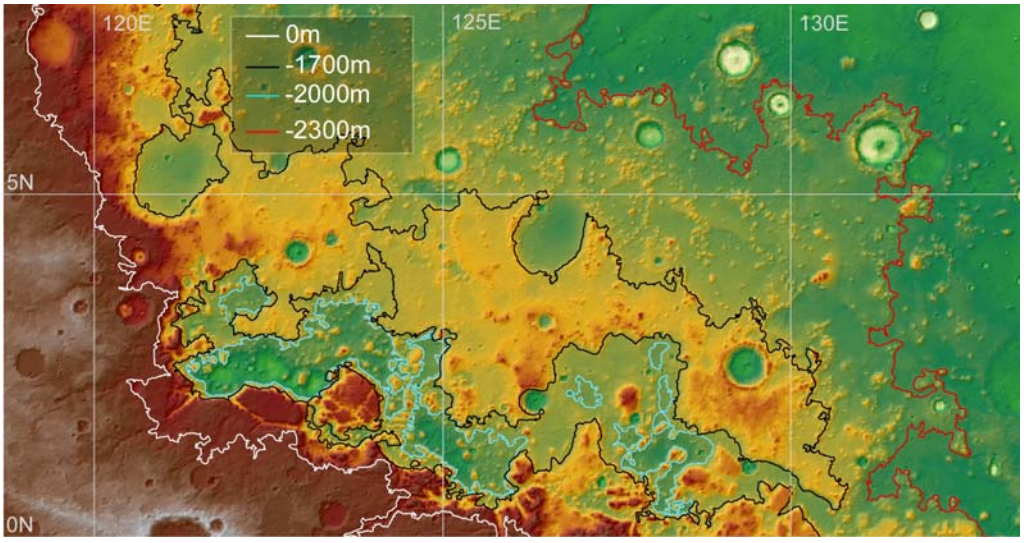

Fig. 1: MOLA-derived color-coded map of Nepenthes Mensae. Contour lines indicate four selected altitudes, discussed in the text, showing the Nepenthes Mensae Plateau and the chain of depressions near the Martian highlands-lowlands boundary.

The depression between the highlands and the plateau in Nepenthes Mensae is about 50-75 km wide (from South to North) and about 500 km long (from Northwest to Southeast), elongated parallel to the martian highlands-lowlands boundary. The southern edge (with the highlands) of this depression is more irregular, sharp, and clear than the northern edge (with the plateau) what is more lobated and smooth. Depth and shape of this depression changes a lot what made possible to describe such a chain of depressions more than a unique depression.

A general analysis of the MOLA-derived contour lines (equidistance 100 meters) confirms the existence of a chain of depressions between the plateau and the highlands spatially distributed parallel to the highlands -lowlands boundary (Fig.1). In addiction, the chain of depressions seems to have a rough inner structure in small scarps or terraces. These terraces mark the edges of most of the depressions. The approximated altitudes of these features are about -1200, -1500, -2000, -2200, and -2400. The deeper point of this chain of depressions is about -2800 meters and it is located at the northwestern extreme of the chain (at 121.5ºE, 2.3ºN). The narrower point of the chain is in the southeastern extreme (at 130.6ºE, 0.3ºN) where it is only about 10 kilometers wide. This site marks also the eastern edge of the plateau in Nepenthes Mensae.

Interpretation: The plateau and depressions here described with help of the topography could be related with (1) the origin of Nepenthes Mensae, and (2) the evolution of water on Mars, especially the changes on the watersheet of the Martian ocean.

Firstly, Nepenthes Mensae is characterized by frequent morphological alignments related to faults in this region [6][7]. This alignments result from the erosion of fractures and faults due to a wide variety of processes such as fluvial, glacial, impact, slopes, etc. Recent works, based on the analyses of these morphological alignments and other tectonic features on post-Viking era data (MOC, MOLA, THEMIS, and HRSC data) reveals the important role of the tectonics in the origin and evolution of Nepenthes Mensae. In addiction, a graben and a tectonic depression have been proposed to explain the chain of depressions located between the highlands and the plateau here described [7][8][9]. Our analysis of the topography at the present stage is not enough for corroborate those hypotheses, but it is in agreement with them.

Secondly, since this chain of depression is located northern ward of the highlands-lowlands boundary, it is necessary to analyze its relation with the watersheet of the ancient Martian ocean. The higher altitude of the Oceanus Borealis [1] was proposed to be lower than 0 meters in this region of Mars [2]. This altitude is higher than the altitude of the plain of Nepenthes Mensae, what imply that this entire region was under the water level in the period of Oceanus Borealis. Recently, evidence of small water level changes in this region were described [4], moreover of the global changes of water level due to climatic changes [10][11]. Then, the decrease on the water level in this region under an altitude of -1700 meters produced (1) the formation of a new peninsula in Nepenthes Mensae due to the emergence of the here described plain, and (2) the formation of an small sea due to the chain of depressions which was still completely covered by the water. In this evolution stage, the surface of the plateau was exposed to the erosion, meanwhile the depressions accumulated the sediments coming from the channels of the highlands, some of them forming different deltas in the study region [12][4]. A new possible descent on the water level increased the surface of the peninsula and reduced the extension of the watersheet forming the coastal lake. Descent of water level under -2000 meters produces the formation of a coastal lake or a chain of lakes in the deeper areas of the chain of depressions, due to the disconnection between the small sea and the ocean in the southeastern (and narrower) sector of the study area (Fig. 1).

The geomorphological analysis of MOC, THEMIS, HRSC, CTX and HiRISE images supports the idea of the existence of a small sea and later the chain of lakes, mainly by (1) the existence of possible shorelines related to the different terrace-like features, (2) the irregular (and smoother texture) surface of the depressions meanwhile the plateau has a more regular (and rough texture) surface, and (3) the presence of deltas ad other fluvial deposits in the depressions. Other works revealed the important role of water (liquid and frozen) in the evolution of this region [13][14][5] and they support the here presented interpretation of the possible evolution of the watersheet in this sector of Nepenthes Mensae of Mars.

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