A POSSIBLE SMALL FROZEN LAKE IN UTOPIA PLANITIA, MARS. M.A. de Pablo[1,2], A. Pacifici[2], and G. Komatsu[2]. [1]Dpto. de Geología. Universidad de Alcalá. 28871 Madrid, Spain. (miguelangel.depablo@uah.es), [2]International Research School of Planetary Sciences. Università d'Annuzio. 65127 Pescara, Italy.

Introduction: Searching and studying the existence, location and distribution of water (ice or liquid) is one of the main scientific objectives of the planetary exploration of Mars. There are a number of scientific papers describing landforms that imply the existence of water (1) as liquid and ice, (2) on or below the surface, (3) in both ancient and recent times, (4) under warm or cold climatic conditions, and (5) in various geological settings. Here we describe a possible small frozen lake on the surface of Utopia Planitia. Its relevance for geological and climatic implications is also briefly discussed.

Description: At 135.34ºE, 38.93ºN in Utopia Planitia, about 3 kilometers from the eastern edge of Hrad Vallis, we found an apparently flat area in a small depression. This feature was visually interpreted in a single MOC-na image (E0402007) covering this site (Fig. 1). Geologically this site is located in a relatively rough area of possible mega-lahar deposits derived from the Elysium Rise [1][2]. This small flat area is about 2.3 - 3 kilometers in diameter and it covers an area about 6.3 square kilometers. Morphologically, it is not completely plain because it is crossed by narrow, low-relief and discontinuous ridges: They show two different distribution patterns: (1) SE-NW and (2) radial from the center. The first pattern is characterized by less clear and shorter ridges, which seem to be cut by the ridges forming the second pattern. Those ridges do not continue outside of the flat area. In the surrounding area there are other ridges but their morphology and distribution are very different, especially at the NE of the area covered by the MOC-na image (Fig. 1). In the flat area the ridges are narrow, and they show a curved spatial distribution and also they form a parallel group of ridges. The edge is clear all around the flat area being marked by a change of the roughness. Outside the flat area the surface is rough. Only the southern edge of the flat area is not clear due to the presence of a smooth deposit that made impossible to delineate exactly the edge. The rough surrounding area is also characterized by the presence of a number of pitted cones. Diameters of the cones range between 50 and 150 meters. They are distributed all around the flat area, although four of them are located inside on its southern side. The pitted cones are isolated or forming groups and clusters in the rough surrounding area, but never on the ejecta deposits of the three impact craters located in the surrounding area (Fig. 1). Three possible small impact craters (diameters ranging between 100 and 180 meters) are located in the flat area. They are bowl-shaped, very shallow, with thin ejecta deposits lobated in shape. However, they do not have a rim. Due to the size of those relieves with respect to the resolution of the MOC-na image we can not apply the shadow measurement technique to obtain the heights of ridges, pitted cones and impact craters. THEMIS-vis and HRSC images shows that the region where the flat area is located at the eastern side of Hrad Vallis, is marked by an irregular surface of topographic steps of smooth materials. The region includes other sites with pitted cones isolated or forming groups and clusters. Some of them are located inside the channel of Hrad Vallis. Besides this channel there are no other channels, gullies or water marks in the region.

A possible frozen lake: In order to establish a possible origin for this flat area in Utopia Planitia, we tested various geologic processes following a multiple working hypothesis methodology [3]. We analyzed tectonic, fluvial, sedimentary, volcanic, glacial and periglacial processes. We also made a review of previous works describing those types of processes on Earth and Mars. Our research included an analysis of satellite images from Earth with *Google Earth* and *World Wind* software. The interpretation we provide here could explain the relieves and landforms observed in analyzed images, taking into account the geological setting and the terrestrial analogues.

Based on previous descriptions [4][5][6][7], we interpret the pitted cones as possible pingos formed by ground water freezing and a later growth of ice lenses at shallow depths. The origin of the water in this terrain could be explained due to the proposed origin of the geologic materials where they are located: mega-lahars deposits [1]. Hrad Vallis, a channel emanating from the Elysium rise, and the path of the mega-lahars, are consistent with the presence of the groups and clusters of pingos [7]. The parallel groups of linear and curved ridges are referred in previous bibliography [8][9] to be grooved and fluted terrains with a periglacial origin. However, the ridges observed in the flat area with diverse patterns are very similar to cracks on the surface of frozen lakes on Earth [10], such as Frixell and Vanda lakes on Antarctica, or El'gygytgyn Lake in Siberia (Fig. 1). In order to check if materials forming the flat and ridged area are different from materials of the surrounding terrain, we analyzed surficial temperature (diurnal and night) in THEMIS-IR images (I1368006 and I053322011,

respectively). Those images show a clear contrast of temperature between the flat area and the surrounding terrains. We calculated the diurnal and night surface temperature [11] and we obtained qualitative Apparent Thermal Inertia (ATI) values for these materials [12]. The result of these calculations was that the material forming the flat area shows higher Thermal Inertia (TI) than the surrounding materials. Experimental and real measurements of TI revealed that solid ice have very high values than those of Martian materials [13]. Moreover, lobate ejecta deposits of the small impact craters located inside the lake area are a probable indication of the ice existence melted during the impact process. Pingos located in this region and near the edge of the flat area is another marker of ground ice. Thus, all those observations and interpretations point to the flat area as a possible frozen lake.

The origin of the water: Assuming that the flat area is a possible frozen lake, the origin of the water necessary for creating this lake is the next issue to be solved. In our visual analysis of the surrounding area we did not find markers of water flows outside of Hrad Vallis. There are not channels flowing to the frozen lake, and gullies are not observed. Then, water forming the lake does not come from the surface runoff. A climatic origin is the second possibility. Temperature and pressure conditions reveal that the site where the possible lake is located is near a region where the probability for liquid water existence is about 20% [14]. On the other hand, conditions for the existence of an active layer in the last 10 Ma at this latitude seem not to be adequate [15]. We can not rule out the climatic origin for the water, but we need to check other hypotheses such as a hydrothermal activity in this region [16]. The materials where the lake is located (possible mega-lahar deposits [1]) could be water-rich (liquid or ice, as indicated by the abundant pingos in this region [4][5][6][7]) and different processes could be the cause of the water melting, later freezing under the recent cold climate conditions.

Future works: In order to test our hypothesis about the possible frozen lake in Utopia Planitia, we need to review HiRISE images covering this site, HRSC images with better resolutions than those of available images. Spectral data from OMEGA and CRISM could provide chemical and mineralogical composition information of the materials forming the flat area if it is free of sand or dust. In order to check if the ridges in the flat area are related to cracks in ice or if they have other origins, we will apply a fractal analysis to the Martian features, and compare the results with the fractal analysis of other terrestrial and Martian landforms (volcanic lakes, fractures, etc.). If future investigations confirm our hypothesis, the possible frozen lake of Utopia Planitia would be considered an interesting landing site for future astrobiological missions to Mars.

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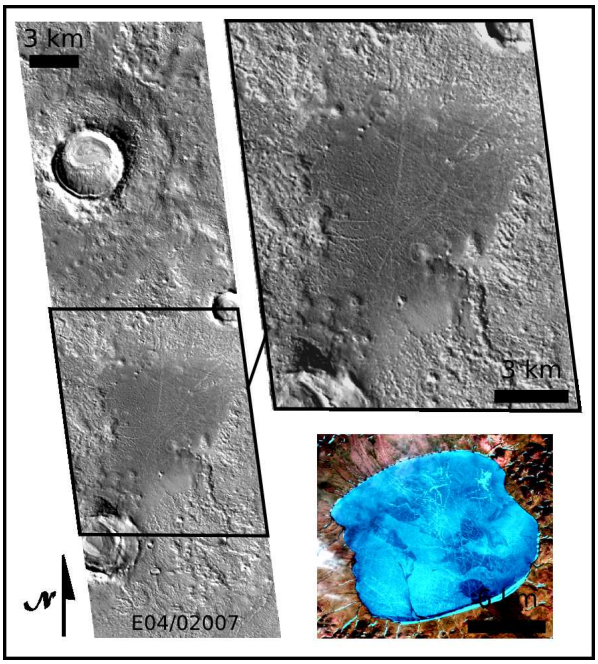

Figure 1: MOC-na image frames showing the possible frozen lake in Utopia Planitia, Mars. El'gygytgyn lake shows similar fractures on the surface when it is frozen (Landsat image).