ANALYSIS OF LAYERED DEPOSITS IN TERBY CRATER (HELLAS REGION, MARS) USING MULTIPLE DATASETS MOC, THEMIS AND OMEGA/MEX DATA. V. Ansan[1], N. Mangold[1], A. Lucas[1], A. Gendrin[2], S. LeMouelic[3], F. Poulet[2], J.-P. Bibring[2], and the OMEGA co-Investigator TEAM [1] Laboratoire IDES-UMR8418-CNRS, bât. 509, Université Paris-Sud, 91405 ORSAY cédex, France - [2] Laboratoire IAS-UMR8617, bât 121, Unviersité Paris-Sud, 91405 ORSAY cédex, France - [3] Laboratoire de Planetologie et Geodynamique, 2 rue de la Houssiniere BP 9220, 44322 Nantes cedex 3 France; ansan@geol.u-psud.fr

Introduction: Impact crater paleolakes have been proposed by morphological analysis on Viking images [1, 2, 3, 4]. These impact craters show atypic morphologies with an inner flat floor and sedimentary features such as alluvial fans, deltas, sedimentary terraces and lacustrine shore. The presence of these potential paleolakes suggests that hydrological cycle was related with erosion-transport and sedimentation cycle during their formation. However, many questions remain: when did they form, how long time did they live and under which conditions? We focus our study on a closed impact crater paleolake, Terby crater, located at the northeastern part of Hellas basin. The MOLA [5] altimetry gives the regional information about their morphology. But the good spatial resolution (few m to 100 m/pixel) of MOC [6] and THEMIS [7] images improves the geomorphic analysis of erosional and sedimentary features in paleolakes. Moreover, the new spectral data acquired by the imaging spectrometer OMEGA [8] onboard Mars Express give information about the mineralogy of layered deposits.

Terby Crater: Terby crater is located at the north-eastern part of Hellas basin (75°E - 30° S) on densely cratered terrains dated of Noachian [9]. It shows an atypical morphology compared to other Martian impact crater of ~200-km in diameter. Instead of a circular depression with a central peak, it exhibits an inner flat topography standing at 2 km below the Mars mean radius. It is locally eroded by a 2-km deep, W-shaped closed depression (Fig. 1). This flat surface has been interpreted from Viking images as the result of friable aeolian, fluvial and volcanic ash deposits during the Noachian-Hesperian boundary [9].

The mid-infrared (IR) THEMIS (100 m/pixel) allows us to determine three geologic units : 1) the W-shaped depression floor would consist of poorly indurated material, 2) the flat topography and "mesas" spaced of branches of the W-shaped depression consist of bright, layered material observed on sides of the depression, 3) the top of plateau and mesas is covered by a thick grey layer.

The visible THEMIS image (18m/pixel) allows us to determine the geometry of bright material observed on sides of the depression. It consists of a series of sub-horizontal layers with a constant thickness of few meters. Moreover, all geologic features are covered by a thick grey layer interpreted as a dust mantle which thickness is estimated to be greater than 100 m at the top of the plateau and mesas.

The MOC images (1.5-6m/pixel) available on the bright layers of the depression sides show that their sub-horizontal geometry is locally disturbed by stratigraphic unconformities between which bright layers exhibit a ~ 5° dip southward (Fig. 2). This suggests that bright layers could correspond to detritic sediments (mixing of sand and clay sized particles) regularly deposited in alluvial fan or delta prograding southwards. However, we have no direct evidence of fluvial valley converging in Terby crater and carrying sediments. If it existed, it has been underlain by post sediments or eroded by later external processes.

The flat floor of the W-shaped closed depression is covered by fine-grained material which is locally eroded. At the MOC scale, these eroded areas display a serie of bright layers which seem to be horizontal. These layers are locally disrupted by small closed depressions suggesting that some of these layers could consist of soluble material (e.g. salts, sulfates, carbonates). Then recent dark sand dunes formed in the W-shaped depression.

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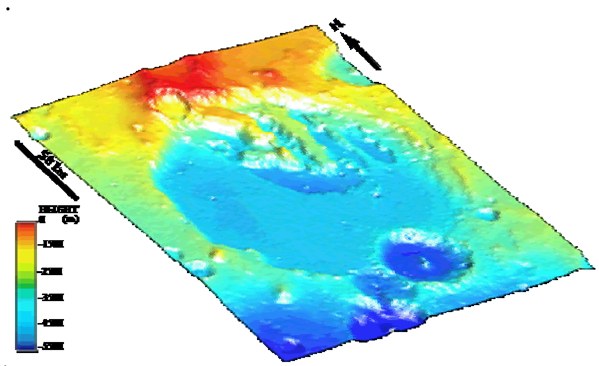

Figure 1. MOLA altimetry of Terby crater (blue flat circular area) at the NE bondary of Hellas Basin (lower left corner).

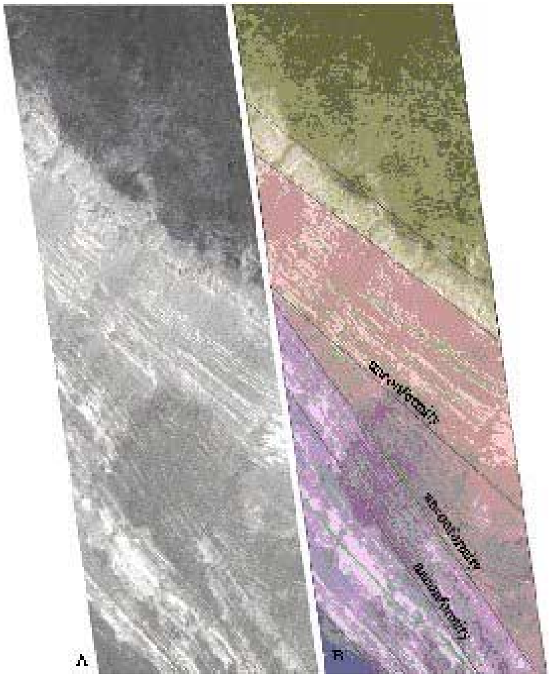

Figure 2. Extract of the R0900856 MOC image (2.84m/pixel), located at the western side of the W-shaped depression: bright layers with stratigraphic unconformities.

During the first year of operation, OMEGA observed Terby at high resolution only once (orbite 232, 74°E/26.8°S). This orbit displays subtle absorption features at 1.9 et 2.3 µm in very localized spectra (Fig. 3). This signature is correlated on a few pixels with bright layers on the sides of the W-shaped closed depression. This suggests that the corresponding material is hydrated (1.9 µm feature) and the 2.3 µm drop is consistent with a detritic hydrated material [10,11], e.g. clays, which is in good agreement with the geomorphologic analysis. Nevertheless, this signature is not observed everywhere on layers with flat spectra without apparent signature in that case.

The age of Terby crater is Noachian from crater counts. Its sedimentary filling occurred before the end of Hesperian (2.8 Gyr). A geologic scenario can be proposed: After the formation of Terby crater during the Noachian, the crater has been buried by subhorizontal layers locally cut by stratigraphic unconformities. Their mineralogic composition (hydrated mineral) and their geometry suggest that these layers could have a lacustrine origin. Some could be deposited in an alluvial fan or a delta prograding southwards. However, we have no direct evidence of fluvial valley converging in Terby crater and carrying sediments. If it existed, it has been underlain by post sediments or eroded by later external processes. When the detrictic horizontal filling of Terby crater finished, mechanical and chemical processes could be at the origin of closed W-shaped depression inside the Terby Crater, e.g. wind, dissolution. Then, the overall surface has been covered by a 100-m thick dust mantle locally eroded later allowing to observe the bright layers of plateau and mesas.

Conclusion: The Terby impact crater has collected the record of climatic changes on Mars. The superimposition of sedimentary layers of 2 km in thickness involves a sedimentary cycle throughout a long period of time before the end of the Hesperian. The presence of hydrated minerals detected on some OMEGA spectra implies that weathering processes were efficient. The forthcoming OMEGA observations will be helpful to further constrain the mineralogy of this site which is of great interest for the understanding the layered deposits present North of Hellas basin.

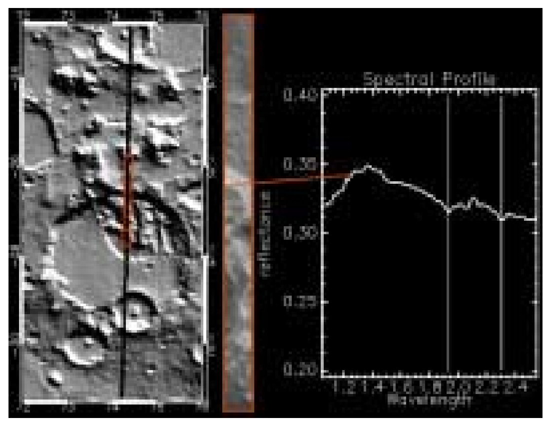

Figure 3 : OMEGA spectrum of bright material in Terby, showing features at 1.92 and 2.30 µm

References: [1] De Hon, R. A. (1992) *Earth, Moon, Planets*, 56, 95-122. [2] Newsom, H. E. et al. (1996) *JGR,101*, 14951-149551. [3] Cabrol, N. A. & Grin, E. A. (1999) *Icarus,142*, 160-172. [4] Cabrol, N. A. & Grin, E. A. (2002) *Global and Planetary change, 35*, 199-219. [5] Smith et al. (1999) *Science*, 284, 1495-1503. [6] Malin, M. C. et al. (1998) *Science, 279*, 1681-1685. [7] Christensen, P. R. et al. (2003) *Science, 300*, 2056-2061. [8] Bibring, J-P. et al. (2004) *ESA special publications*, 1240. [9] Leonard, G. J. & Tanaka, K. L. (2001) USGS geologic map I-2694. [10] Gendrin, A. et al. (2004) Second conference on Early Mars, 8030.pdf. [11] Poulet, F. et al. (2004) DPS AAS n°31-06. [12] Craddock, R. A. & Maxwell T.A. (1997) J*GR, 102*, 13321-13340. [13] Mangold, N. et al. (2004) *Science, 305*, 78-81.