LAYERED DEPOSITS IN TERBY CRATER (HELLAS REGION, MARS) FROM MULTI-DATASETS (MOLA, THEMIS AND MOC) : GEOLOGIC IMPLICATIONS

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Introduction: Terby impact crater is located at the northeastern part of Hellas region (75°E – 30°S) on the cratered highlands. Using multi-dataset available on this area, we investigated the geological story of Terby crater. MOLA altimetry [1] shows that Terby impact crater displays an anomalous morphology compared to other impact crater of ~200 km in diameter. Instead of a circular depression with a central peak, it displays an inner flat topography locally eroded. This kind of impact crater with an atypical morphology often showing an inner floor and sedimentary features such as alluvial fans, deltas, sedimentary terraces and shores have been interpreted as impact crater paleoloakes by morphological analysis on Viking images [2, 3, 4, 5]. The good spatial resolution (few m to 100m/pixel) of MOC [6] and THEMIS [7] images improves the geomorphic analysis of geological features.

Terby crater morphology: Terby impact crater of ~200 km in diameter displays a flat topography standing at 2 km below the Martian mean radius, in its inner southern part. This flat surface has been interpreted as the result of friable aeolian, fluvial and volcanic ash deposits during the Noachian-Hesperian boundary [9]. The southern area of the flat surface has been impacted by meteors forming two complex impact craters. They also show a modified morphology with a flat surface.

The northern part of Terby crater displays an anomalous W-shaped closed depression locally deep of 2 km and an oval closed depression deep of 1 km below the altitude of flat surface. These closed depressions are enigmatic and numerous questions remain about their formation. But, these depressions allow us to study the geometry of rocks located beneath the flat surface.

The mid-infrared (IR) day THEMIS images (100 m/pixel) show that the flat area located at the southern part of Terby and between the closed depression consists of a 100 m thick grey layer (Fig. 1a). The floor of closed depressions appears often dark, whereas the sides of depressions show bright layered material locally covered by grey material.

The mid-infrared night THEMIS images (100 m/pixel) give information about the thermal properties of material interpreted as a function of cohesion and/or granulometry of material [8]. Figure 1b shows that the flat area is relatively bright in the western part suggesting that this part consists of indurated material or coarse-grained material, whereas the other part is relatively dark suggesting that this part consists of non-cohesive material or fine-grained material. The floor of closed depressions are dark indicative of non-cohesive material of fine-grained material. The sides of depressions show an alternative dark and bright signal suggesting that they are formed by different kinds of material distributed in layers.

The 32 visible THEMIS images (18m/pixel) located essentially on the northern part of Terby crater allow us to determine the geometry of bright material observed on the sides of depressions. It consists of a series of sub-horizontal layers with a constant thickness of few meters (fig. 1c): fifty layers are counted on the eastern side of the main closed depression (box e) and ten layers are numbered on the sides of the small hill located inside the main depression (box f). Moreover, all geologic features are covered by a thick grey layer interpreted as a dust mantle which thickness is estimated to be greater than 100m at the top of flat surface (box d).

The mosaic of 87 MOC images (1.5 to 6 m/pixel) shows the detailed geometry of the bright layered rocks. All bright layers are sub-horizontal (Fig. 1e and f) and they appear with a regular metric thickness. However their sub-horizontal geometry is locally disturbed by stratigraphic unconformities between which bright layers exhibit a ~5° dip southward (Fig. 1d). The flat floor of the W-shaped closed depression is covered by dark “fine-grained” texture material which is locally eroded and locally by dark sand dunes. At the MOC scale, the eroded areas correspond small hills consisted of a series of bright layers. In other areas, the terrains without mantle correspond to small closed depression in which bright layers are also sub-horizontal.

At all scales, Terby crater displays a filling by a series of a fifty of sub-horizontal layers more and less cohesive or with different granulometry. As it was suggested by previous studies on this area, bright rocks could correspond to volcanic ash [9] or detritic sediments regularly deposited in lake, alluvial fan or delta [2, 3, 4, 9, 10]. The numbers and the rhythmicity in layers favor the second hypothesis without excluding the contribution of a volcanic event in layered deposits. However, we have no direct evidence of fluvial valley converging into Terby crater and carrying sediments. If it existed, it has been underlain by late sediments or eroded by later external processes.

The age of Terby crater is Noachian from crater counts [9]. 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, subhorizontal layers locally cut by stratigraphic unconformities have buried the crater. Their geometry and their rhythmicity suggest that these layers could have a lacustrine origin rather than a volcanic one. Some of them could be deposited in an alluvial fan or a delta propagating southward. When the detritic horizontal filling of Terby finished, mechanical and chemical processes could be at the origin of closed W-shaped depression inside the crater, e.g. wind, dissolution, withdraw… Then, the overall surface has been covered by a thick dust mantle locally eroded later allowing us to observe the bright layers filling the Terby crater.

Conclusion: Terby crater shows that there has been a sedimentary cycle during a long period of time before the end of Hesperian. Indeed, the filling by subhorizontal bright layers with a repetitive rhythmicity implies that 1/ the sedimentary processes were efficient during the Noachian and Hesperian, 2/ the liquid water was present to transport and deposit layered material in a 2km thickness in the Terby crater.

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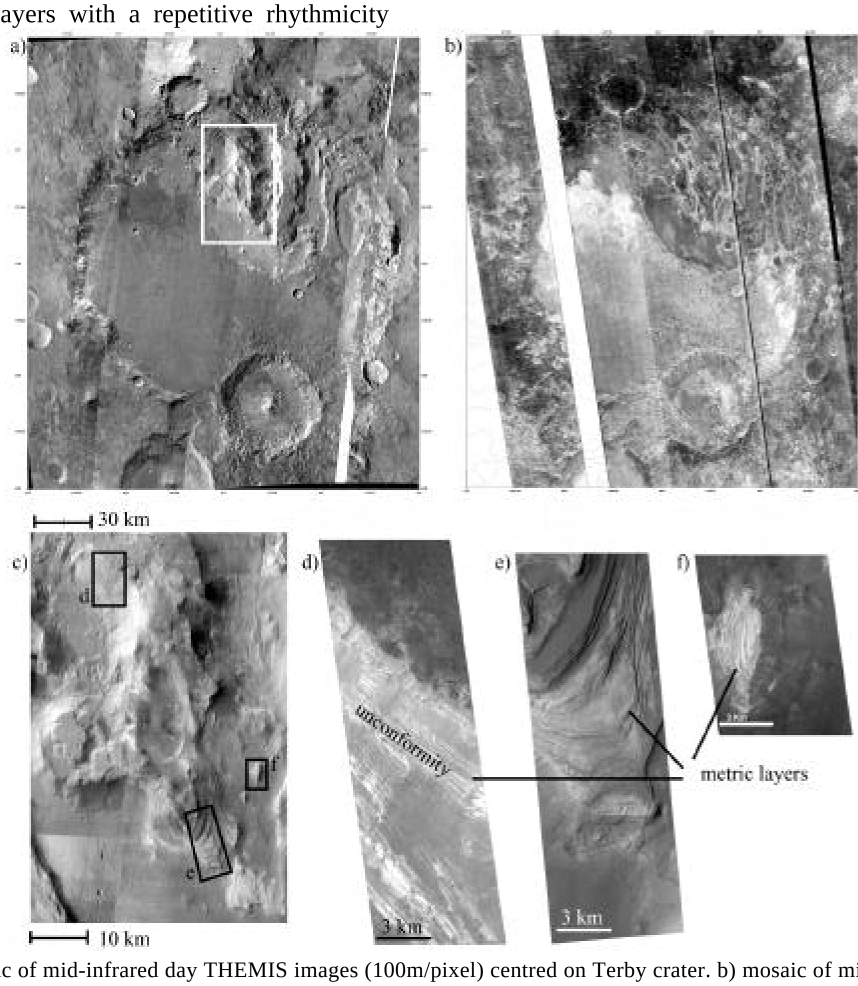

Figure 1. a) Mosaic of mid-infrared day THEMIS images (100m/pixel) centred on Terby crater. b) mosaic of mid-infrared night THEMIS images. C) Mosaic of visible THEMIS images (17m/pixel) located in white box (fig. 1a). Black boxes correspond to the location of MOC images (fig. 1d,e,f) where bright layers are observed in details.