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Potential site of preservation of early sedimentary environment on Mars in Terby Impact crater and North Hellas rim

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1. Introduction

The 174 km diameter Terby impact crater (28.0°S - 74.1°E) and other impact craters located on the northern rim of the Hellas basin display anomalous inner morphology [e.g. 1, 2], including a flat floor and light-toned layered deposits [e.g. 3, 4, 5]. Although some of anomalous impact craters show small well preserved alluvial fans, dated of the Hesperian epoch, the more remarkable evidence of huge amount of liquid water at the surface of Early Mars comes from the geometry of layered deposits outcropping inside the flat floor of impact craters, like Terby. The geometry of layered deposits was consistent with that of clastic sediments that settled mainly in a sub-aqueous environment.
The analysis of these deposits was performed using multiple datasets with visible images for interpretation, infrared data for mineralogical mapping [6, 7], and topography for geometry.

In Terby impact crater, the inner geometry of thickest sediments is similar to that observed in terrestrial fan deltas, as identified by 100 m to 1 km long clinoforms, as defined by horizontal beds passing to foreset beds dipping by 6°-10° toward the center of the impact crater [8]. The identification of distinct sub-aqueous fan sequences, separated by unconformities and local wedges, showed the accumulation of sediments from prograding/ onlapping depositional sequences, due to lake level and sediment supply variations [8].
The mineralogy for several layers with hydrated minerals, including Fe/Mg phyllosilicates, supports this type of sedimentary environment. The volume of fan sediments was estimated as >5,000 km^3 [8] (a large amount considering classical Martian fan deltas such as Eberswalde (6 km^3, [9])) and requires sustained liquid water activity. Such a large sedimentary deposition is characteristic of the Noachian/Phyllosian period [8] during which the environment favored the formation of phyllosilicates. The latter were detected by spectral data in the layered deposits of Terby crater in three distinct sequences. During the Hesperian period, sediments experienced strong erosion, possibly enhanced by more acidic conditions (in the Theiikian), However, small fluvial valleys and alluvial fans formed subsequently, attesting to late fluvial processes dated as late Early to early Late Hesperian. After this late fluvial episode, the northern boundary of Hellas was submitted to aeolian processes and permanently cold conditions as confirmed by viscous flow features in this area.

On the northern rim of Hellas basin, layered terrains have been identified by different image orbiters [3, 4] whose mineralogy is associated to hydrated minerals including Fe/Mg phyllosilicates [10] detected from OMEGA and CRISM spectrometers [6,7]. These layered terrains draped widespread area with large degraded impact craters. They would date of middle to late Noachian, during the same climatic period as those found in Terby impact crater (e.g. detrital lake/shore/alluvial plains).

2. Conclusion

The northern rim of Hellas basin displays, in a single region, geologic features that characterize the three main periods of time on Mars, with the presence of one of the thickest sub-aqueous fan deposits reported on Mars in Terby crater.

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