EPSC Abstracts
Vol. 9, EPSC2014-630-1, 2014
European Planetary Science Congress 2014

Creep of ice and debris in Promethei Terra, Mars: Observations and implications for past climate environments in an impact crater infill using optical and radar dataset

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1. Introduction

On Mars ice-related landforms have been identified at mid-latitudes between 30° and 50° in both hemispheres including Tempe Terra, Deuteronilus-Protonilus Mensae, Phlegra Montes and the rims of the southern hemispheric impact basins Argyre and Hellas [1-7].
Our study area – informally termed hourglass-shaped crater by [8] – is located in Promethei Terra at the eastern rim of the Hellas impact basin (39° S, 102.8° E) (Fig.1 and 2). The Impact crater is filled by what was described as debris-covered piedmont-type glacier [8] based on analysis of High Resolution Stereo Camera (HRSC) data. This implies a glacial origin for the infill with precipitation of ice during higher obliquity phases [8].
The aim of this study is to identify qualitative and quantitative characteristics of this ice-related landform and to separate different processes and timings that have contributed to shaping this feature.

2. Methods

In order to observe surface and subsurface of the ice-related crater infill, we analyzed optical and radar datasets. Medium to higher-resolution imagery obtained by the High Resolution Stereo Camera (HRSC), the High Resolution Imaging Science Experiment (HiRISE) and the Context Imager (CTX) (Fig. 2) provide a detailed image of the spatial distribution of different small-scale surface features indicative of periglacial and/or glacial origin. High Resolution Stereo Camera (HRSC) DTM was used to construct topographical profiles and geological cross-sections. Based on these data a geomorphological map has been compiled to show the diversity of the main surface units in the impact crater infill (Fig. 1). SHARAD radargram profiles provide information about the subsurface and potential signals for climatic cycles in the past.
Initial age determinations based on impact-crater size-frequency statistics indicate an age of 3.4 Gyr for the impact-crater and an age of 75 Myr for the infill [8]. For age determinations of the two main geomorphological units (Fig. 1) we used the standard production and chronology functions [9-11].

3. Observations

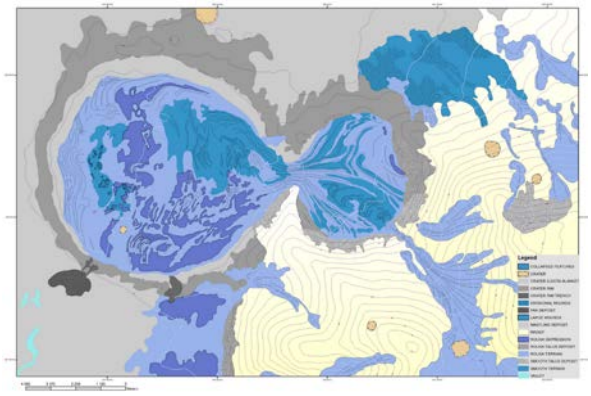

Figure 1: Geomorphological map of the Hourglass-shaped crater infill and the surrounding area, Promethei Terra, Mars.

3. Results

Based on geomorphological mapping and observations we are currently reconstructing the (peri-) glacial history of the deposits at the eastern Hellas basin.

- Analyses of impact-crater deposits are in good agreement with a (peri-) glacial origin as suggested in earlier work by [8]. Ages are in the
- range of 40 Myr for the smooth area and 70 Myr for the rough terrain.
- The impact-crater infill shows observational evidences for ice-related structures, such as lobe-like features, knobby texture, scalloped terrains (inside the rough depressions), perpendicular and parallel furrows indicating differential extension and compression akin to glacial flow textures (e.g., crevasses).
- The rough terrain was probably formed by creep of debris and ice from the eastern massifs towards the main impact craters and to surrounding areas.
- The smooth terrain unit was formed by debris flow-like landslide. The evidences are the boulder blocks arranged in arc-shaped pattern in the direction of the movement.
- Initial photoclinometric results connected to the analysis of inverted-relief craters or pre-glacial impact structures provided a first thickness estimate: The thickness of the rough terrain averages at ~53 m and the smooth terrain has a thickness of approximately 15 m.

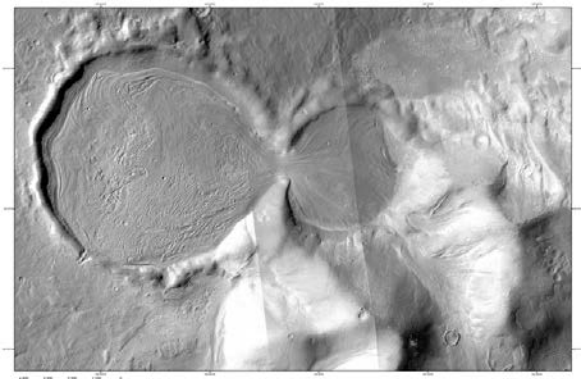

Figure 1: CTX mosaic of the Hourglass-shaped crater infill and the surrounding area, Promethei Terra Mars.

- We believe that origin of water-ice is probably atmospheric precipitation, which accumulated homogeneously in this area. There is observational evidence for detachments and downslope-sliding of precipitated material later.
- A pronounced north-south asymmetry in the impact crater infill is probably due to insolation.

Acknowledgements

This work has been partially supported through funding by the German Space Administration, fund 50 QM 1301 (Mars Express). We are grateful for data provided by the instruments team of HRSC, CTX and HiRISE.

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