EPSC Abstracts
Vol. 9, EPSC2014-215-2, 2014
European Planetary Science Congress 2014

Phlegra Montes – Spatio-Temporal Distribution of Ice and Debris at Martian Mid-Latitudes

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Introduction and Motivation

Mars hosts an abundance of landforms indicative of near-subsurface ice. Lobate debris aprons belong to a group of well-studied but still enigmatic ice-related landforms which have been identified at mid–latitudes between 30° and 50° in both hemispheres. While nature and origin of ice in these aprons are still controversially debated there is a general consensus that these features are sensitive to climate variability and, consequently, a potential indicator of past climate conditions, and potential water reservoirs today.

The northern hemisphere hosts three populations of debris aprons: the Tempe Terra/Mareotis Fossae (TT) region [2, 5], the Deuteronilus/Protonilus Mensae (DPM) [1, 4, 9], and the Phlegra Montes region (PM) [3]. In southern latitudes the impact-basins rims of Argyre (AP) and Hellas Planitiae/Promethei Terra (HP) host a similar, albeit less well-pronounced set of features [1, 2, 6]. While most research is being concentrated on the HP, TT and DPM areas, studies discussing the population of the PM (located at 165°E, 30–50°N, see figure 1) are rather sparse [3, 14, 15, 16] although features are generally well-developed, representative due to their spatial distribution and well-imaged by high-resolution instruments.

We performed an integrated spatio-temporal analysis of the PM population and focus on the age distribution of debris aprons in order to constrain their formation age. Our research is motivated by the assumption that if young-Amazonian climate variations have controlled formation and appearance of geomorphic landforms on Mars, we should observe traces of this process in PM as latitudinal trends and variations should provide measurable characteristics. If so, and if surface ages based on crater-frequency analysis are consistent with these assumptions, the exact timing of climate shifts may be assessable.

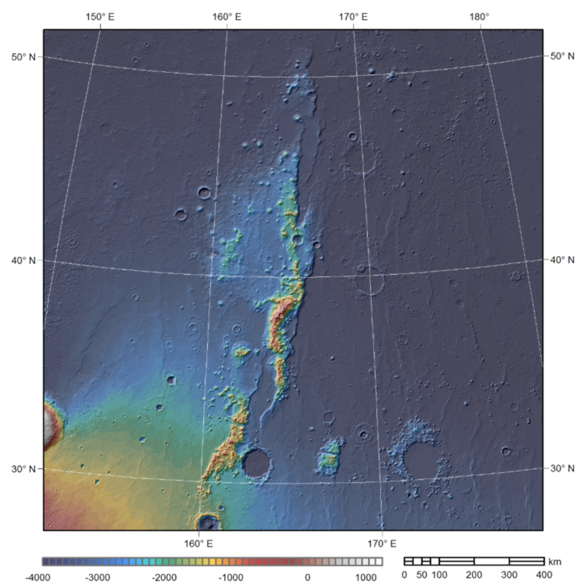

Figure 1: Topography of the Phlegra Montes (MOLA topography)

Data and Methods

Our study makes use of panchromatic image data obtained by the High Resolution Stereo Camera (HRSC) [7, 10, 11] onboard Mars Express and the Context Imager (CTX) [8] onboard Mars Reconnaissance Orbiter. Imaging data are further complemented by digital terrain-model data derived from HRSC based stereo imaging [12] and from altimetry profiles obtained by the Mars Orbiter Laser Altimeter (MOLA) [13].

We conducted morphometric measurements to constrain spatial distribution characteristics as well as crater-size frequency analyses in order to constrain absolute surface ages. The combination of both datasets provided further insights into the spatio-temporal distribution of features in PM.

Observations Summary

For the remnant–apron system in PM, an initial number of eight areas distributed over the area have been selected and prepared for age determinations through crater-size frequency-statistics.

All ages derived thus far indicated deposition of aprons during the Late Amazonian with the oldest age around 1,060 Ma in the south and 515 Ma in the north. Older ages show distinct resurfacing features indicating potentially multiple episodes of denudation and resurfacing cycles.

If ice-rich material was deposited as a result of obliquity changes and if older patterns were eliminated through resurfacing, ages would provide insights into the rate of de- and increase of spin-axis inclination. For the Phlegra Montes a rate of approximately 20° in 500 Myr can be observed — or up to 60° in 1,500 Myr. This initial result requires further investigations and a thorough discussion as it differs from earlier published assessments by several orders of magnitude.

Acknowledgements

This work is supported by the DLR Space Administration on behalf of the Federal Ministry for Economic Affairs and Energy, grant 50QM1301 (HRSC on Mars Express). We thank the HRSC experiment team at DLR Berlin and the HRSC operations team at ESOC for their successful planning, acquisition and processing of the HRSC data. We thank the CTX team at MSSS for their successful acquisition of data and for making it publicly available.

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