EPSC Abstracts
Vol. 12, EPSC2018-848, 2018
European Planetary Science Congress 2018

Morphological and spectroscopic analysis of light-toned materials in southeastern Gorgonum Chaos, Mars

David Haack (1), Solmaz Adeli (1), Ernst Hauber (1), Katrin Stephan (1), Ralf Jaumann (1,2)
(1) Institute of Planetary Research, Deutsche Zentrum für Luft- und Raumfahrt, Rutherfordstrasse 2, 12489 Berlin, Germany, (David.Haack@dlr.de)
(2) Planetary Sciences and Remote Sensing Group, Institute of Geological Sciences, Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany

1. Introduction

Gorgonum Chaos is an eastern sub-basin of the hypothesized Eridania paleolake system [1] in the southern highlands of Mars. The basin morphology is characterized by a bowl-shaped floor and numerous fluvial valleys and erosional features at its rim [2]. Its floor consists of light-toned material which forms hundreds of meters-thick deposits and is observable at numerous outcrops throughout the basin [3,4]. This light-toned material contains hydrated minerals such as phyllosilicates and indicates a genesis in which abundant liquid water was involved [e.g. 3,4]. Therefore, the analysis of these materials and their geomorphological history is crucial to understand the evolution of Gorgonum Chaos and the role of liquid surface water in its current morphology. Here, we present a reconstruction of the past geological events and aqueous activities in the study area.

2. Data

To study the morphological context between units and relief, CTX, HiRISE, HRSC images and HiRISE based DEMs were used. The spectroscopic analysis was realized with THEMIS and CRISM data.

3. Results

3.1 Geomorphological investigation

At the southeastern rim of Gorgonum Chaos a heavily degraded crater with 22 km diameter forms an approximately horizontal plain (Figure 1). A prominent gap appears in the northern crater wall and forms a curved, 60 m deep path towards the north.

Adjacent to the west of the degraded crater a depression extends over ~380 km^2, which displays numerous km-scaled inverted fluvial valleys and impact craters with diameters up to 1.5 km. Both inverted features are up to 150 m high. The valleys trend to originate near the northern gap in the crater wall. The inverted valleys and craters are completely embedded in highly polygonised bedrock of light-toned units, which were heavily degraded by aeolian erosion. The unit formed of light-toned material is covered with different darker units of varying texture, morphology, and thickness.

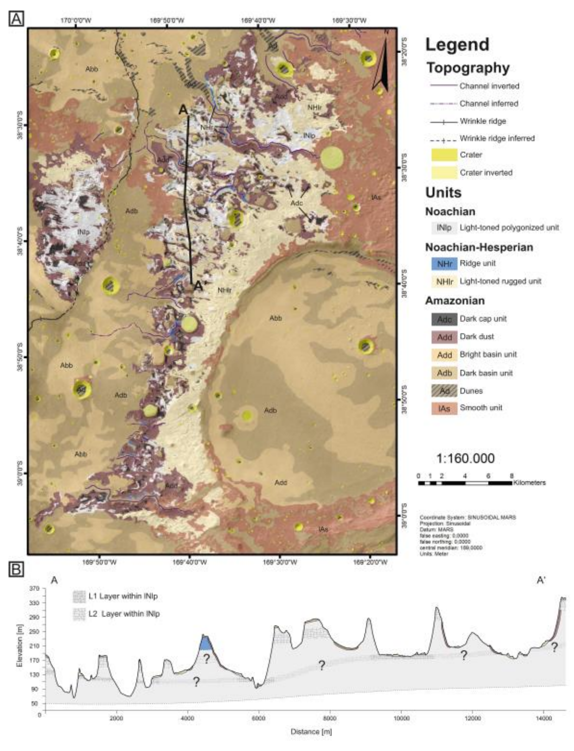

Figure 1: (A) Geological map of the study area. (B) Interpretative cross section of profile line AA' based on a HiRISE DTM. The topography is exaggerated by factor 10.

3.2 Spectroscopic analysis

CRISM spectra from the light-toned material revealed the presence of Al-phyllosilicate similar to kaolinite and a sulfate similar to jarosite (Figure 2) This material was deposited in the Late Noachian – Early Hesperian. These minerals were most likely deposited under humid conditions and form the upper layer of lacustrine sediments that is at least 150 m thick.

Chlorides were detected locally at upper layers of inverted features and do not occur over extended areas. They were deposited most likely in the Late Noachian – Early Hesperian after the formation of light-toned materials when sediments transported with brines refilled fluvial valleys and small craters.

Olivine and pyroxene are ubiquitous in the 3-m thick mantling units of Amazonian age. They may represent airfall material of ultramafic volcanic ashes.

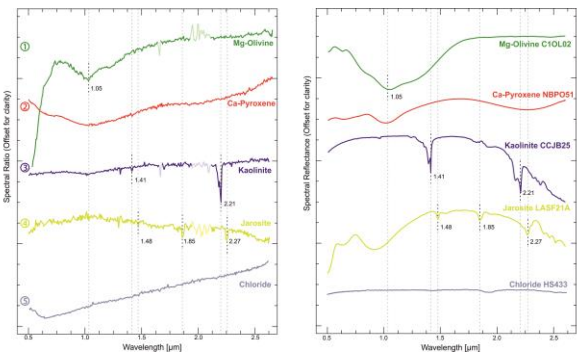

Figure 2: (Left) Measured and ratioed CRISM spectra. (Right) Laboratory spectra of analog materials to compare with measured spectra.

4. Summary and Conclusions

In the Late Noachian a hundreds of meter thick light-toned unit, enriched in hydrated minerals, was deposited on the floor of the hypothesized Eridania paleolake. Approximately during the Noachian-Hesperian transition the paleolake desiccated [1] and fluvial systems and impacts started to modify the surface. Deposits have accumulated later in these fluvial valleys or craters when liquid surface water was present after the desiccation of Eridania. These deposits contain considerable amounts of chlorides that may have cemented the sediments and increased their competence.

During a period of aeolian erosion and deposition throughout Hesperian the formation of hydrated minerals was reduced to marginal amounts. The depressions with inverted structures as sinuous ridges and circular mesas were formed and partially refilled with new sediments. They are of low competence and reminiscent of loess-like sediments [5]. The ultramafic and morphological characteristics of these younger deposits are consistent with arid conditions.

In the Amazonian all features were covered with a thin layer of ultramafic air fall material of probably volcanic origin. The olivine in this latest unit is stable only under anhydrous conditions over long periods of time. This indicates the complete absence of water during and after their deposition.

The stratigraphic sequence of all units and their mineralogical composition indicates an environmental transition in this region from wet conditions during the Late Noachian over rather dry environments during Hesperian to ultra-arid conditions in the Amazonian and today.

References

[1] Irwin, R. P., Maxwell, T. A., Howard, A. D., Craddock, R. A., and Leverington, D. W.: A large paleolake basin at the head of Ma'adim Vallis, Mars, Science, Vol. 296, pp. 2209–2212, 2002.

[2] Howard, A.D., Moore, J.M.: Late Hesperian to early Amazonian midlatitude martian valleys: Evidence from Newton and Gorgonum basins. J. Geophys. Res. 116 (E5), E05003, 2011. doi: 10.1029/2010JE003782.

[3] Wendt, L., Bishop, J. L., and Neukum, G.: Knob fields in the Terra Cimmeria/Terra Sirenum region of Mars: Stratigraphy, mineralogy and morphology, Icarus, Vol. 225, pp. 200–215. doi:10.1016/j.icarus.2013.03.020.

[4] Adeli, S., Hauber, E., Le Deit, L., and Jaumann, R.: Geologic evolution of the eastern Eridania basin: Implications for aqueous processes in the southern highlands of Mars, J. Geophys. Res. Planets, Vol. 120, pp. 1774–1799, 2015. doi:10.1002/ 2015JE004898.

[5] Grant, J.A., Wilson, S.A., Noe Dobrea, E., Fergason, R.L., Griffes, J.L., Moore, J.M., Howard, A.D.: HiRISE views enigmatic deposits in the Sirenum Fossae region of Mars. Icarus, Vol. 205 (1), pp. 53–63, 2010.