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Detailed geological mapping of the fluvial deposits in Magong crater, Xanthe Terra, Mars

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Abstract

We present a detailed geological map of Magong Crater in Xanthe Terra, Mars. The ancient crater is situated at the terminus of Sabrina Vallis and hosts sedimentary deposits that were transported through this long and deeply incised valley. The sediments may represent a delta or, alternatively, an alluvial fan. Weak signatures of Fe/Mg-bearing phyllosilicates were detected in the central delta cliff section. A long and narrow, NE-trending topographic ridge is interpreted as a partially exhumed dyke. Numerous ~1 m-thick dark patches are distributed over the entire crater floor and may be remnants of a formerly continuous blanket of volcanic tephra or ash. The overall age of the aqueous sediments is dated to the Late Noachian/Early Hesperian epochs. This applies also to the surrounding highland materials. High-resolution images of the crater floor show a heterogeneous morphology, featuring a large variety of degraded craters and ejecta blankets, honeycomb-like depressions and polygonal fractures similar to mud cracks. Apart from the sedimentary deposits, the crater floor is very flat and meets the geological and technical criteria for a future possible landing site.

1. Introduction

Magong Crater has a diameter of ~40 km and is located in the north of Xanthe Terra at 11.9°N, 313.4°E. Its degraded rim and the flat floor suggest that it has formed in the Noachian. Sabrina Vallis is a deeply incised valley with few tributaries which extends for about 250 km in W-E direction through Middle Noachian highland material [1] and terminates in Magong Crater. Layered sedimentary deposits [2,3] at the mouth of Sabrina Vallis may be a promising target for in situ investigations by a future rover [4]. We performed detailed geological mapping of Magong Crater to distinguish between a deltaic and alluvial fan scenario for the origin of these sediments. Previous studies focused mainly on criteria for a possible landing site [5] and showed a simplified geological map featuring age determinations based on crater counts. The goal of this study is to clarify stratigraphic relationships, determine layer geometries, refine the sedimentary characteristics of the layers, improve the knowledge of the crater history by obtaining additional crater retention ages, and establish the crater floor resurfacing history.

2. Data and Methods

Morphological mapping (Fig. 1) was performed on HRSC (12.5 m/px), CTX (5-6 m/px) and HiRISE (0.25 m/px) images in a GIS environment. For age determination we used the CraterTools [6] and Craterstats [7] software packages. Digital Elevation Models (DEM) based on stereo images were used for topographic measurements.

3. Observations

The sedimentary deposit extends from the apex at the terminus of Sabrina Vallis to the center of Magong crater, covering ~220 km² (~19% of the crater floor). The sedimentary deposits are subhorizontally layered (Fig. 2a) and can be traced for >1km along the eroded cliffs at the distal part of the sediments. The main body of the sediments is covered with eolian deposits, which fill small craters and tend to form transverse aeolian ridges (TAR). The deltaic deposit is partly surrounded by a shallow topographic moat, which is flat-floored and dissected by polygonal fractures (Fig. 2b). Faint traces of polygonal fractures can also be found near the northern crater rim and outside of the moat in southern parts of the crater.

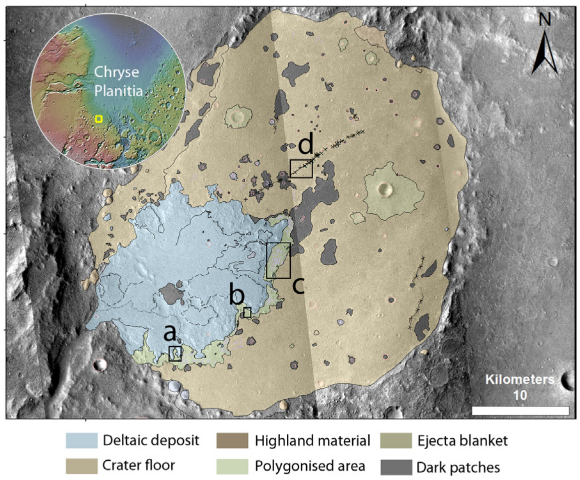

Figure 1: Refined geological map of Magong Crater and the sedimentary features. Boxes mark the locations of Figs. 2a-d. The geology of the sedimentary body is still mapped in preliminary form.

Circular depressions surrounded by concentric fractures are locally observed (Fig. 2c) and resemble “honeycomb” terrain identified in western Hellas Planitia [8], although at a smaller scale. The crater floor shows various heterogeneous morphological features. The most striking feature is a NE-trending ridge (Fig. 2d). Two similar small ridges are located near the western crater rim and are oriented in E-W direction. The crater floor appears dust-free and exhibits a rough texture with a variety of degraded craters. Aeolian bed forms can be found in some larger craters. Fresh craters exposed dark-toned underlying strata. Patches of dark deposits overlie the crater floor and can also be locally observed on top of the delta.

4. Discussion

Sabrina Vallis and the surrounding highland terrains show characteristics for periods of extensive fluvial activity. The Sabrina valley system was formed at about 3.8 Ga (all ages relate to the Neukum chronology), whereas the delta represents the last stage of fluvial activity at 3.4 Ga [3-5]. The dark patches are hypothesized to be remnants of a tephra blanket emplaced through eruptions in nearby Lederberg crater [9], although it is not possible to unambiguously confirm this. The topographic ridge is interpreted to be a partially exhumed dyke. It is unclear if the similar ridges elsewhere in the crater are also associated with igneous activity. The polygonal features are possibly mud or desiccation cracks. It is unknown whether the circular depressions near the deltaic deposits represent diapiric processes as in the Hellas basin floor [9].

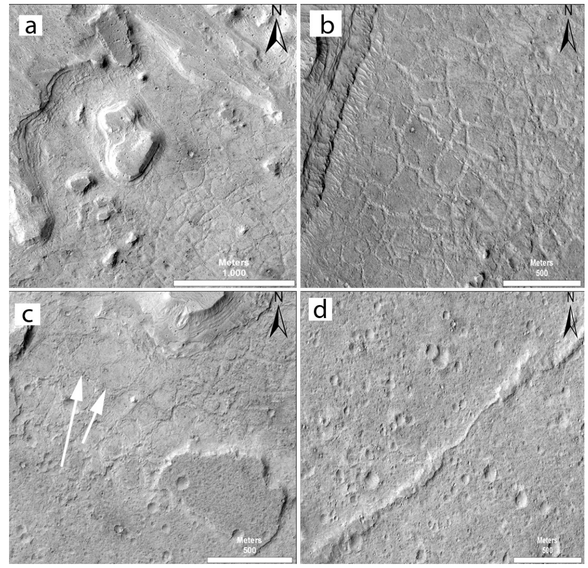

Figure 2: Close-up HiRISE views of (a) the layered sediments, (b) polygonally fractured floor of the moat surrounding the eroded margin of the sedimentary body, (c) the *miniature* “honeycomb” terrain (arrows), and (d) the NE-trending topographic ridge.

References

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