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A potential Mars 2020 rover landing site at a delta in Magong Crater, Mars

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Abstract

For the upcoming NASA 2020 Mars rover mission we identified a potential landing site that meets all geological criteria including the presence of Noachian/Early Hesperian aqueous sediments and mineral phases and access to unaltered igneous rocks. Our proposed landing site is located at the terminus of Sabrina Vallis in Magong crater. The 25 km × 20 km landing ellipse is centred at 11.990°N, 313.425°E. This site features deltaic sediments and distal lacustrine sediments. Weak signatures of Fe/Mg-bearing phyllosilicates were detected at central delta cliff sections. Lacustrine sediments are cut by a partially exhumed igneous dyke. On the crater floor of Magong crater remnants of an approximately 1 m thick dark deposit are observed, which is interpreted to be a tephra layer sourced from an adjacent volcanic field within Lederberg crater. Detailed terrain analysis of the landing site shows that engineering constraints are met with respect to slope and relief.

1. Introduction

Our proposed 2020 Mars rover landing site is located in Magong crater at the highland/lowland transition zone in northern Xanthe Terra. The landing ellipse is placed at the distal end of the Sabrina Vallis delta. Sabrina Vallis extends for about 250 km in W-E direction, cutting into Middle Noachian highland material (unit mNh; [1]).

2. Data and methods

For morphological investigations we used HRSC nadir (12.5 m/px), CTX (5-6 m/px), and HiRISE (0.25 m/px) images. Terrain analysis was performed on HRSC (75 m/px) and CTX-derived (15 m/px) digital elevation models (DEM). Albedo and thermal inertia values are derived from TES data. Spectral signatures are based on CRISM images.

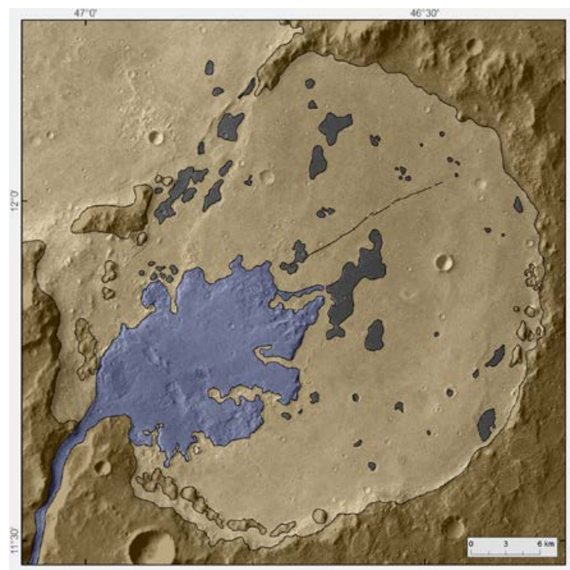

Fig. 1: Simplified geological map of Magong crater hosting the Sabrina Vallis delta. Blue: deltaic deposits, pale brown: crater floor unit, dark grey: tephra deposit, brown: highland material. The narrow line feature in the centre represents a dyke.

3. Geology

In our initial survey we prepared a basic geological map (Fig. 1), where four units are distinguished: 1) crater floor unit, 2) dark deposit, 3) deltaic deposits, and 4) highland material. Deltaic deposits are layered subhorizontally as exposed in distal cliff sections (Fig. 2a). The delta is covered by fine-grained sediments obscuring any potentially coarse-grained components and surficial proximal to distal facies changes. Due to the mantling, CRISM data only show weak signatures of Fe/Mg phyllosilicates (person. comm. J. Carter) exposed in central delta cliffs. The crater floor unit appears dust-free and exhibits a rough texture peppered with eroded impact craters (Fig. 2c). Small aeolian bedforms are only observed in some larger craters. The crater floor unit represents aqueous and subaqueous sediments. Fresh craters exposed dark-toned underlying strata. The dark deposit overlies the crater floor unit and is approximately 1 m thick (Fig. 2b). It occurs in isolated patches throughout the crater floor. A narrow ridge runs across the crater floor in NE-SW direction, which is interpreted to be the top portion of a partially exhumed dyke (Fig. 2d).

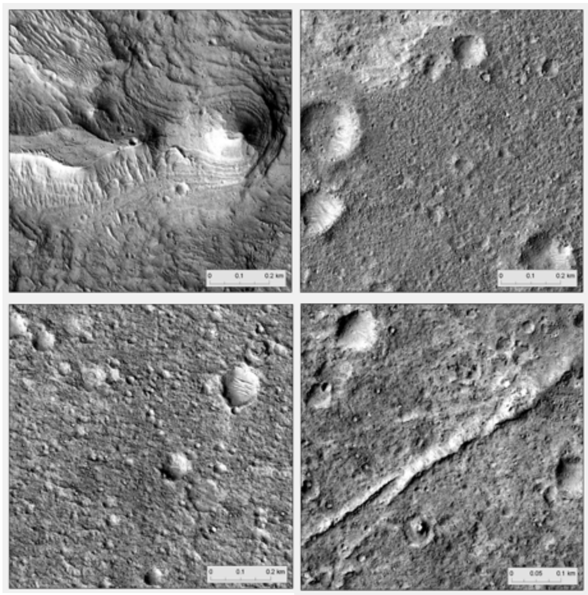

Fig. 2: Close-up HiRISE views of the deltaic sediments (a), hypothesized tephra deposit (b), crater floor material (c), and the linear ridge (an exhumed dyke?) (d).

3. Terrain analysis

The mean elevation within the landing area based on the HRSC-DEM is -2681m ± 48 m (1σ). Slope values range between 0-18.1° with an average of 2.4° ± 1.8° (1σ). The expected slopes at a 2 m baseline length are expected to be about 2.9° based on CTX and MOLA DEMs. The relief over a 1000 m baseline length is for most areas within the landing ellipse less than 75 m with a few patches exceeding 100 m (Fig. 3).

Fig. 3: Relief/slope map of Magong crater for a 1 km baseline length. Red areas exceed the 100 m relief threshold value. Yellow and orange colours mark relief values of 50-75 m and 75-100 m, respectively. Greenish colours mark the relief of <50 m within a 500 m radius. The 25 km × 20 km landing ellipse is shown in yellow. →

4. Discussion

Sabrina Vallis and the surrounding terrain are characterised by periods of extensive fluvial activity. The Sabrina valley system was formed at about 3.8 Ga with its delta representing the last stage of activity at about 3.4 Ga [2]. The crater floor material was deposited at 3.7 Ga with a major erosive event taken place at about 2.2 Ga. This event eroded most of the tephra leaving only isolated patches behind. The tephra was likely emplaced through explosive eruptions at hypothesized volcanic tuff rings within the adjacent Lederberg crater [3]. At the landing site there is access to fluvial and lacustrine sediments where signatures of life may be found. Sampling igneous rocks from the dyke will advance our understanding of the Martian magmatic evolution. The widespread tephra deposit would give insights into eruption dynamics and will also serve as a regional time-stratigraphic marker horizon.

References

[1] Tanaka, K.L., et al.: USGS Scientific Investigation Map, SIM 3292, 2014. [2] Hauber, E., et al.: JGR, 2013, pp. 1-16. [3] Brož, P. & Hauber, E.: JGR, 2013, pp. 1656-167.