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Preliminary grid mapping of fluvial, glacial and periglacial landforms in and around Lyot crater, Mars

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Abstract

Lyot crater, a 215 km diameter, Hesperian-aged martian impact crater, contains many landforms that appear to have formed by glacial, periglacial and fluvial processes [1-3]. Around Lyot are large channels potentially formed by groundwater release during the impact event [1,3]. Hence, the landscape of Lyot crater appears to record the action of both ancient water sourced from underground, and more recent water sourced from the atmosphere. We have used a grid mapping approach [5] to describe the distribution of these landforms and landscapes in and around Lyot crater. These data are presented here and potential avenues of future work discussed.

1. Introduction

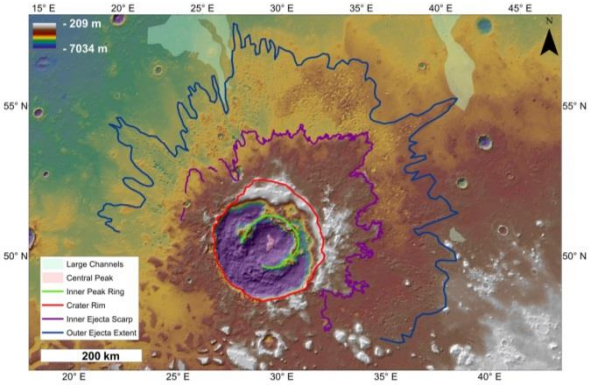

Figure 1: MOLA topography map showing Lyot crater with ejecta extents and large channels marked.

Lyot crater (50°N, 30°E) is located in the northern hemisphere of Mars, north of Deuteronilus Mensae [1-3,6] (Fig. 1). Lyot has an ejecta blanket consisting of both an inner continuous ejecta sheet, and an outer, more hummocky ejecta [1,3,6]. Large outflow channels that cover an area of ~300,000 km^3 and extend >300 km beyond the ejecta margin can be seen to the north, west and east of Lyot [3]. Lyot crater includes many geomorphic features which indicate prior fluvial activity [1–4] and possible periglacial and/or glacial activity [1,2,4].

2. Grid Mapping Method

Grid mapping employs a gridded "tick box" approach to record the presence or absence of particular landforms in a certain area [5]. A 6m/pixel Context Camera (CTX) mosaic of the study area was divided into a grid of 1680 squares, each 20 x 20 km in size. Alternating squares across the study area have been viewed, and each selected landform has been described as either "present", "dominant", "possible", "absent" or "no data". In this way a coarse-resolution map has been created which shows the distribution of the different landforms across the area. Below we outline some of our mapped landforms which are important indicators of the history of water in and around Lyot crater.

3. Key Geomorphological Features

3.1 Fluvial Valley Networks and Channels

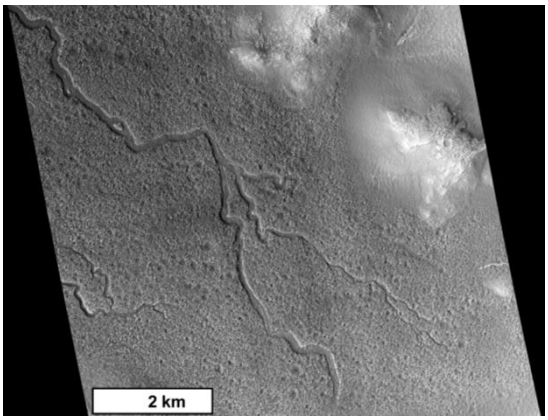

Figure 2: HiRISE image showing a rare contributory channel from the south east of Lyot crater.

Fluvial valley networks and channels are commonly found throughout the interior of the crater and within the inner ejecta blanket [1,4]. Channels are generally small (up to hundreds of metres across and up to tens of kilometres in length) and unbranching. Several channels have fans at their termini which vary from broad smooth surfaces, to smaller dissected fans [2]. Ages derived from impact crater size-frequency statistics for the networks place them as Mid/Late Amazonian in age [2,4]. Their distribution and morphology could be consistent with both an atmospheric and groundwater source.

3.2 Glacier Like Forms (GLFs)

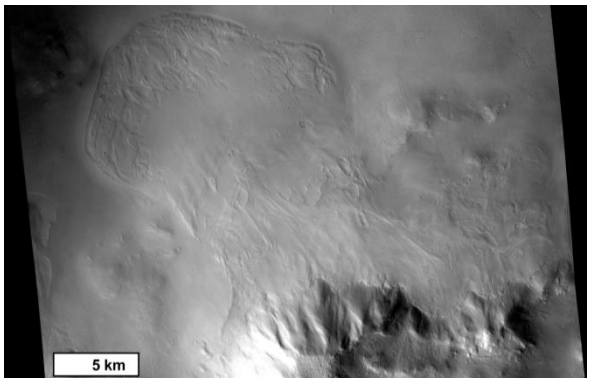

Figure 3: HiRISE image showing a GLF from the southern rim of Lyot crater.

GLFs are lobate features with convex-outwards and convex-upward profiles, and occur mainly in the south of Lyot crater along north-facing slopes of the rim and peak ring [1,2]. Some fluvial channels have been associated with GLF's, but not enough to indicate potential proglacial fluvial activity [1]. Their orientation is consistent with climate-driven deposition of water ice.

3.3 Polygonal Networks

Polygonal networks are common, and are limited to the north and south east regions of the outer ejecta [1]. Networks are commonly associated with mantling deposits in the outer ejecta blanket [1,4]. Some polygonal networks are enigmatic due to the presence of clasts which demarcate the edges of the polygons [1]. The location of these features, only within the ejecta, indicates that the conditions for formation are only met within this area/material [1].

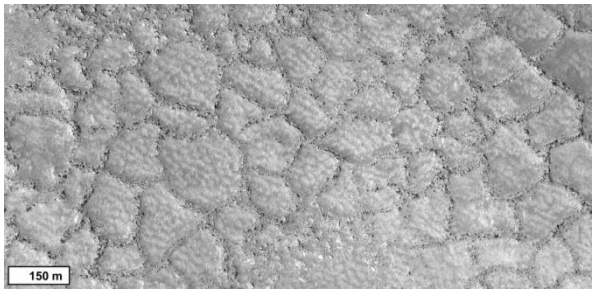

Figure 4: HiRISE image showing a clastic polygonal network from the outer ejecta to the east of Lyot crater.

4. Summary and Further Work

Lyot crater contains fluvial landforms and possible periglacial and/or glacial landforms that indicate the presence of liquid water in a recent period of Martian history. The distribution of these landforms indicates that the conditions for the formation of water may only be met in certain areas. In particular, there appears to be a genetic relation between polygonal networks and outer ejecta material. Cratering mechanics indicate that the impact event which formed Lyot crater could have penetrated the martian cryosphere [6]. As such ejecta material may represent cryospheric material deposited onto the martian surface [6]. To further explore this, the impact event that formed Lyot crater will be modeled using hydrocode impact modelling. This will provide an insight into the conditions for formation of the crater, and a means of testing if subsurface ice could have been released onto the surface as a result of the impact event.

References

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