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Lyot crater, Mars: preliminary mapping of glacial, fluvial and – perhaps – periglacial geomorphologies

M.R. Balme (1, 2), C. Gallagher (3) S. J. Conway (1) R. J. Soare (4)
(1) The Open University, Department of Physical Science, Walton Hall, Milton Keynes MK7 6AA, UK. Email **matt.balme@open.ac.uk**; Phone +44 (0)1908 659776 (2) Planetary Science Institute, 1700 E. Fort Lowell, Suite 106, Tucson, AZ 85719, USA. (3) School Of Geography, Planning & Environmental Policy, University College Dublin, Ireland (4) Department of Geography, Dawson College, Montreal, Canada.

1. Introduction

Lyot crater, Mars, is a relatively young (<3 Ga), deep (~ 7 km below Mars datum) impact basin situated at about 50°N, just north of the dichotomy boundary. The impact almost certainly penetrated the cryosphere, and would have exposed any groundwater zone existing beneath. Recent studies have linked large fluvial channels located outside Lyot's ejecta blanket with impact-release of groundwater or melting of ice [1], and small fluvial channels within the basin with much later climate-related events [2]. Thus the terrains in and around Lyot crater provide an ideal study area for (i) investigations aimed at exploring the sediments and volatiles excavated during impact, and perhaps a way of testing whether there *was* a groundwater zone, and (ii) studies of glacial and periglacial environments useful for understanding recent climate on Mars.

2. Method

We have used CTX (6 m/pixel) and HiRISE (25 cm/pixel) data to study Lyot Basin and its ejecta in detail. We have created a CTX mosaic that covers the whole basin, including the continuous ejecta blanket. We have used these data to begin a survey and mapping programme, aimed at exploring possible water- and ice-related process in this area.

3. Observations

We present preliminary mapping of probable ice- and water-related landforms in and around Lyot crater. Of particular interest are (i) a variety of channels with fan-like terminal deposits that appear to be associated with lobate 'glacier-like' flows at their source regions, and (ii) a variety of landforms that could be indicative of periglacial processes. These include polygonal fracture networks, 100m-scale basins linked by small channels (suggesting transfer of thaw fluids by 'tapping'), large regions dominated by meter-scale clasts with what appears to be some degree of sorting, and, finally, distinctive polygonal networks of metre-scale clasts.

The channel/fan-like deposits/lobate flow assemblages have been interpreted as glaciofluvial systems [2]. These assemblages are found both within the crater rim and in high relief areas outside the crater. Based on MOLA data, all the channels appear to have formed parallel to local slope and seem to have flowed downhill. All the terminal deposits appear to occupy local basins.

Of the putative periglacial landforms, the clastic polygons networks are the most distinctive. These networks are 100-200 m across and consist of lines of clasts (sometime double lines) with flat, low centre-regions (Figs. 1, 2). The networks of polygonal clast occur only within hummocky terrain on the margins of the continuous ejecta blanket, at a radial distance of about 300 km from the crater centre (Fig. 3). They are found only on the Eastern side of the basin, and extend in a broad swathe from about north-northwest to southwest of the crater. Their spatial distribution suggests strongly that they have a genetic link to the formation of the impact basin, or with a lithology specific to this part of the ejecta blanket. The clastic regions with limited sorting have a similar distribution, but occur further out from the crater centre, at the margin of the continuous ejecta.

Polygonal fracture patterns are seen in most of the study area and are associated with mantling deposits. They probably represent thermal contraction fracture polygons, as observed in other mid- to high-latitude regions on Mars [3]. We have found only one good example of a possible 'tapping channel' but have not exhaustively examined the continuous ejecta regions for this type of landform yet.

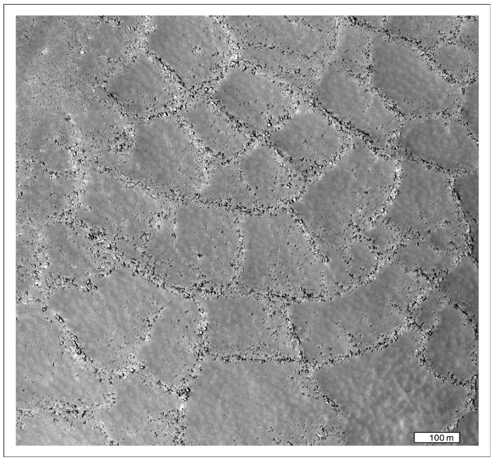

Fig. 1. Clastic network with high clast abundance in Lyot crater ejecta. Note scale bar. HiRISE image PSP_01789_2345.

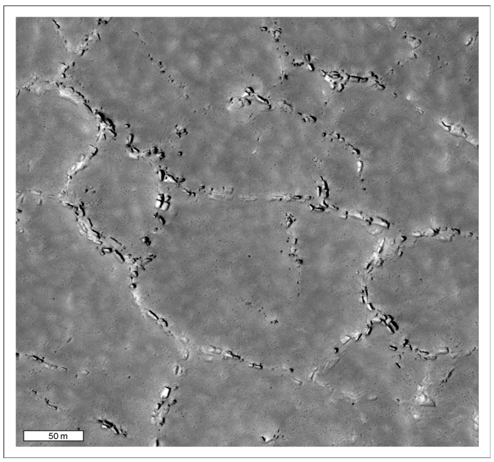

Fig. 2. Clastic network with fewer, more elongate clasts. HiRISE image PSP_01789_2345.

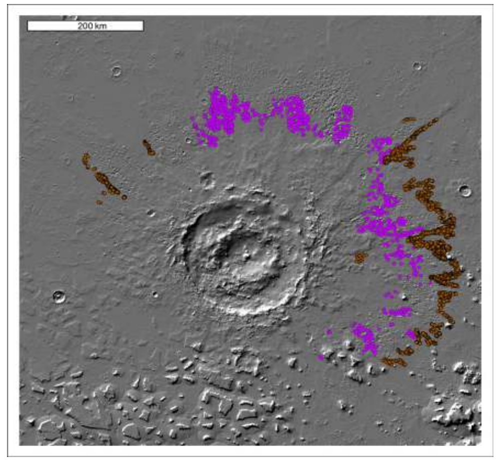

Fig. 3. MOLA hillshade map of Lyot crater showing the spatial distribution of the large clastic polygonal networks (pink dots) and the clast dominated surfaces that have little to no sorting (brown dots).

4. Conclusions

Our working hypothesis is that the glacial/fluvial assemblages are related to climate-controlled deposition of ice, with later flow and probably thaw as well. The same climate control probably applies to most of the periglacial landforms, but the polygonal clast network is harder to explain. The polygons are larger than sorted clastic landforms seen on Earth, and the spatial distribution is puzzling. If these are periglacial landforms, their distribution could reflect the location of water-ice-rich zones of the ejecta blanket. Hence, this could be material excavated from the cryosphere during impacts and then reworked by periglacial processes at a much later time. Alternatively, these could be structural features, formed within and the ejecta post-emplacement, and now exposed on the surface after erosion.

References

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